COLORADO DEPARTMENT OF HEALTH

Richard D. Lamm
Governor

Thomas M. Vernon, M.D.
Executive Director

STATE OF COLORADO, UNION CARBIDE CORPORATION
AND UMETCO MINERALS CORPORATION
URAVAN SUPERFUND AGREEMENT

The State of Colorado, Union Carbide Corporation and Umetco Minerals Corporation (a wholly-owned subsidiary of Union Carbide) have reached agreement on a plan to reclaim and cleanup the Uravan uranium mill in Uravan, Colorado.

This agreement, though signed by the parties, has not yet been approved by the court. On November 4, 1986 a 30-day public comment period began, during which time comments from the public concerning the settlement agreement will be welcomed. At the close of the public comment period, all comments will be presented to Federal District Judge Jim R. Carrigan for his review. Following the review, the settlement agreement will be finalized and submitted as an order of the court.

The agreement settles a "Superfund" suit brought by the State of Colorado for natural resource damages, state-incurred costs, and cleanup of the nearly 1.5 square mile uranium mill site. This suit, one of seven filed against various companies by the State in December, 1983 seeking natural resource damages, is the first of the seven to be resolved.

The agreement involves land and water conveyances and expenditures by Union Carbide and Umetco having an estimated value between $40 to $44 million. Moreover, the agreement entails no net cost, now or in the future, to the taxpayers of Colorado.

Under the agreement, Union Carbide and Umetco will perform remedial activities that the parties agree are appropriate to cleanup this site. Major elements of the work to be performed under this agreement include:

- o Reclamation of nearly 10 million tons of radioactive tailings (the by-product of uranium ore processing). This reclamation will involve placement of a 10-foot thick cap on existing tailings piles. The cap is designed to maintain the stability and integrity of the tailings containment system for thousands of years.

- o Construction of a state-of-the-art disposal system comprised of a series of independent clay pods. This system will be used to dispose of highly soluble radioactive crystals. This pod system is designed to withstand natural erosive forces for thousands of years.

B/1

- o Removal of more than 1.5 million cubic yards of solid waste generated by milling operations and presently situated in ponds along the San Miguel River. The waste will be place in secure disposal areas away from the river.

- o Placement of a seepage collection and groundwater cleanup program.

- o Implementation of a soil cleanup program in the mill, town, and adjacent areas.

- o Restoration of the San Miguel River Valley to its uses prior to contamination.

- o Reclamation and revegetation of areas disturbed by the removal, relocation and cleanup activities.

Accompanying materials include photographs of the site and drawings of pertinent design elements of the work to be performed under the agreement. Under this agreement, the State of Colorado has received $450,000 and will receive an additional $2.3 million from Union Carbide and Umetco as reimbursement for state-incurred costs, settlement of natural resource damage claims, and future State oversight of remedial activities.

The State will also receive:

- o Vested water rights in the San Miguel River held in trust to protect any member of the public whose water rights may have been injured by contamination.

- o A conveyance from Union Carbide and Umetco of senior non-consumptive water rights (i.e., power rights) to Colorado for the State's in-stream flow program which preserves the river's ecology.

- o A conveyance to Colorado from Union Carbide and Umetco, for transfer to the Nature Conservancy, of approximately 200 acres of pristine river bottom land for a cottonwood and willow tree nature preserve.

- o The opportunity, at Colorado's option, to utilize areas at the Uravan site for disposal of radioactive wastes from the Denver Radium Sites and the Colorado School of Mines, at no net cost to Colorado, for the acquisition of an appropriate site.

The agreement included in a proposed Consent Decree, has been made available for a thirty (30) day public comment period commencing November 4, 1986. Written comments regarding the Consent Decree and/or clean-up plan should be addressed to:

Mr. Thomas Looby
Director of Remedial Programs
Colorado Department of Health
4210 East 11th Avenue
Denver, CO 80220

Copies of the pending Consent Decree, which describes the agreed-upon remedy in detail, are available for public inspection at the locations listed below.

INFORMATION REPOSITORIES

Nucla Public Library
P. O. Box 63
Nucla, CO 81424
Telephone: 864-7664

Naturita Public Library
P. O. Box 466
Naturita, CO 81422
Telephone: 865-2848

Montrose Regional Library
Zerma Kinkel
434 S. First & Uncompaghre Street
Montrose, CO 81401
Telephone: 249-9656

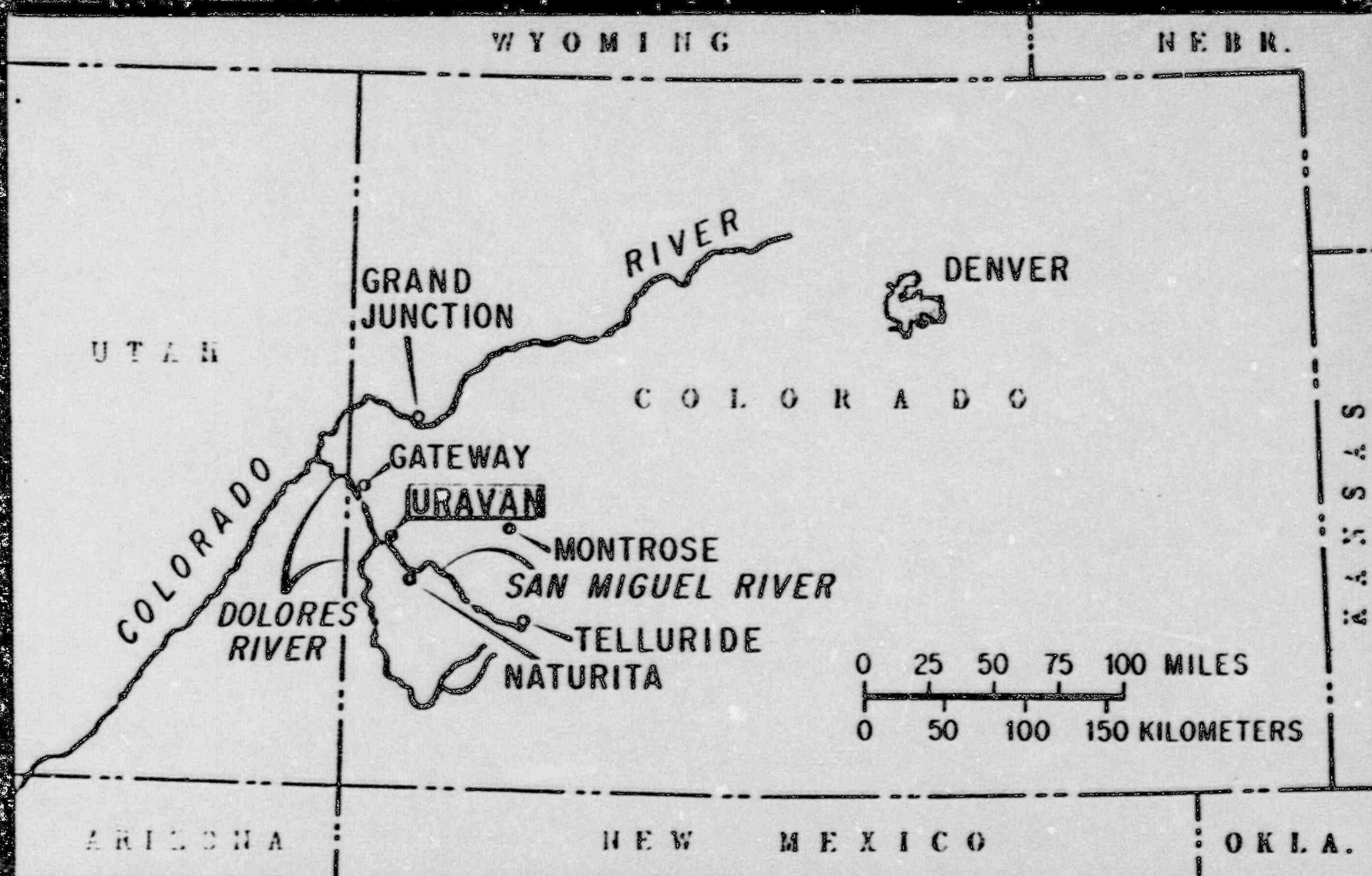
Mesa County Library
Terry Pickens
Reference Department
530 Grand Avenue
Grand Junction, CO 81501
Telephone: 243-4442

Denver Public Library
1357 Broadway
Denver, CO 80203
Telephone: 571-2000

Office of the Attorney General
CERCLA Litigation Section
One Civic Center Plaza
1560 Broadway, Suite 250
Denver, CO 80202
Telephone: 866-4343
866-4344

Colorado Department of Health
Office of Health Protection
4210 East 11th Avenue
Denver, CO 80220
Telephone: 320-8333

URAVAN LOCATION MAP




URAVAN URANIUM MILL SITE
URAVAN, COLORADO
ATKINSON CREEK
ATKINSON CREEK
CRYSTAL PILE
SPRING CREEK MESA
SAN MIGUEL RIVER
CLUB RANCH PONDS
TOWN DUMP
TOWN
RIVER PONDS
TAILINGS PILES 1 & 2
A-PLANT
SPRAY DISPOSAL AREA
B-PLANT
SLUDGE PILES
ORE STORAGE AREA
TAILINGS PILE 3
CLUB MESA

URAVAN WASTE CHARACTERISTICS

Solids	Components	Volume
Uranium Mill Tailings	radionuclides, heavy metals	10,000,000 tons
Neutralized Sludges	radionuclides, heavy metals	150,000 cubic yard
Contaminated Soils	some radionuclides, heavy metals	345,800 cubic yard
Raffinate Crystals	ammonia aluminum sulfate, some radionuclides, heavy metals, highly soluble	1,010,000 cubic yard

Liquids	Components	Volumes, Flow Rates
Ponded Raffinate	high total dissolved solids, heavy metals, radionuclides, ammonia	30,000,000 gallons
Tailings Liquid	" "	Unknown, 30 gpm
Hillside Seepage	" "	Unknown, 30 gpm
Contaminated Groundwater	" "	Unknown
Precipitation Runoff	total suspended solids	Calculated, Occasiona

URAVAN REMEDIAL ACTION PLAN MAJOR ASPECTS

- Zero Point Discharge to San Miguel River
- Groundwater Cleanup
- Soil Cleanup
- Tailings Pile Stabilization and Closure
- Cleanup of River Valley
- Waste Containment (No Releases)
- Monitoring (Long Term)
- Contingent Actions

URAVAN REMEDIAL ACTION PLAN - SOLIDS

RIVER VALLEY

Atkinson Creek Crystal Pile

- excavate to Burbank Crystal Repository

Club Ranch Ponds

- excavate crystals and soils to Burbank Crystal Repository

River Ponds

- excavate to Tailings Piles

Plant Area

- excavate contaminated soils to Tailings Piles

Town Area

- excavate contaminated soils and discrete tailings to Tailings Piles

Town Dump

- investigate and remediate as required

CLUB MESA

Tailings Piles 1,2,3

- three meters of cover on sides, allow settlement clay cover on top, place final rip-rap on top

Spray Evaporation Area

- remove crystals to Burbank Crystal Repository, clean-up contaminated soils and remove to Tailings Piles

Neutralized Sludge Piles

- remove sludges and contaminated soils to Tailings Piles

Mine Openings

- seal openings

Burbank Quarry/Crystal Repository

- excavate rip-rap for Tailings Pile cover, dispose crystals in engineered pods, and cover

URAVAN REMEDIAL ACTION PLAN - LIQUIDS

RIVER VALLEY

Contaminated Groundwater

- pumped from Club Ranch Pond area, disposed in lined evaporation ponds [45 acres] in the Club Ranch Pond area

Lined Evaporation Ponds

- 45 acres in Club Ranch Pond Area, leak detection, for evaporation of all contaminated liquids

Club Ranch Pond Liquids

- evaporated in-place

CLUB MESA

Hillside Seepage

- collected by improved [lined], expanded seepage collection system, disposed in evaporation ponds in River Valley

Tailings Pile Seepage
[Toe Berm]

- collected and disposed in evaporation ponds in River Valley

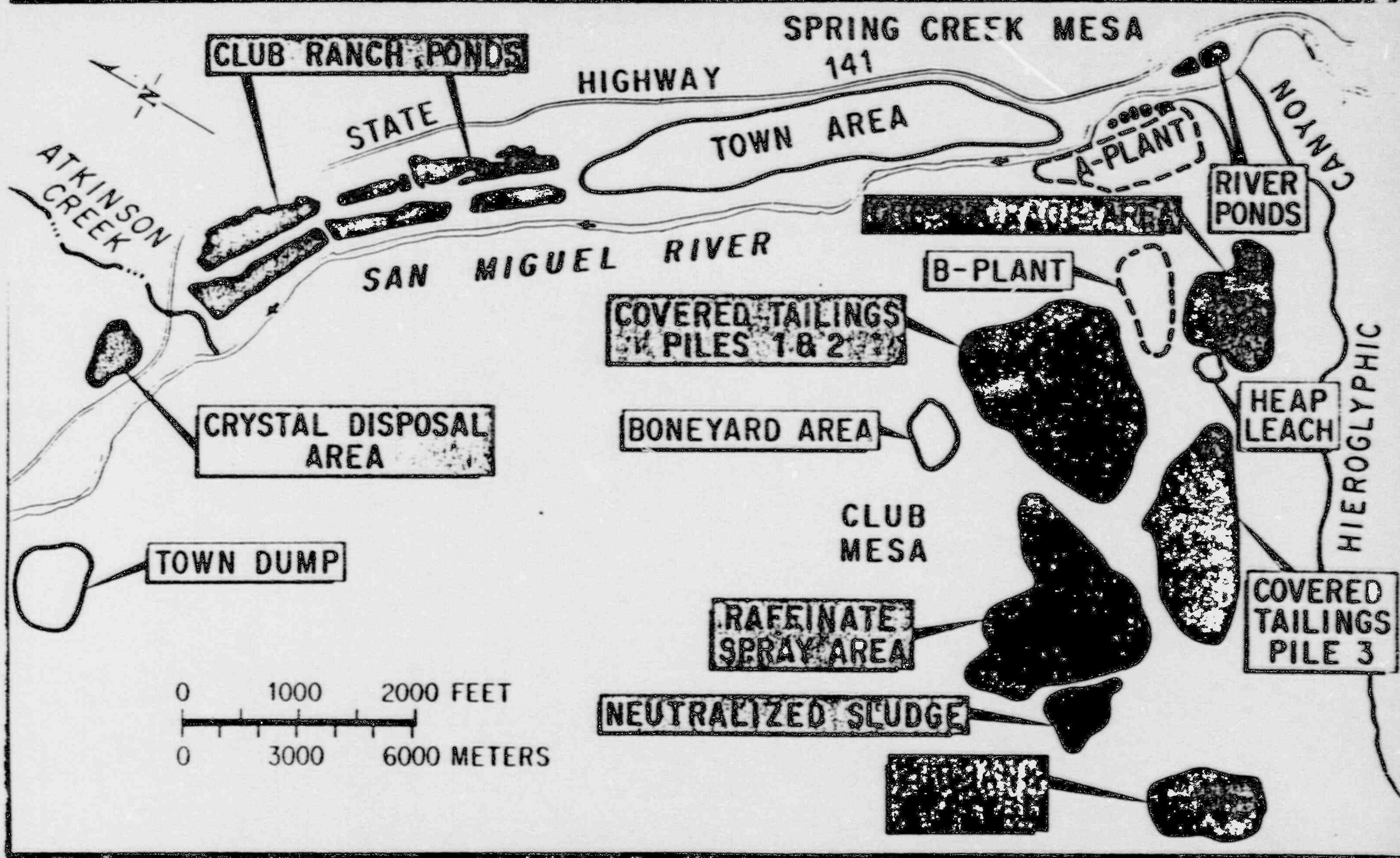
Tailings Dewatering Liquid

- pumped from dewatering wells to evaporation ponds in River Valley

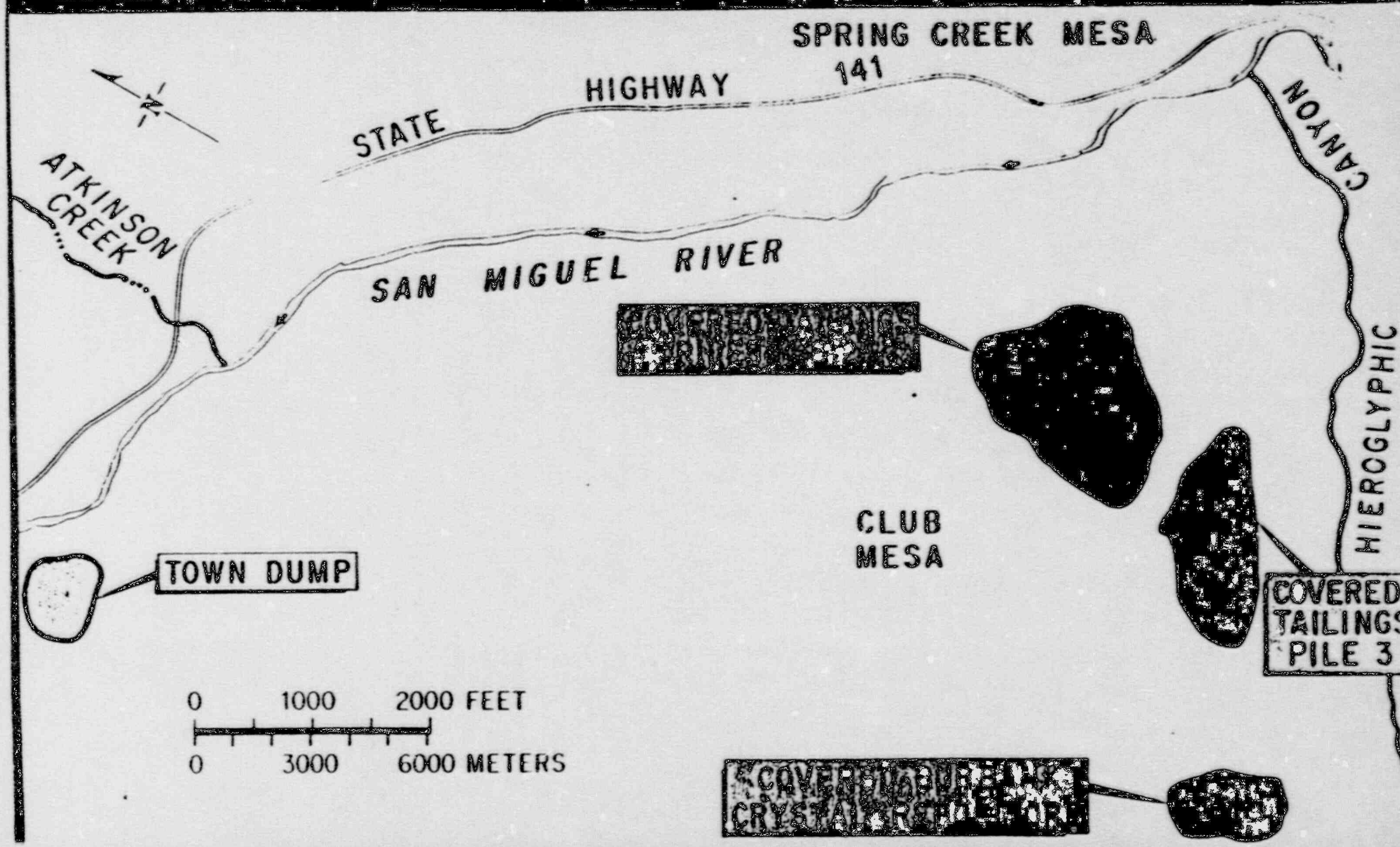
Surface Runoff

- collected in channels and routed to storm-water retention ponds

FEATURES AT THE URAVAN URANIUM MILL



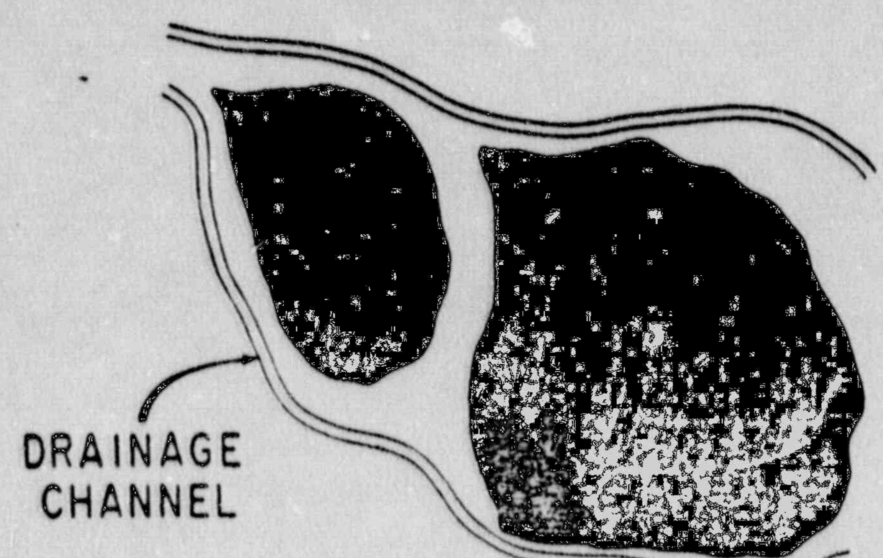
POST-REMEDIATION FEATURES AT THE URAVAN URANIUM MILL



TAILINGS PILE REMEDIATION

SLOPE COVER DESIGN, CROSS-SECTION

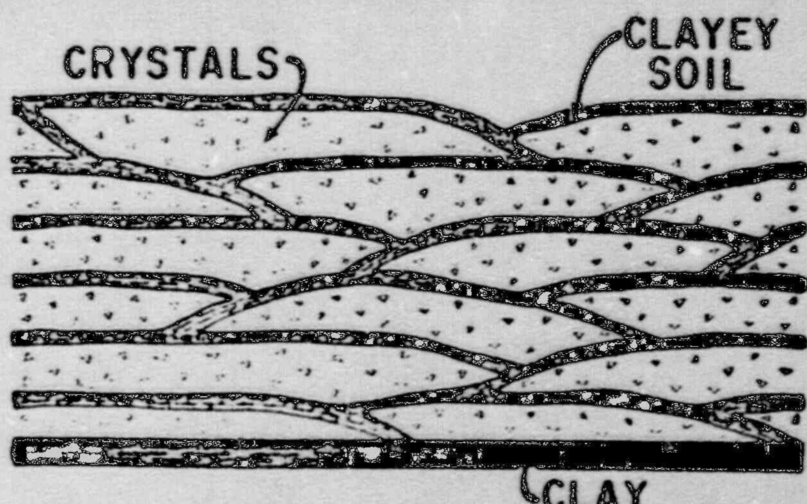
DRAINAGE CONFIGURATION



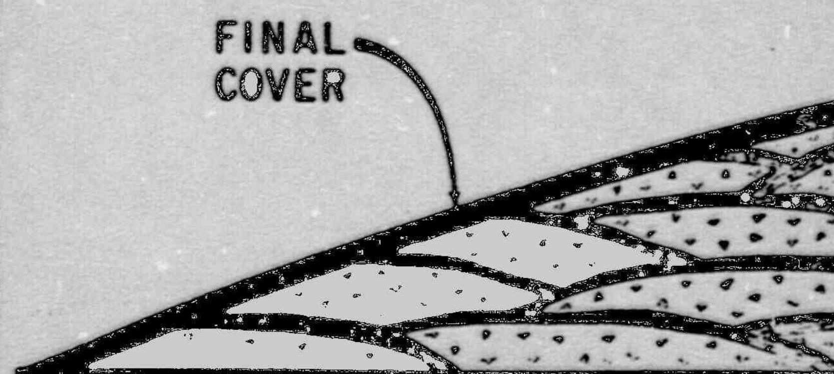
BURBANK CRYSTAL REPOSITORY

FINAL COVER DESIGN
CROSS-SECTION

CELL DESIGN
CROSS-SECTION



SITE CROSS-SECTION
FINAL SLOPE, CROSS-SECTION



COLORADO DEPARTMENT OF HEALTH
4210 EAST 11TH AVENUE
DENVER, COLORADO 80220

TO: Dennis Sollenberger

U.S. Nuclear Regulatory Commission

We are pleased to send the attached material in response to your recent request.

Please feel free to call on us any time we may be of further service.

'86 DEC 10 P2:11

WM DOCKET CONTROL CENTER

FROM: Albert J. Hazle, Director

DATE: December 2, 1986

Radiation Control Division

WM Record File 409.6

WM Project

Docket No.

PDR

LPDR ✓

Distribution:

Sollenberger Haisfield

DEM

(Return to WM, 623-SS)

COLORADO DEPARTMENT OF HEALTH
RADIATION CONTROL DIVISION

FINAL LICENSING STATEMENT
for the
URAVAN URANIUM MILL

owned by

UNION CARBIDE CORPORATION / UMETCO MINERALS CORPORATION

8907310114 346 pp

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COLORADO DEPARTMENT OF HEALTH

FINAL LICENSING STATEMENT

For Evaluation of the
Radioactive Materials License Applications and Environmental Reports

Submitted by
Union Carbide Corporation/Umetco Minerals Corporation
For the Uranium Mill at Uravan, Colorado

December 15, 1986

Albert J. Hazle, Director
Radiation Control Division

Kenneth L. K. Weaver
Uranium Recovery Unit Leader

URAVAN URANIUM MILL

FINAL LICENSING STATEMENT

1.0 INTRODUCTION

Umetco Minerals Corporation ("Umetco") has owned facilities at Uravan, Colorado since 1928, through its parent corporation, Union Carbide Corporation ("UCC"). Umetco and UCC are generally referred to as "UCC/Umetco" throughout this Final Licensing Statement.

This Final Licensing Statement ("FLS"), written by the staff of the Radiation Control Division (the "Radiation Division"), Colorado Department of Health (the "Department"), presents a brief description of the Uravan facility, a description of the review and hearing process, and a summary of health and environmental issues which have been addressed.

Colorado Radioactive Materials License No. 660-02S, signed December 19, 1986, accompanied by this Final Licensing Statement, constitutes the Department's final licensing decision.

This FLS was based on review of numerous documents, including the updated Radioactive Materials License Application, the updated Environmental Report, and other technical reports. Adjudicatory-style public hearings were held at Nucla, Colorado August 21-22, 1984 and November 19-20, 1984. The formal record closed December 17, 1984. The record was reopened October 31, 1986 through December 4, 1986 to receive comments on supplemental information.

All documents and records pertaining to this action are available at:

Room 355
Colorado Department of Health
4210 E. 11th Avenue
Denver, CO 80220.

For additional copies of this FLS or for further information, please contact Ken Weaver, Principal Health Physicist, Radiation Control Division at (303) 331-4800.

2.0 Brief Project Description

The Uravan uranium site, controlled by Umetco Minerals Corporation, Inc., a wholly-owned subsidiary of Union Carbide Corporation, is located approximately 90 miles southwest of Grand Junction, Colorado, along State Road 141 in Montrose County within the canyonlands section of the Colorado Plateau. The mill is situated along the canyon of the San Miguel River and recovered uranium and vanadium from ores mined underground in the Uravan Mineral Belt. Figures 2-1 and 2-2 show the regional setting and local vicinity.

The mill facility is divided into two parts. The B Plant is located on a canyon plateau bench where Hieroglyphic Canyon joins the San Miguel River. Ore arrived by truck and was placed either in a storage bin or selected stockpile. At the B Plant the ore was crushed, ground and leached by acid. The tailings disposal areas and raffinate spray evaporation were located southwest of the B Plant on the plateau.

The A Plant is directly below the B Plant on the canyon floor beside the river and adjacent to the town of Uravan. Uranium-vanadium separation by ion exchange and solvent extraction, product drying and packaging, and maintenance work occured at the A Plant.

Figure 2-3 is a flow chart of the mill process for reference throughout this FLS (00-780831:3-7).

The town of Uravan, extending in both directions along the river from the mill, is also UCC/Umetco property. Uravan was a housing complex for company workers and contained other facilities such as a boarding house, store, elementary school and recreation hall.

New disposal of uranium tailings and waste liquids was proposed across the San Miguel River on Spring Creek Mesa (U-18 tract). Details and the State's decision are in Section 5 of this FLS.

For reference throughout this FLS the uranium radioactive decay series is presented here as Figure 2-4. A detail of the radon decay scheme is presented as Figure 2-5.

Sections 4 and 5 provide more detailed description of the project and site. Cleanup and reclamation for all UCC/Umetco property at Uravan are described in the Remedial Action Plan incorporated as LC 11.1 in the new Radioactive Materials License 660-02S.

Figure 2-1 REGIONAL SETTING

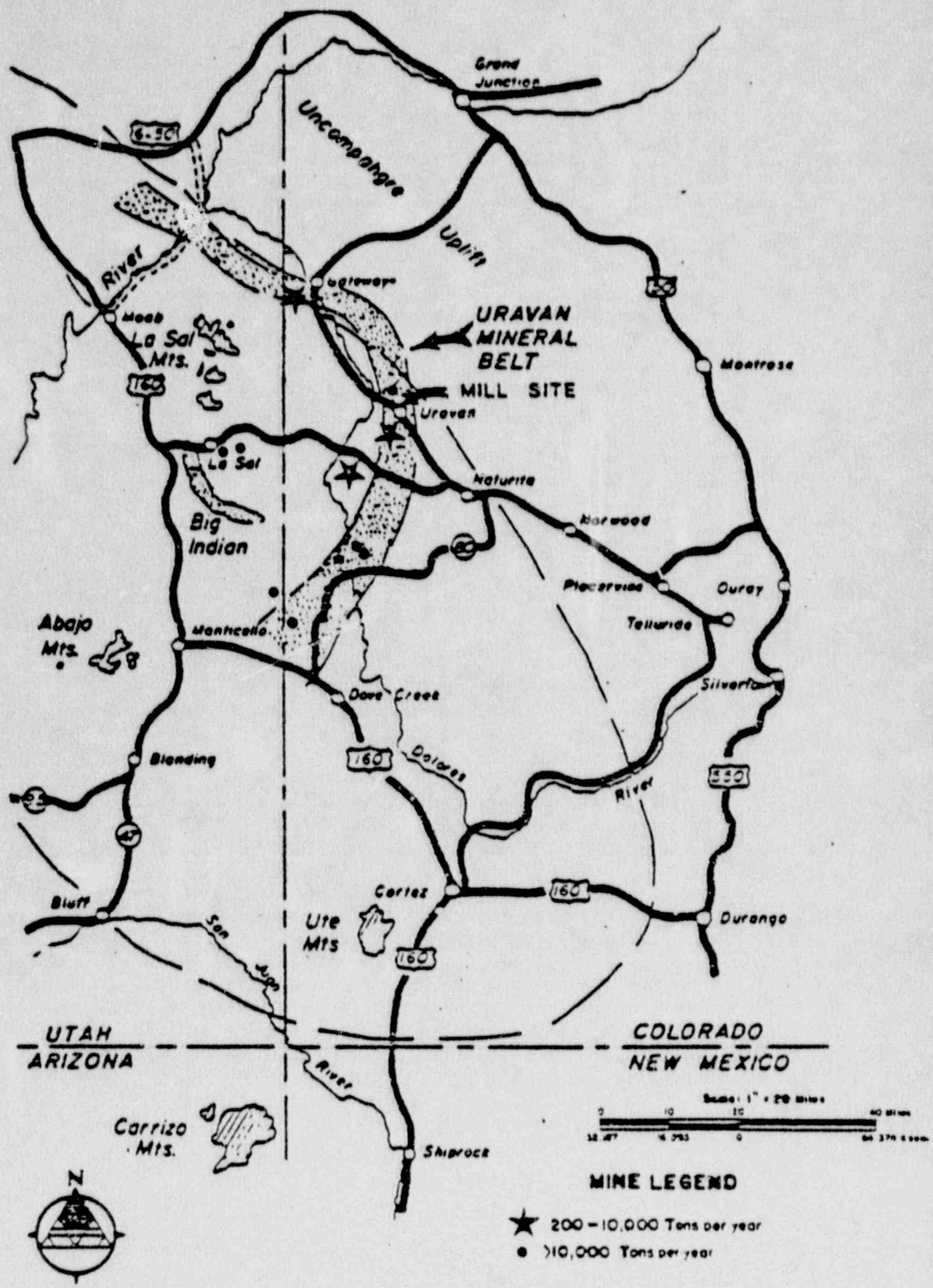


Figure 2-2 SITE VICINITY

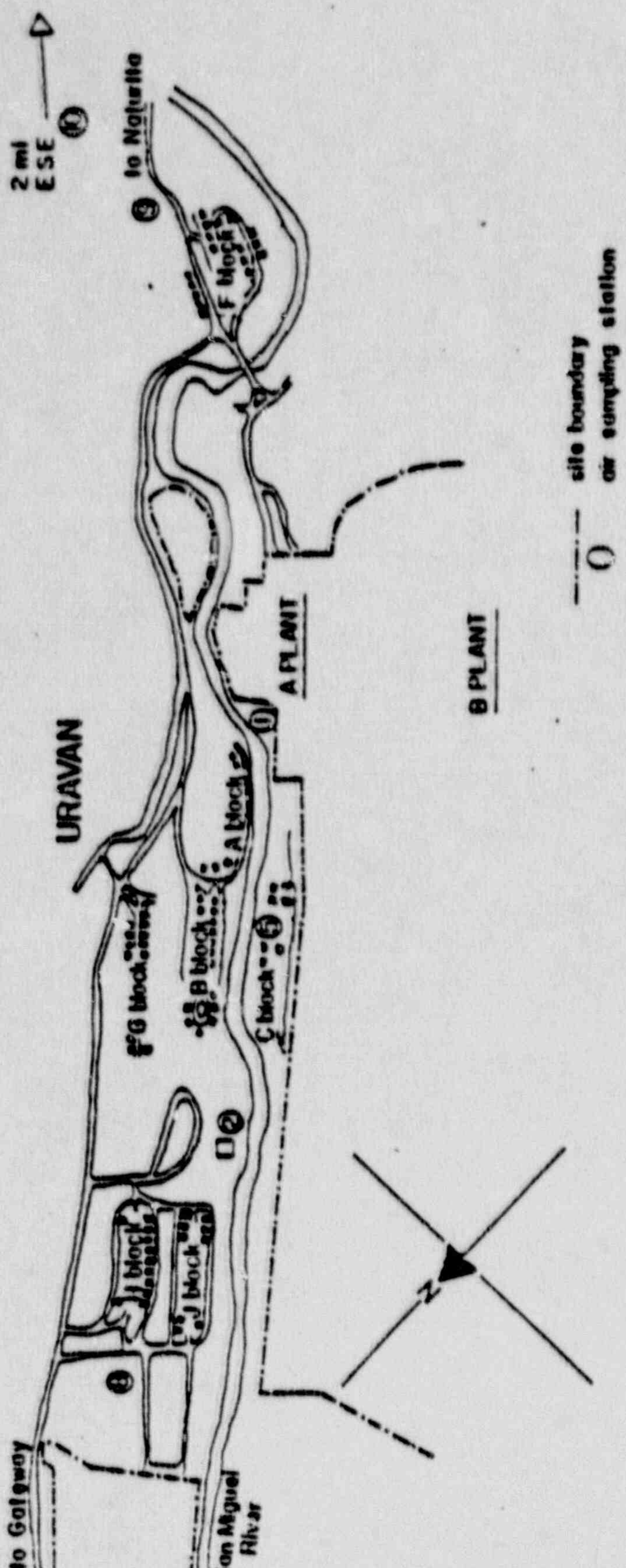


Figure 2-3 MILL PROCESS

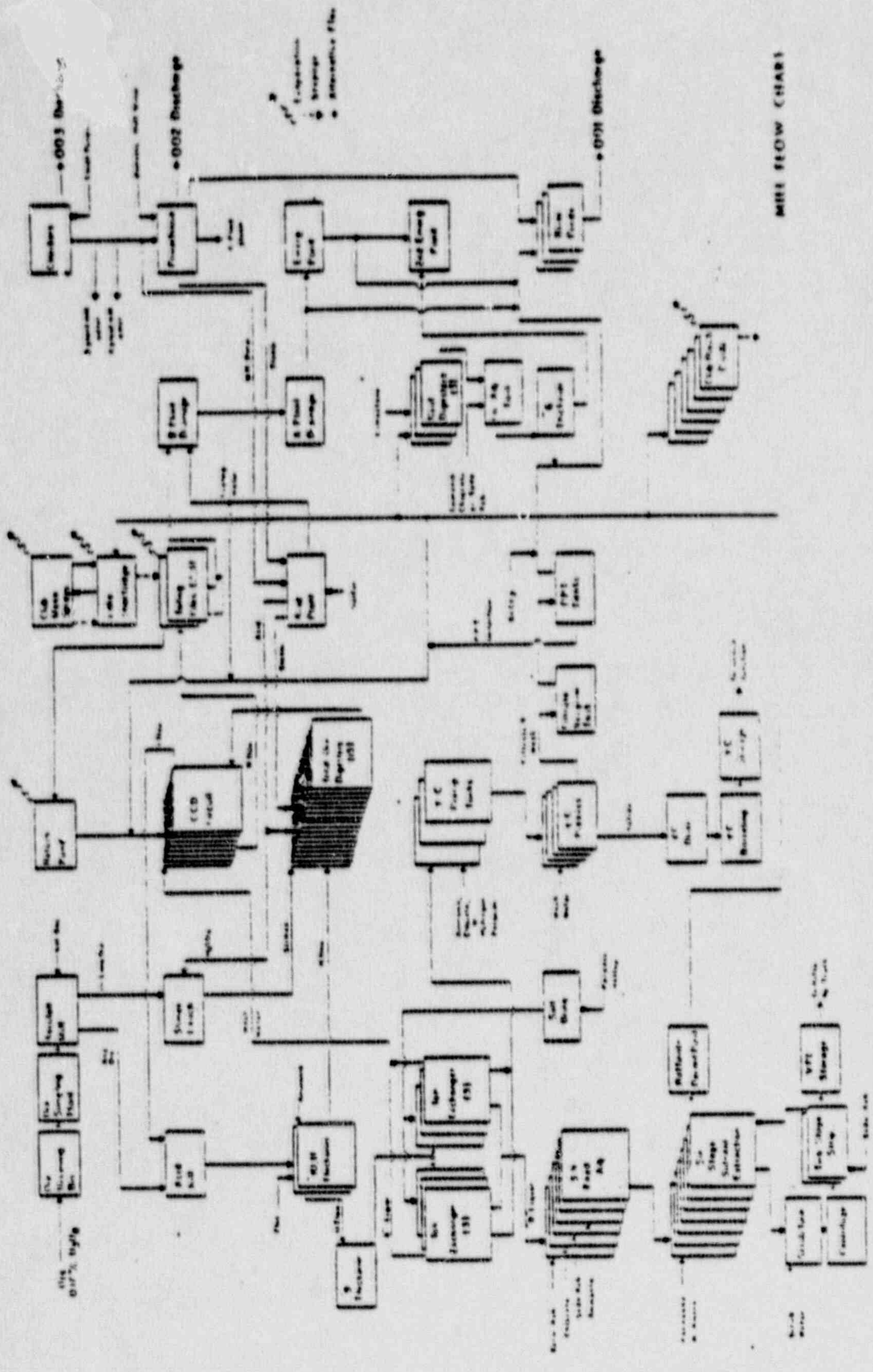
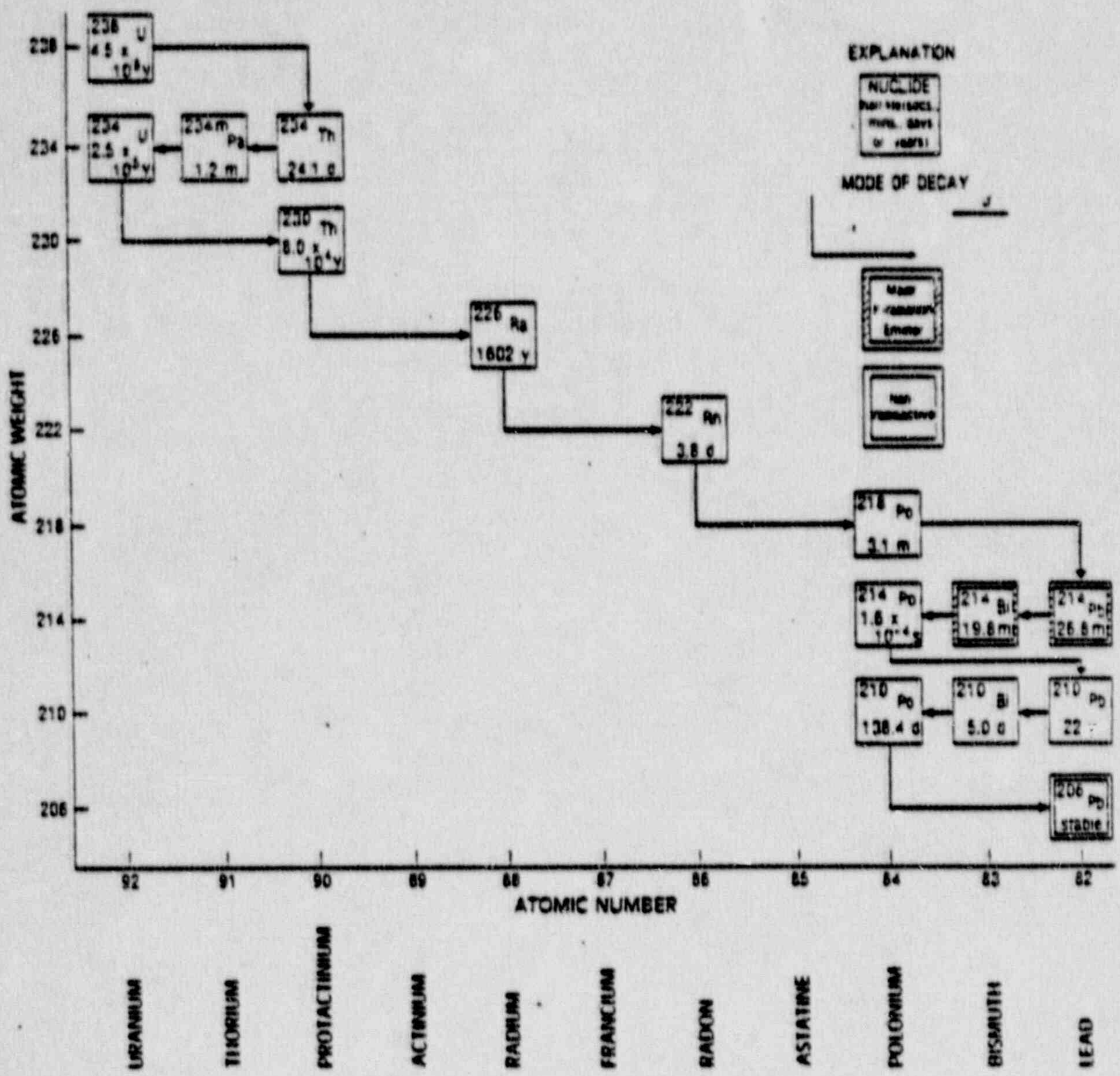
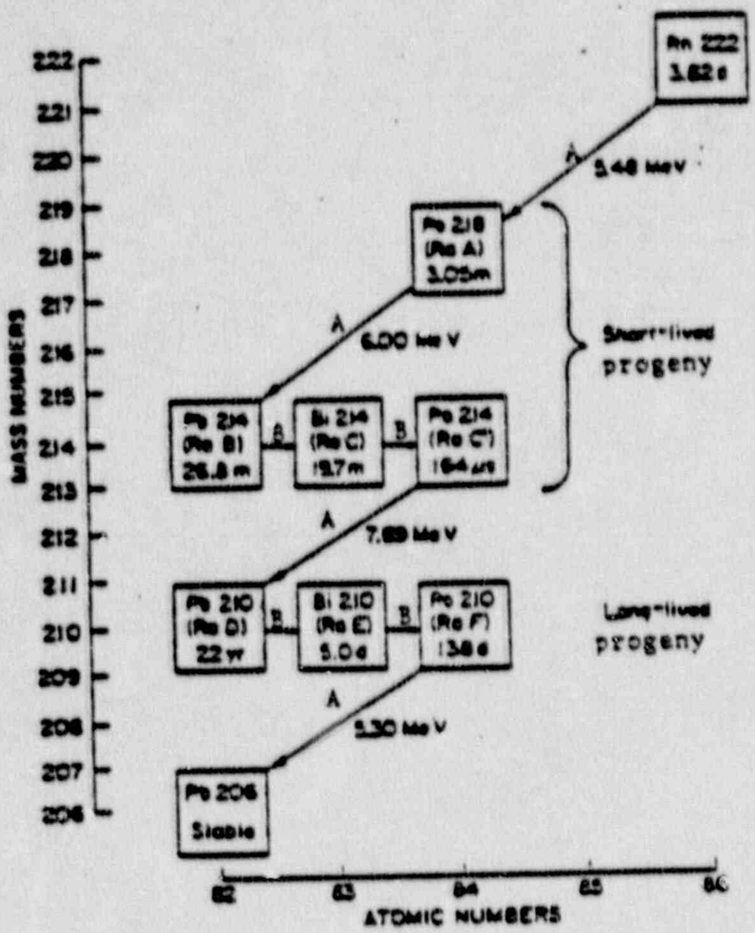


Figure 2-1 URANIUM DECAY CHAIN



The radioactive decay scheme of uranium-238. Only dominant decay modes are shown.

Figure 2-5 RADON DECAY SCHEME



Half-life Values

us=microseconds
m=minutes
d=days
y=years

Type of Decay

A=alpha particles
B=beta particles

Energy of alpha particle emission is expressed in mega electron volts (MeV).

3.0 SUMMARY OF EVALUATIONS BY LOCAL, STATE, AND FEDERAL AGENCIES

To resolve issues and obtain additional information required participation of many agencies. Site visits by staff members of the State Departments of Health and Natural Resources were made. Review correspondence is on file at the Radiation Division. Much of this correspondence is listed by agency in Section 11 of this FLS.

3.1 LOCAL AGENCIES

Local agencies participated in review of the project with respect to impacts to local services, environmental impacts, benefits and costs to the affected counties.

3.1.1 The Montrose County Board of Commissioners reviewed land uses and endorsed license issuance.

3.1.2 The Town of Naturita Board of Trustees passed a resolution supporting the mill license renewal application and encouraging license issuance.

3.1.3 Town of Nucla representatives participated in numerous discussions.

3.2 STATE AGENCIES

For the State of Colorado, the Department of Health has sole authority for the issuance of the Radioactive Materials License. The mill operator must also obtain several other State permits. During the review of the radioactive materials license application, numerous State agencies have served as sources of information on hazard potential, dam construction and stability, natural resources protection, and socioeconomics, and have provided comments on the license application, the environmental report, and supporting documents.

3.2.1 Colorado Department of Health (the "Department")

The Air Pollution Control Division (APCD) provided memoranda relating to air pollution from construction and operation.

The Water Quality Control Division (WQCD) analysed impacts on ground and surface waters. Contamination of surface and ground waters by seepage from the tailings and evaporation ponds was reviewed thoroughly by an independent consultant in cooperation with Water Quality Control Division members of the Technical Review Committee. Numerous changes to the proposed water management and water monitoring programs had review and concurrence by WQCD staff.

The Radiation Control Division, Denver Radiation Control Section evaluated radiological and other impacts to the human environment during and after mill operation. The applicant's proposals for mill decontamination, decommissioning and reclamation of the tailings and residue areas were carefully evaluated using the criteria in the State of Colorado "Rules and Regulations Pertaining to Radiation Control", 6 CCR 1007-1-1 *et seq.* (see Section 10 of this FLS).

Attention was given to workplace radiation protection and monitoring. Requirements for the radiological monitoring of air, water, soil, plants, animals and persons have been established by conditions of licensure prepared by the Radiation Division staff.

The Radiation Division coordinated the evaluation of all agency and public comments. The Radiation Division recommended the final Department licensing decision.

The Hazardous Materials and Waste Management Division evaluated mill site and waste disposal alternatives and recommended license conditions relating to additional seepage control methods, decontamination and reclamation standards, and facility ground water monitoring. In addition, the Division worked with Montrose County in determining Certificate of Designation status.

The Laboratory Division, Chemistry Section reviewed the environmental report and the license application with regard to chemical processes and hazardous materials.

3.2.2 Colorado Department of Natural Resources

The Colorado Geological Survey evaluated the geological, geohydrological and seismic aspects of the project. Extensive geologic review of tailings impoundment alternatives was made. Numerous site visits were conducted.

The Division of Water Resources (State Engineer) reviewed surface and ground water rights and approved well permit applications. The Dam Safety Branch reviewed the proposed tailings dams for compliance with the "Colorado Rules and Regulations for the Construction of Dams".

The Division of Wildlife was consulted on those portions of the environmental report which address potential effects on local wildlife and wildlife habitats from the mill, primarily the new disposal areas.

The Mined Land Reclamation Division reviewed the reclamation program for the tailings disposal area. As the proposed mill is not associated with a mine, the Mined Land Reclamation Board does not have direct jurisdiction over reclamation of the site but issues necessary permits for quarrying operations.

The Division of Mines commented on the application with respect to safety and the safe handling of hazardous chemicals.

3.2.3 Colorado Department of Law

The Office of the Attorney General (AGO) reviewed legal aspects of the applicant's project, and evaluated the reclamation and long-term care financial assurance agreements between UCC/Umetco and the Department. The Uravan Consent Decree and Remedial Action Plan were negotiated by the Department of Law. The Findings of Fact, Conclusions of Law and Order in Section 6 of this FLS were prepared in conjunction with the AGO.

3.2.4 Colorado Department of Local Affairs, Division of Local Government commented on socioeconomics.

3.2.5 The Colorado Department of Highways reviewed impacts to regional secondary roads occurring as a result of ore and mill product hauling.

3.2.6 Colorado Historical Society

The Office of the State Historian and the State Archaeologist studied the project's potential effect on archaeological sites, particularly the proposed new disposal area, and reviewed the archaeological evaluation submitted by the applicant for significance.

3.3 FEDERAL AGENCIES

Since February 1, 1968 the State of Colorado has held licensing authority for uranium mills. On April 20, 1982, Colorado signed an amended agreement with the U.S. Nuclear Regulatory Commission (NRC) continuing full authority for uranium mills, as required by the Uranium Mill Tailings Radiation Control Act of 1978 (PL 95-604).

Although the NRC has transferred its authority to the State of Colorado, its technical expertise was obtained to address certain aspects of the proposed project. Other federal agencies reviewed and commented on the application and the environmental report at the specific request of the Department.

3.3.1 U.S. Nuclear Regulatory Commission (NRC)

The NRC performed a radiological assessment of past operations and an evaluation of the tailings management site and system.

3.3.2 U.S. Environmental Protection Agency (EPA)

The EPA reviewed and commented extensively on environmental monitoring programs, tailings disposal, phasing of final reclamation plans, mill safety, mill emissions levels, monitoring and control, and off-site radiological and chemical impacts.

3.3.3 U.S. Bureau of Land Management (BLM)

BLM controls parts of the licensed site, town, and adjacent impacted lands.

3.3.4 U.S. Mine Safety and Health Administration (MSHA)

MSHA, in the Department of Labor, reviewed tailings dam stability aspects of in-place reclamation of the existing impoundments and reviewed the proposed tailings cell design for Spring Creek Mesa.

SAFETY EVALUATION

TABLE OF CONTENTS

4.1 PROTECTION OF HEALTH AND SAFETY AT URANIUM MILLS

The regulatory framework for a uranium mill is a combination of formal requirements in law, rule and license condition which bind the licensee to employ sound practices and meet applicable standards.

The Radiation Control Division ("Radiation Division") uses two basic approaches to radiation protection.

First, minimum standards for protecting workers and the public have been adopted by the federal and state governments and are to be met by all users of radioactive material. These standards are recommended by two expert groups, the International Commission for Radiation Protection and the National Council on Radiation Protection and Measurements. Among the standards are annual limits for radiation dose (in rem) and maximum permissable concentrations (MPCs) of radionuclides in air and water for both worker and off-site environments.

Second, to provide additional protection for workers and nearby residents, the Radiation Division uses the principle that any unnecessary exposure to radiation is to be avoided. This is called ALARA, which stands for "As Low As Reasonably Achievable", and is a matter of technical judgement. Cost may be a consideration in matters pertaining to ALARA.

The tiering of these standards is discussed in detail in Section 5.5 of this FLS.

The basic goal is that every reasonable effort be made by the licensee management to keep exposures and releases as far below specified limits as possible. This is done by good planning and practices, as well as by discouraging any departure from good practices. The same basic goal and standards apply whether during operations or reclamation activities, as reflected by this FLS.

The Radiation Division recommends, as general background reading for the interested members of the public, the International Atomic Energy Agency publications listed in Section 11 (30-760000-01; 30-760000-07) under General References and the U.S. Nuclear Regulatory Commission (NRC) guides, in particular NRC Regulatory Guides 4.14 (31G-800400) and 8.30 (31G-830619), for evaluating health, safety and environmental protection at conventional uranium milling facilities. Regarding worker safety as discussed in this Section 4, NRC published a summary document, "Occupational Radiological Monitoring at Uranium Mills" (NUREG/CR 3598) in February 1984 (31G-840200).

4.2 SCOPE OF HEALTH, SAFETY AND ENVIRONMENTAL REVIEWS

4.2.1 The safety review of the licensee's previous Uravan operations, which may be found in the Department's May 22, 1984 Preliminary Executive Licensing Review Summary (PELRS, 00-840522) and which is incorporated here by reference, included evaluation of:

4.2.1.1 LC 11.2, Procedures Manual for Plant Operations at Uravan, dated March 31, 1982, revised as of February, 1984 (00-820331-05), with an addition October 24, 1984 to describe in-plant monitoring during the indefinite shutdown;

4.2.1.2 LC 11.4-1, Procedures Manual for Environmental Monitoring at Uravan, dated March 31, 1982, revised as of February, 1984 (00-820331-04);

4.2.1.3 Environmental Report, submitted by UCC August 31, 1978, (00-780831) and Updated Environmental Report, revised in full March 31, 1982 (00-820331-13);

4.2.1.4 Radioactive Materials License Application, submitted March 31, 1982 (00-820331-01).

4.2.2 Compliance correspondence and the compliance inspection history were reviewed. Notable were visits of November 1979, November 16-20, 1981, April 12-14, 1983, July 1984, August 1985, and July 1986.

4.2.3 Numerous meetings to discuss unresolved issues are documented in Department files.

4.2.4 This Safety Evaluation was based upon the State of Colorado "Rules and Regulations Pertaining to Radiation Control" (the "Radiation Rules"), and upon Department and U.S. Nuclear Regulatory Commission (NRC) regulatory policy and guides.

Specific provisions of the Radiation Rules are abbreviated in this text as 6 CCR 1007-1- x.y.z, e.g. , 6/CCR/1007-1- 1.6 "Definitions".

LC 11.x refers to a given document in License Condition (LC) 11, the license proposals and commitments "referenced documents" condition in the Radioactive Materials License. Subsections are added either as "-y", e.g. LC 11.2-29 for LC 11.2, subsection 29, or as "-y(z)", e.g. LC 11.4-1(30) for LC 11.4-1, Subsection 30.

Much of this Section was prepared by Mr. Edd Kray from an earlier draft by Mr. Dennis Brown.

4.3 AUTHORIZED ACTIVITIES

4.3.1 Historical Background

Mineral recovery operations began at the Uravan site in 1915 when the Standard Chemical Company began processing ores for the recovery of radium. In 1928, the U.S. Vanadium Company, a Union Carbide Corporation (UCC) subsidiary, purchased the site and by 1936 was milling for vanadium. Uranium and radium were at that time discarded with the tailings. The associated townsite originating at this time was named Uravan.

In the early 1940's, the U.S. Army Corps of Engineers undertook efforts to recover uranium from the tailings. This activity continued until 1945 when, at the war's end, the need of the Manhattan Project for uranium ceased. The mill resumed activity in 1948 in response to buying by the U.S. Atomic Energy Commission (AEC) and operated until November 15, 1984. Since November 1984 the mill has been on indefinite shut down, "stand-by" status.

Licensing of the mill site began in 1948 with the issuance of a Radioactive Materials License by the AEC. The old number was changed in 1963 when the AEC issued the original SUA-673 license to UCC. On February 1, 1968, after seven amendments by the AEC, jurisdiction was transferred to the State of Colorado pursuant to an Agreement with NRC.

Since 1968, Amendments 8 through 23 have been issued to UCC or Umetco. Radioactive Materials License SUA-673 expired July 31, 1975. In compliance with the Radiation Rules, Union Carbide applied for renewal June 20, 1975, more than 30 days prior to the expiration date, and continues to operate under a valid license pursuant to the "timely renewal" provision of the Radiation Rules. Between 1975 and 1986, License SUA-673 was periodically updated with respect to operations, while cleanup and reclamation plans remained under negotiation.

By letter dated March 31, 1982, UCC submitted, at the request of the Department, an updated application for renewal of a radioactive materials license to possess and use source materials at their existing mill in Montrose County. On April 2, 1984, Umetco Minerals Corporation was formed by UCC. Amendment 20 was issued effective upon the transfer to Umetco, although financial assurance arrangements remain unchanged pending renewal action.

Amendments 21, 22, and 23 to License SUA-673 were issued subsequent to the close of record on this licensing action. Amendment 21 approved modified procedures for non-operating periods. Amendment 22 required an irrevocable letter of credit for financial assurance. Amendment 23 authorized construction of two lined waste cells. Amendment 22 was appealed in total. Amendment 23 was appealed in part. New license 660-02S, Section 7 in this FLS resolves all appeals of Amendments 22 and 23.

This safety evaluation is a key part of the review and continual updating of the radioactive materials license. This review was used in redrafting the license to reflect compliance history, current status, and current procedures.

4.3.2 Facilities Description and Authorized Limits

4.3.2.1 Description

The overall layout of the town and mill is shown in Plate 2.1-3 of the licensee's updated Environmental Report (00-820331-13). The close proximity of the town and mill is primarily a function of the historical growth of the town and its ancillary facilities.

The licensed Uravan Facility, as defined in the Consent Decree, to which reference is made in LC 11.1, encompasses more than 806 total acres including 79 acres of tailings disposal, 85 acres of effluent ponds and over 640 other acres including the mill and ore storage areas.

4.3.2.2 Authorized Limits

LC 8.0 authorizes possession, storage and use of natural uranium and associated decay products in the following forms and maximum amounts:

- Milling residues: Currently 12,500,000 dry tons (11,000,000 metric tonnes)
- Milling refuse: unspecified quantities
- Uranium Concentrate Liquors currently stored on site: 4,100,000 gallons
- Uranium Product Concentrates currently stored on site: 333,512 pounds

4.3.3 Former Operations

The former process, including flow sheets (See Figure 2-3) is described in Updated Environmental Report, Section 3 and plates 3.2-1 through 3.2-3. (00-820331-13)

The Uravan operations consisted of a conventional hot sulfuric acid leach processing plant, featuring a two-stage circuit and separation of the "pregnant" liquor from tailing through a counter-current decantation circuit. Uranium was recovered and isolated from the pregnant solution by ion exchange. The uranium was precipitated as sodium or ammonium diuranate and calcined to U_3O_8. The remaining pregnant vanadium solution then progressed through a solvent extraction circuit producing a vanadium solution concentrate. During normal operations, the mill processes 1500 tons (1,350 metric tonnes) of ore and produces 5100 pounds (2300 kg) of uranium concentrate and 20-25,000 gallons (8×10^4 liters) of vanadium concentrate per day.

The B-plant, situated on the benches of Club Mesa above where Hieroglyphic Canyon joins the San Miguel River Club Mesa, included ore storage, grinding and tailings disposal, the spray evaporation system, the sulfuric acid plant, and the process extraction up to and including the counter-current decantation step.

The A-plant, situated along the San Miguel River, included the solvent extraction, ion-exchange, yellowcake precipitation and drying facilities, the power plant, process water clarification, radium removal, settling ponds, Club Ranch evaporation ponds, laboratory shops, warehouses and offices.

4.4 FACILITY ORGANIZATION AND ADMINISTRATIVE PROCEDURES

4.4.1 MANAGEMENT ORGANIZATION

Umetco Minerals Corporation (Umetco) was established March 6, 1984 as a Delaware corporation. On April 2, 1984, Umetco, a wholly-owned subsidiary of Union Carbide Corporation, incorporated the former UCC Metals Division.

4.4.1.1 Description

An organizational chart indicating hierarchy under UCC's Metals Division is included in LC 11.2-1. Revisions were submitted by Umetco in March 1984 and November 1986.

Further information is documented in LC 11.2-13 describing the ALARA program. It is therein stated that radiation control policy is established by the "manager of occupational health", coordinated through the "operations group" and applied by the individual at the facility in charge of environmental control, industrial hygiene, and radiation monitoring.

UCC/Umetco states that the radiation safety officer (RSO) shall establish radiation control policy in regards to the ALARA program (LC 11.2-3). Coordination of policy shall be accomplished by the Director or the manager of occupational health through division and plant operation management. Division and plant management are responsible for the coordination of division policy. The plant superintendent is responsible for approval and adherence to procedures for operation of the plant in reference to the ALARA concept.

4.4.1.2 Evaluation

Details, including the authority and responsibility of each level of management in regard to development, review, approval, implementation and adherence to operating procedures, radiation safety programs, routine and non-routine maintenance activities, and changes in any of the above should be documented in LC 11.2. LC 18.5 requires an annual update of management assignments.

4.4.2 RADIATION SAFETY STAFF

4.4.2.1 Authority and Responsibilities

4.4.2.1.1 Description

The radiation safety officer (RSO) is head of the radiation safety staff at Uravan and as such is responsible for the development of and adherence to radiation safety procedures. The duties of the RSO are described in LC 11.2 within section 13 dealing with the ALARA (As Low As Reasonably Achievable) policy.

The duties assigned the RSO include: implementing the ALARA policy; the authority, in conjunction with the appropriate level of management, to halt any operation deemed unsafe; assuring necessary equipment is available, well maintained and properly used; investigating unusual exposures, recommending remedial actions if necessary and documenting corrective actions; reviewing and approving operating and maintenance procedures related to radiation safety prior to their instigation; preparing and/or reviewing of reports dealing with radiation safety; and on-the-job counseling regarding radiation safety.

Plant operations management is assigned responsibility for several facets of radiation safety in LC 11.2-13. The plant superintendent is responsible for approval and adherance to procedures for operation of the plant in reference to the ALARA concept as well as deciding what actions are to be taken in cases of unusual exposures.

No mention is made of other members of the radiation safety staff, their numbers, qualifications or responsibilities.

4.4.2.1.2 Evaluation

Although duties of the RSO are listed in LC 11.2-13 in connection with the ALARA Program, a more comprehensive explanation of the radiation safety staff is needed for adequate evaluation. A listing of all members of the staff, including technicians, together with a full listing of their responsibilities is necessary. Procedures presently in force leave some confusion regarding overlap between responsibilities of the RSO and the plant superintendent. LC 11.1 will address the RSO/mill manager relationship. The RSO will have authority to immediately halt any activity deemed unsafe without consultation with other management. LC 19.1.2 requires this.

4.4.2.2 Qualifications

4.4.2.2.1 Description

UCC/Umetco's minimum qualifications for the RSO position are set forth in the 1978 Environmental Report (00-780831), Section 6.4.1.2. The qualifications include a B.S. degree in environmental engineering or related scientific fields or equivalent education, two to five years experience related to industrial hygiene and/or radiation control, and one month training in practical radiation control or six months in actual uranium mill radiation control experience.

4.4.2.2.2 Evaluation

The minimum qualifications for the RSO generally meet Department and NRC guidelines as set forth in NRC Regulatory Guide (RG) 8.31. In addition to the qualifications listed by the licensee, it is necessary for the RSO to attend refresher training on uranium mill health physics every two years; LC 14.5 so requires.

Minimum qualifications for health physics technicians and other members of the radiation safety staff are not defined within referenced documents as required. Proposed LC 14.6 requires specification of minimum qualifications in LC 11.2.

4.4.3 ADMINISTRATIVE PROCEDURES

4.4.3.1 Description

The decision making process on the administrative level is described by the "organization chart" in present LC 11.1-2 and in LC 11.2-13, "ALARA Program".

Routine operating procedures are described within UCC/Umetco's two Procedures Manuals, LC 11.2 and 11.4-1. The manuals detail health and safety procedures for radiological protection, describe monitoring and reporting procedures, explain employee training programs for radiation safety, and detail emergency response plans.

4.4.3.2 Evaluation

Although most administrative procedures as described are adequate to provide for proper handling of issues related to radiological safety, several areas described below are not adequately documented within the referenced materials. The Department will seek the necessary definition of administrative responsibilities to be included within LC 11.2.

The licensee is required by LC 20.0 to maintain a management control program which includes written operating procedures, reviewed and approved by the RSO and the Department, for all aspects of mill operations, including the radiation safety program and the environmental monitoring and control program.

When non-routine maintenance procedures are necessary, preparation of a Radiation Work Permit (RWP) is required. LC 19.4 specifies that these permits be prepared by the RSO or his designee prior to the start of any work or maintenance having radiation safety implications and for which no written procedure exists. Specific radiological controls, such as protective equipment necessary, monitoring required and/or personal hygiene measures prescribed, are specified within the permit. The permits are retained, in file, for a minimum of five years.

The Radiation Work Permit program must be described within LC 11.1 in greater detail, including: conditions for initiation of RWP action, responsibilities for implementation of action, approval procedures, monitoring criteria, employee training as to use, and record-keeping. LC 19.4 clarifies Department requirements.

4.4.4 INSPECTIONS

RG 8.31, "Information Relevant To Ensuring That Occupational Radiation Exposures at Uranium Mills Will Be As Low As is Reasonably Achievable", (31G-830500) recommends an inspection and audit program for maintaining occupational exposures ALARA.

For an operating mill, the program entails daily, weekly and monthly inspections to ensure proper implementation of good radiation safety procedures, including good housekeeping and cleanup practices that would minimize unnecessary contamination. For an operating mill, daily walk through inspection of all work and storage areas of the mill by the RSO or designated technician is suggested. A weekly inspection by the RSO and the mill foreman to observe general radiation control and to review required procedural changes is also to be performed. The RSO must review the RWP and shift log records for radiation safety concerns. A monthly RSO review of daily and weekly inspections, including a review of all monitoring and exposure data for the month must be accomplished and incorporated into a written monthly report provided to the plant superintendent and all department heads for their review.

For a non-operating mill, lesser frequencies are appropriate.

4.4.4.1 Description

UCC/Umetco's operational inspection program was described in their In-Plant Procedures Manual, LC 11.2. This program committed to weekly inspections of the yellowcake area and monthly inspections of all mill operations by a radiation safety technician. The RSO was committed to a quarterly review and written report to management on the ALARA program.

This program was modified in 1985 for non-operating status.

4.4.4.2 Evaluation

LC 29.0 requires weekly inspections by the RSO and review with management.

The program currently in effect is satisfactory for the indefinate shutdown mode. A revised inspection program will be required prior to restart of any operation or production.

4.4.5 ALARA AUDIT PROGRAM

Regulatory guidance (RG 8.31) specifies that licensee management cause annual audits of the radiation protection and ALARA program to be performed. All members of the audit team should be knowledgeable concerning the radiation protection program at the mill. The RSO should accompany the team but not be a member.

The audit report should examine and summarize data concerning: employee exposure records, bioassay results, inspection logs, documented training program activities, radiation safety meeting reports, radiological survey and sampling data, overexposure reports, operating procedures review, trends in personnel exposures, and use and maintenance of exposure control equipment. Recommendations of ways to further reduce personnel exposures should be addressed.

4.4.5.1 Description

Umetco maintains an internal audit program. No commitment to nor description of an annual outside audit program is given by the licensee.

4.4.5.2 Evaluation

An acceptable audit program is prescribed by LCs 29.3 and 29.4. Details of this program will be required to be included in LC 11.2. An independent outside effort is required for Colorado's other operating conventional uranium mill license. Either or both an internal or external effort is acceptable for the indefinite shutdown, non-operating mode.

4.4.6 RADIATION SAFETY TRAINING

The Radiation Rules, in RH 10.3, require that, prior to starting their jobs, all individuals working in or frequenting any portion of a controlled area receive instructions, including information on inherent risks of exposure to radiation and proper safety procedures for minimizing exposure.

NRC Regulatory Guide 8.31 (31G-830500) specifies the content of this training which should include provisions for personal hygiene, including washing, contamination surveying prior to eating or leaving the site, instructions for wearing personnel monitoring devices and respirators, and instructions for good housekeeping and for cleaning up dust and spills. Information on fundamentals of health protection, facility-provided protection, health protection measurements (bioassay and TLD's), radiation protection regulations, and emergency procedures should be included.

A written test, later reviewed with the instructor, is to be given to each employee and maintained on file.

Annual retraining should be completed and documented.

Specialized instruction, relating to the specific job an employee will perform, is required.

Radiation safety matters should be discussed with workers during regular monthly or bimonthly safety meetings.

Visitors and contractors need radiation safety training before being allowed access.

4.4.6.1 Description

The licensee has committed to an employee training program, details of which are included in LC 11.2. Radiation safety training is included with other new employee training such as that required by the federal Mine Safety and Health Administration. Radiation safety instructions are included in the handbook "General Safety Rules for Plant Employees" (00-810100) given to all employees, which the new employee studies and reviews with his/her supervisor. Both certify in writing as to the employee's understanding of the regulations.

All female employees are given a verbal presentation regarding prenatal radiation exposures along with a copy of the Appendix to Regulatory Guide 8.13, "Possible Health Risks to Children of Women Who Are Exposed to Radiation During Pregnacy".

An annual safety meeting is scheduled specifically for radiation protection, awareness and review of policies. These meetings are used to reiterate safety precautions and demonstrate the use of personal safety equipment such as repirators to all employees.

LC 11.2-3 indicates 1/2 to 1 hour periods of refresher training are to be given monthly.

4.4.6.2 Evaluation

The radiation safety training program provided by Umetco meets Departmental and NRC guidelines in most respects. New employee training, annual refresher training and specialized instructions for each job are provided as required.

The Department has concern over the scope of the present new employee training as the material in Appendix A of LC 11.2-13 is deficient as compared to RG 8.31, Section 25, (31G-830500) specifying the content of a new employee training program. The "safety test" contained in LC 11.2-5 is insufficient as a measure of radiation safety comprehension. A new training program and test must be devised and provided to the Department for review pursuant to LC 19.2.1.

Regulatory guidance recommends safety meetings be held at least bimonthly during which radiation safety matters may be discussed. The monthly refresher training committed to in LC 11.2-3 is the means by which this is accomplished.

LC 19.2 adds to those procedures already committed to by the licensee. LC 19.2.3 indicates that each employee shall accumulate at least 90 minutes of meeting time per year for the review of radiation protection topics.

4.5 RADIATION SAFETY CONTROLS AND MONITORING

The attainment of adequate radiation safety within and near a uranium mill site necessitates the use of numerous control methods for minimizing the release or presence of radioactive contaminants. Monitoring programs to demonstrate the proper function of these controls are necessary.

This section considers the methods used for control of radioactive contaminants at the Uravan site plus the procedures used to determine their efficiency.

4.5.1 AIRBORNE EMISSION CONTROL TECHNIQUES

The design of uranium mills and uranium ore processing equipment is not based solely on chemical process efficiency, but is also based on the relative potential for radiologic and toxic hazards.

A mill site is a source of particulates as a result of ore crushing, sampling, conveying and grinding; the operation of the gas-fired steam generators and yellowcake dryer; and the packaging of U_3O_8. In addition to particulates, sulfur dioxide, nitrogen oxides, carbon monoxide, and nonmethane hydrocarbons are generated as a result of the combustion of natural gas in the steam generators, aerofall mills (grinding circuit), yellowcake dryer, and sulfuric acid plant. In the acid-leach process, sulfuric acid mist is generated by the production, storage, handling and use of sulfuric acid. The solvent extraction process for the production of vanadium is a source of nonmethane hydrocarbons because of the evaporation of organics including kerosene and a tertiary amine used in the process. In addition, the storage and handling of these organics, as well as gasoline and diesel fuel, are sources of emissions of nonmethane hydrocarbons. Ammonia is emitted through storage, handling and use in the process of precipitating the uranium from the purified liquid streams. The handling and storage of other chemical reagents may result in the emissions of small amounts of these reagents in particulate form.

Regulatory guidance for the evaluation of airborne emission controls is provided by NRC as follows. NRC RG 3.5 (31G-771100) and 3.8 (31G-821000) describe the scope of the material necessary to support an acceptable license application. RG 8.31, "Information Relevant To Ensuring That Occupational Radiation Exposure At Uranium Mills Will Be As Low As Is Reasonably Achievable", (31G-830500) describes the acceptable methods for control of airborne uranium and its daughters for specific plant processes. RG 4.14, "Radiological Effluent And Environmental Monitoring at Uranium Mills", (31G-800400) describes the minimum monitoring program necessary to ensure proper operation of airborne control techniques.

The Updated Environment Report, Section 3 describes the Uravan mill layout and the locations of principal emissions sources.

Two types of sources of airborne effluents are found at the mill. Airborne materials are released from point sources such as stacks, vents and general ventilation systems. Area sources include spray systems, evaporation ponds, ore stockpiles, and waste piles.

All emission sources during operations at the Uravan mill were "grandfathered" under Colorado Air Pollution Control rules. Under this requirement, the mill was not required to meet the most recent "Lowest Achievable Emission Rates" but limits consistent with requirements in force during earlier periods. Detailed discussions, emission point by emission point, are in the Section 4.5.1 of the PELRS (10-840522).

A source-by-source summary follows below.

4.5.1.1 Haul Road Traffic

4.5.1.1.1 Description

Although some roadways on the mill property are paved, others are not. Unpaved haul road traffic is an area source. Fugitive dust emissions are controlled by: maintenance of 15-20 mph speed zones; supervisory visual observations of dust conditions and; sprinkling of roadways with water on a daily routine basis except as unnecessary during inclement weather. A water sprinkler equipped tanker truck and driver provide the dust control capability with the magnitude of watering controlled at the request of the supervisory personnel based on visual observations of road and traffic conditions.

4.5.1.1.2 Evaluation

Data in the NUS 1980 study indicated that roadway fugitive dust may have accounted for up to 25% of the airborne Ra-226 concentrations in Uravan.(00-800530-06:2-5) Reclamation activities are likely to result in significant releases if uncontrolled. Control of these dusts is therefore significant.

At the time of the NUS study, control consisted of roadway watering "as necessary". The above described improvements, initiated in a 1983 addition to LC 11.4-1(30) have served to reduce fugitive dusts.

The above methods are acceptable and meet APCD requirements (watering has been shown to produce 25-50% emission decreases).

From an ALARA standpoint, further reductions could be accomplished by oiling (70% efficiency) or chemical suppressants (85% efficiency). Paving is of course best (99% efficiency). These methods will be considered if post licensing data indicates an unexpected problem.

4.5.1.2 Disposal Site Construction and Reclamation Activities

4.5.1.2.1 Description

Disposal site reclamation is a potential area source. LC 11.4-1(30) and the November 30, 1983 radiation dose report (00-831130-03) outlined a plan for emissions control of tailings areas. Road dusting is to be controlled by water spraying and speed limits as described under 4.5.1.1 above, "Haul Road Traffic". Fugitive dust from the top surface is temporarily under minimal control. Fugitive dusts from the external slope have been suppressed by construction of a random fill cover six inches to one foot in thickness until the final side slope cover is constructed.

4.5.1.2.2 Evaluation

For erosion resistance, tailings, dust control, and radon reduction, the Department is requiring in LC 22.3 a program to minimize to the maximum extent reasonably achievable dispersion of airborne particulates.

The implementation of LC 11.1 will eliminate dust emissions from the tailings disposal area upon the completion of reclamation.

For beach areas, chemical dust suppressants such as lignin sulfonate are known to form crusts stable for up to a year on undisturbed areas. Since the potential for dust emissions from the uncovered areas of the impoundment top is significant, the program required in LC 22.3 will be reviewed for steps proposed by the applicant to suppress dust on those areas not involved in active disposal.

4.5.1.3 Ore Storage Areas

4.5.1.3.1 Description

LC 11.4-1(30) described the ore stockpiles at Uravan and the emission control measures in use.

The quantity of ore stockpiled at any one time ranged from near zero to over 150,000 tons. A six month mill feed rate supply was 275,000 dry tons. The concrete ore pads at the sample plant were maintained in a wetted condition by repeated daily applications of water, except during inclement weather.

4.5.1.3.2 Evaluation

The emission control scenario, described by LC 11.4-1(30) and implemented beginning in early 1984, reduced the blowing of ore dust as compared to past operations. APCD guidance indicates that wetting can be expected to produce 25% reductions in emissions. Only residual contamination remains in the ore areas.

4.5.1.4 Ore Crushing and Grinding Areas

4.5.1.4.1 Description

The stockpiled ore was crushed and ground to sand-sized particles via the action of several mill circuits. The sampling plant performed the primary crushing action via jaw crushers after which the ore was finely ground in the aerofall mill. Storage prior to leaching took place in the fine ore bins. The PELRS (10-840522) on pages 4-15 through 20 describes these circuits in detail.

4.5.1.4.2 Evaluation

The ore crushing and grinding circuits at Uravan were a major contributor to particulate releases from the operating mill. These circuits were indicated as significant contributors to the exceedance of the 25 mrem standard within the town.

4.5.1.5 Digestion (Leaching) and CCD Circuit Stacks

During prior operations these circuits appeared to make negligible contributions to airborne emissions. No emissions will take place during the shutdown period.

4.5.1.6 Yellowcake Precipitation, Conditioning, Drying and Packaging

4.5.1.6.1 Description

Uranium-bearing solutions from the ion-exchange circuit were pumped continuously through two mechanically agitated tanks in series and heated by direct steam injection to 120°F. Anhydrous ammonia, caustic soda and hydrogen peroxide were used to precipitate uranium. The pH was raised in two or three steps to about 3 then to 7.3 to 7.4.

The new yellowcake calciner, put into use in 1981, is described in UCC's letter to the Department of July 11, 1980. (00-800711; 00-801219-02)

The precipitated yellowcake was thickened and the underflow solution from the thickeners was pumped to a horizontal vacuum belt filter, located on the top floor of the new calciner building, where the yellowcake was fed onto a moving belt filter with suction applied to the underside of the filter. At the end of the horizontal belt travel, the moist cake dropped vertically into a hopper which in turn fed a screw conveyor. The enclosed screw conveyor transferred the pressed cake to the top of the calciner, eliminating any exposure to persons supplying the material to the calciner.

The calciner consists of a seven hearth rotary furnace with access doors at each hearth to allow access for cleaning drops and rake arms. The access doors consist of a double door arrangement with approximately one foot clearance between doors. The plenum area between the two doors is maintained under negative pressure.

During cleaning of the drops or rake arms, negative pressure pulled any generated dust away from the personnel's breathing zone area and to the scrubbing system. Heavy particles not entrained by the negative pressure system fell down the plenum chute, between the doors, to an enclosed five gallon container. This system had been designed specifically to minimize employee exposure during the required operating maintenance.

The product being discharged from the base of the calciner dropped vertically through a lump breaker and magnetic trap onto the revolving screws of a screw conveyor which transported the product to a storage bin. The bin was emptied daily from the bottom by actuating a valve which discharges the yellowcake into a product shipping drum of 55 gallon capacity. The drum was enclosed at the top by a hood that maintains a negative pressure on the drum, drawing airborne particulates through a duct work to the calciner emissions scrubbing system. The product drums, upon filling, rolled on a horizontal roller conveying system where they were weighed, inspected, allowed to cool, and sealed. The drums were transported in this manner into another room for immediate storage and labeling.

Emissions from the calciner, product barreling, and calciner drop plenums passed through a dry cyclone, a venturi scrubber and a cyclonic separator prior to being vented to the atmosphere. 1980 figures estimated an 80% efficiency for the dry cyclone and a 95% efficiency for the venturi scrubber. No mention of the cyclonic separators efficiency was given. Based on these figures an emission rate of 50g/hr (0.12 lbs/hr) or 480 kg/yr (.53 tons/yr) was predicted for full operating mill status. This is in contrast to the 2.1 metric tonnes/yr (2.3 tons/yr) emitted by the old system. Data contained in the November 30, 1983 "Radiation Dose Report" show a reduction in radionuclide (U-nat, Th-230, Ra-226) emissions to about one third of the prior level with the introduction of the new yellowcake calciner system.

The work area atmosphere is maintained under negative pressure by a separate ventilation system which includes a Fabri-Pulse reverse jet baghouse with an estimated efficiency of 99.9%.

4.5.1.6.2 Evaluation

The new yellowcake facility was described in detail to the Department and met full requirements for approval in 1981. The description in LC 11.2 fully meets Department requirements. The updated emissions control systems were a significant improvement over past operations and, as long as efficiency is maintained, were acceptable to the Department.

LC 18.2 requires authorization by license amendment prior to refining or producing yellowcake product.

4.5.1.7 Solvent Extraction (SX) Circuit

4.5.1.7.1 Description

The SX circuit was a localized source. It was used in concentrating vanadium recovered in the ion-exchange circuit. Reagents used included sodium chlorate, soda ash, ammonia, kerosene, and a tertiary amine.

In the SX circuit the vanadium solution was mixed with kerosene and a tertiary amine. The vanadium attaches to the tertiary amine and is thereby separated from the process water entering the circuit. Kerosene was generally used as a carrier for this amine and maintains itself as a separate layer from the process liquor. The vanadium and amine solution was scrubbed and pumped to a two-stage strip process where a concentrated vanadium product liquor is obtained. This liquor was stored and shipped to Rifle.

No effluent controls are described. Aerosols and vapors containing amines, kerosene, water, metal ions and anions (primarily as sulfate) were vented to the atmosphere.

4.5.1.7.2 Evaluation

The Uranium Mill Tailings Radiation Control Act of 1978 (PL95-604) requires the RCD to control non-radiological toxic emissions such as vanadium and other metals in addition to radiological emissions.

The principal contributions to plant emissions from this circuit were unmeasured quantities of tertiary amines and hydrocarbons. These could be trapped by a variety of methods.

4.5.2 LIQUID EFFLUENT CONTROL TECHNIQUES

By the nature of the uranium milling process radionuclides in suspended or dissolved forms are generated. This section examines the potential sources for such releases and the control measures in effect at the Uravan mill.

Liquid discharge from the mill has occurred from at least the following sites: 3 discrete discharge points as described by Colorado Water Quality Control Division (WQCD) Colorado Discharge Permit System (CDPS) Permit CO-0000515 (11-831024-01); the outflow of the municipal sewage treatment plant (CDPS Permit CO-0020648); the Club Ranch ponds disposal system (as seepage); the tailings impoundment; and a number of process solution spills as documented in Department records. A description of each follows.

4.5.2.1 CO-0000515 Point 001

4.5.2.1.1 Description

Point 001 was the major discharge point of treated process waste from the mill. It was composed of the following components in the listed approximate proportions:

- (31%) filtrate from the yellowcake precipitation ciruit
- (39%) powerhouse backwash
- (14%) neutralized raffinate from the solvent extraction process--an intermittant discharge occuring approximately 42 days/year
- (12%) sulfuric acid plant cooling water (when the acid plant was operational)
- (4%) "B" Plant seepage from the hillside collection system
- (1%) "A" Plant yard drainage
- (1%) domestic water ion exchange backwash, laboratory waste drainage, compressor cooling water.

Of the effluent streams the powerhouse backwash and compressor cooling water are separated from processes where radioactive materials might be introduced into the system.

The possible contributors of decay chain elements were the yellowcake post-precipitation thickener overflow, process liquors discharging from the yellowcake circuit, the hillside seepage collection system, laboratory waste, the SX raffinate, and the domestic water ion exhange backwash.

A description of the CDPS 001 discharge control systems necessitates a description of controls utilized on the feeder streams and on treatment at the 001 discharge treatment ponds.

The yellowcake post-precipitation thickener liquor was treated with flocculants and maintained at a proper pH to keep uranium out of solution. The overflow solution was treated with barium chloride solution at the overflow discharge to effect sufficient mixing, chemical reaction time, and precipitation and removal of radium prior to entry to the 001 discharge treatment system.

Hillside runoff and seepage (originating from the tailings impoundment on the mesa and collected by a serious of ditches) was treated with barium chloride before being discharged into the 001 setting ponds. If monitoring showed that high uranium or ammonium concentrations would affect compliance, the liquid was diverted back to the CCD circuit.

Treatment of powerhouse backwash prior to release to the 001 treatment ponds was not regarded as necessary.

The incoming streams entered the 001 treatment system through 3 parallel settling ponds with pH alarms on the inlets and outlets. Any water entering the system not between pH 6.3 and 8.6 or requiring additional settling was diverted to an emergency holding pond for treatment before entering the main flow. Parameter control was through appropriate monitoring and process control within the mill circuit. Streams, such as garage washdown, containing oily compounds, were piped directly to a holding pond for separation before entering the 001 system.

The ponds acted to effect the settling of suspended materials within the incoming streams, in particular the $BaSO_4$ with which Radium and other radionuclides had co-precipitated.

UCC/Umetco operations at Uravan obtained a daily (metallurgical-type accuracy) uranium concentration at the plant stream and hillside runoff inlets to the River Ponds. If this internal result exceeded 2 mg/l, the source liquid stream was diverted back away from the discharge point to the counter current decantation circuit.

UCC/Umetco operational period monitoring data for 1982 showed soluble Ra-226 concentrations averaging 2.97 pCi/l, total Th-230 concentrations of 15 pCi/l and U-nat levels of 407 pCi/l, in the 001 discharge into the San Miguel river (CO-830712). Discharge of the 001 stream ceased in 1985 with the plant shutdown.

4.5.2.1.2 Evaluation

Although the facility had an earlier history of spills and operational difficulties in meeting conditions of previous permits by exceeding permit limits for ammonia, TSS, TDS, uranium, radium-226, pH, zinc and iron, data indicated an improvement in operations into 1984.

As described above, the process used for treatment of the 001 discharge consisted of barium chloride addition at effluent sources and settling of suspended materials within the treatment ponds. Data indicated significant removal of radium-226, with effluent concentrations falling generally below 3 pCi/l during the sampling period from 1979 to 1983.

In the past, the mill facility was criticized for operational difficulties leading to failure in meeting effluent requirements. The "rationale" statement used by the WQCD in writing a 1983 permit modification states:

> "Past history of the treatment facility shows the inherent problems. Anhydrous ammonia used for precipitation makes it difficult to meet their ammonia limitation, while caustic soda makes the uranium removal less efficient. This less effective uranium removal causes the uranium in their discharge to occasionally exceed the permit limit (previous permit). Zinc levels can be affected by new ore sources or the limestone supply for the neutralization circuit. Degradation of the ion exchange resin has affected uranium and iron levels in the discharge. When a chelating agent was added to reduce the iron levels, it apparently retarded the barium sulfate co-precipitation of radium-226 thus allowing excess radium-226 in the discharge. Radium-226 levels are also affected by flow rates, settling times, and varying feed concentrations" (11-831024-02:3).

A 1981 report (11-810918) indicated Ra-226 concentrations increased by about 1 pCi/l in the San Miguel river between 1962 and 1972. Natural uranium levels increased by a factor of 4 during that same time period. 1972 EPA data shows uranium levels 3 times higher downstream from the mill (32-720816) than above it.

Requirements which have been in effect in the past include:

For Ra-226, a 3 pCi/l average and 10 pCi/l maximum soluble radium requirement set by WQCD; a 10 pCi/l average and 30 pCi/l maximum total radium requirement set by the WQCD.

For uranium, a 0.8 mg/l (500 pCi/l) stream standard for the San Miguel River based on its categorization as a recreation class 2, warm water aquatic life, and agricultural use water exists; a 2 mg/l (i.e. 1330 pCi/l) standard for the 001 discharge.

For Th-230 (soluble), the Radiation Rules indicate a limit of 2,000 pCi/l at controlled area boundaries.

Discharge data for 1982 indicated an average soluble Ra-226 effluent of 1.7 pCi/l with a low of 0.4 pCi/l and a high of 3.6 pCi/l. Ra-226 levels exceeded the 3 pCi/l standard for 3 months (September, October, November) during the year. Available data for the operating portion of 1983 (June-November) showed a 0.9 pCi/l average.

Stream values for soluble Ra-226 as measured from 1978 through 1982 averaged around 0.5 pCi/l both above and below the mill.

Soluble Thorium-230 values for the 001 discharge for 1982 and 1983 averaged 10 pCi/l. River values for Th-230 generally fell in the 2-4 pCi/l range both above and below the mill as indicated by data for the 5-year period from 1978 through 1982.

Uranium data for 1982 for the 001 discharge indicated an average value of 400 pCi/l. Operating period data for 1983 (June-November) showed an average of 560 pCi/l with a maximum of 1160 pCi/l.

The San Miguel River uranium values averaged 7 pCi/l above the mill for the 1978-82 period. The average below the mill for the same period is 12 pCi/l.

Data are summarized in ERI Logan's March 1986 summary report (01-860301). More recent data are in ERI Logan's August 1986 winter baseline data report (01-860811-01 and -02).

Although permit violations have occurred in the past, the cessation of the 001 discharge in 1985 precludes future recurrence. LC 24.1, reflecting LC 11.1, prohibits any future discharge of radioactive materials or toxic pollutants to the San Miguel River.

4.5.2.2 Other Discharges

4.5.2.2.1 Description

Discharge point 002 was a non-contact cooling water. This point source has not discharged in years and probably will not discharge again because of prohibitive costs even if operations were to be approved by amendment in the future.

The 003 discharge stream consisted of clarifier underflow from a circuit designed to provide clarified river water for the mill process and town irrigation.

The sewage treatment system covered by CDPS Permit No. CO-0020648 consists of an extended aeration treatment system followed by chlorination and a polishing pond. Cross connections whereby radioactive or other industrial wastes may enter the system are not known to exist. Sewage facilities in B-plant are currently connected to a septic treatment and drain field system.

4.5.2.2.2 Evaluation

Operation of the 002 discharge, 003 discharge and sewage plant is unlikely to result in major impacts.

4.5.2.3 Club Ranch Ponds

4.5.2.3.1 Description

The six Club Ranch ponds are unlined ponds located along the northeast bank of the San Miguel River and were used for the evaporation of raffinate from the mill process. Process raffinate discharge to the Club Ranch Ponds was discontinued July 1, 1985 but quantities of radium, uranium, thorium, other radionuclides and toxic metals are present in levels above background.

Although other methods were used by UCC/Umetco (the Club Mesa spray system or neutralization) for raffinate disposal, evaporation from the ponds was the major method for eliminating this waste. Data presented by the International Engineering Co. March, 1982 report (00-820331-09:Table 1) characterized the water quality present within the ponds.

Average values for all ponds for several relevant parameters are:

Table 4 - 3

Club Ranch Pond Chemical Parameters

Total Dissolved Solids	142,000 mg/l
Ra-226	630 pCi/l
Th-230	165,000 pCi/l
U-nat	8,780 pCi/l

No controlled discharge point for the ponds exists. The liquid component of the raffinate evaporates or seeps to ground water and/or to the San Miguel River, leaving behind the crystalline remainder for future disposal. The solid precipitate of the raffinate is primarily ammonium-aluminum sulfate. The Ra-226 content of these crystals is in the range of 20 pCi/g. The Th-230 content may exceed 1000 pCi/g.

Although no controlled discharge from the ponds exists, significant seepage occurs, in the range of 10 to 50 gpm (00-780831:3-33). The seepage enters and contributes to the elevated water table in the vicinity of the pond, travelling in a direction towards and downstream to the San Miguel River, and eventually entering the river from the northeast bank. Evidence of the seepage can be seen in the photos included in the Department's April 1983 compliance inspection report.

Although the radionuclide concentrations within the ponds are quite high, data exists (00-831216-04) indicating that geochemical processes within the sandstones surrounding the ponds temporarily absorbs significant amounts resulting in a seepage effluent with a different composition.

LC 11.4-1(5) describes the licensee's monitoring system for the Club Ranch Ponds which includes semi-annual analysis of ground water from the 15 pumpable wells of the CRP-Envirologic Series.

LC 11.1, in particular Addendum A, describes UCC/Umetco commitments for monitoring pursuant to the Consent Decree.

4.5.2.3.2 Evaluation

Although the temporary mitigating effect of geochemical absorption of radionuclides in the stata underlying the Club Ranch Ponds appears to be significant based on UCC/Umetco data, seepage contributes contaminants to the underlying aquifer and to the San Miguel River. Specific radionuclide concentrations in wells between the ponds and the river are shown by analysis to be reduced, but the gross alpha and beta values for the samples are often elevated. Radionuclides, heavy metals, and salts are contributed to the river and groundwater by the ponds.

The location of the lower ponds in the 100-year flood plain and the upper ponds in the physiographic flood plain of the San Miguel River also is a cause for concern because of potential flooding of the ponds and erosion of the containment dikes.

The recent cessation of input to the ponds followed by final reclamation as described LC 11.1 will reduce or eliminate contaminant migration to the San Miguel River and any future possible flooding problems.

4.5.2.4 Tailings Impoundment

4.5.2.4.1 Description

The tailings impoundment included approximately 17 acres of ponded water coverage in 1983; by 1986, this had decreased to less than 1 acre. Water, as a component of the tailings slurry, was added to the piles during periods of ore processing. Water is lost from the facility by evaporation and seepage.

The seepage from the tailings reappears in at least two major locations on site. Toe drains in the rock berm at the foot of the piles collect seepage. Tailings raffinate also seeps into the underlying bedrock--the Salt Wash Member of the Morrison Formation. Seepage below the piles meets layers of interbedded relatively impermeable shales which impede vertical percolation so that flow becomes much greater in the horizontal direction. This condition results in perched liquid in the more permeable zones. Liquid in the perched zones flows along the bedding above relatively impermeable zones and discharges at seeps along the San Miguel Canyon and Hieroglyphic Canyon.

UCC's Updated Environmental Report indicated that "all" hillside runoff and seepage is collected and treated with barium chloride before being discharged into the 001 settling ponds. Umetco stated that if monitoring shows that uranium or ammonium concentrations would affect compliance with the 001 permit limits, the seepage stream was diverted back to the CCD circuit (00-820331-13).

4.5.2.4.2 Evaluation

The toe drain collection system for the return of tailings seepage at the base of the pile's rock berm captures seepage from the tailings dam face.

The question of tailings seepage percolating to depths allowing entry to and contamination of ground water is addressed in LC 11.1 which requires improvements in the toe berm and hillside seepage collection systems.

4.5.2.5 Process Solution Spills

4.5.2.5.1 Description

WQCD information indicated that prior to 1980 numerous spills occurred and frequently consisted of raffinate. For examples, a spill on October 29th, 1980, released an estimated 225 gallons of neutralized raffinate underflow with 75 pounds of mud spilled to the river.

Radiation Division files show no operating spills reported since late 1980.

LC 11.4-1(29) "Chemical Spill Prevention and Countermeasure Plan" was added to the Plant Procedures Manual in March of 1982. A drainage analysis and spill control plan is spelled out in considerable detail.

A new "Spill Prevention Action Plan" addressing preventive maintenance was agreed upon between Umetco and WQCD in 1984.

4.5.2.5.2 Evaluation

The spill control plan as described by Umetco is well conceived, presented in considerable detail, acceptable, and is a referenced part of LC 11.4-1.

4.5.3 PERSONNEL EXTERNAL RADIATION DOSE MONITORING PROGRAM

Although most mill workers receive external gamma radiation doses of less than 1 rem per year, it is nonetheless essential to monitor gamma levels within the mill in order to maintain exposures ALARA and to identify areas, to be designated "radiation areas", in which an individual could receive a dose in excess of 5 mrem/hr or 100 mrem in any 5 consecutive days. These limits were suggested by the International Atomic Energy Agency (IAEA) in "Manual on Radiological Safety in Uranium and Thorium Mines and Mills". (30-760000-01)

NRC guidance (RG 8.30) recommends semiannual gamma surveys throughout the general mill area and quarterly surveys of designated "radiation areas". To determine the need for personnel monitoring, quarterly radiation exposures for each category of plant worker should be calculated from the measured radiation levels and predicted occupancy times. If the quarterly gamma dose exceeds 0.31 rem the worker is required to wear a personnel radiation dosimeter.

Beta surveys of specific operations involving the direct handling of large quantities of aged yellowcake (yellowcake stored more than 1-2 months) are advised to ensure that exposures to extremities and skin are not unduly high. These surveys are required only once or at times when procedural modifications may alter the dose received by a worker.

4.5.3.1 Description

The UCC/Umetco gamma survey program was described in detail in LC 11.2-19.

Surveys were to be performed on a quarterly basis at 54 locations within the mill area. Data from the surveys were used to calculate a time distribution study, and job weighted exposures. Areas with exposures over 312 mrem/quarter required badging of employees.

For comparison, the April, 1983 Department inspection report (10-830312) indicated an average exposure of 20 mrem/quarter and a maximum of 100 mrem/quarter as measured by employee badges.

Methods for sampling, data analysis, calibration of instruments and quality assurance are described in detail within LC 11.2.

4.5.3.2 Evaluation

The gamma survey program has been well designed and documented and therefore acceptable to the Department. The quarterly sampling at 54 in plant locations exceeded regulatory requirements for semi-annual sampling of at least 20 sites. LC 27.3 requires control badges to be kept in a background location.

The methods used for data analysis and instrument calibration are consistent with NRC recommendations.

At present, an adequate description of the personnel dosimeter (TLD) program has not been received from Umetco. The Radiation Division recommends an administratively more simple and practically more defensible threshold of 300 mrem/quarter for badging. Although Department inspections indicate the present program to be adequate, a description will be required for inclusion in LC 11.2. LC 27.1.2 provides for revisions.

Beta monitoring is needed only at times when production-related procedural changes might lead to undue exposures to extremities by virtue of new employee manipulations. The cessation of operations and absence of yellowcake onsite result in no need for regular beta surveys.

4.5.4 CONTAMINATION CONTROL PROGRAM

Yellowcake or ore dust lying on surfaces can become resuspended in the air if disturbed. Thus, surface contamination presents a potential source of hazardous airborne material and is limited by 6 CCR 1007-1-4.4 (equivalent to NRC's 10 CFR 20.103).

Cleanup attempts by methods such as sweeping are likely to produce a more serious hazard through resuspension in the air than if the ore dust were allowed to remain where it lies. When necessary, cleanup may be performed by hosing down the ore dust into floor sumps or by using vacuum-cleaning systems.

In the precipitation circuit and the yellowcake drying and barrelling areas, surface contamination can be a problem because of the concentrated nature of the yellowcake.

The International Atomic Energy Agency (IAEA) and NRC Regulatory Guide 8.30 (31G-830619) recommend a limit for surface contamination in restricted areas on walls, floors, benches, clothing, etc., of 10^{-3} uCi/cm^2 (220,000 dpm/100 cm^2), which is equivalent to almost 2 mg/cm^2 of natural uranium. This value is based on experience which indicate that if surface contamination is kept below this value, the contribution to airborne radioactivity from surface contamination will be well below applicable limits. Department staff considers these levels acceptable to meet the ALARA concept in uranium mills. The levels are low enough to ensure little contribution to airborne radioactivity, yet not so low that the cost of meeting them in uranium mills is too high. This amount of surface contamination is readily visible and does not require a survey instrument for detection.

In yellowcake areas daily visual inspection should be made for locating yellowcake contamination on surfaces. Visible yellowcake should be cleaned up promptly expecially where the possibility of resuspension exists.

In clean areas such as eating, changing or control rooms a lower level of surface contamination should be maintained. Weekly smear tests for removable contamination should be used with prompt decontamination of any area exceeding 1,000 dpm alpha/100cm^2.

4.5.4.1 Area Contamination Control

4.5.4.1.1 Description

UCC/Umetco's description of its visual inspection program for yellowcake and ore dust indicated within sections 7 to 10 of the In-Plant Procedures Manual LC 11.2 that monthly visual inspections will be conducted. Section 11 of LC 11.2 indicated weekly visual inspections of the yellowcake area for contamination.

Section 20 of the Procedures Manual described the alpha contamination program. Surveys were accomplished with a Ludlum counter and model 43-5 alpha scintillator probe calibrated semiannually. Eleven (11) stations are sampled weekly and 9 others monthly. The A plant and yellowcake change rooms fell under the weekly inspections. The office lunch areas were surveyed monthly.

In October of 1984 in response to the long term shutdown, the RSO requested a reduction in the alpha monitoring program which now surveys the six active lunch rooms on a monthly basis.

4.5.4.1.2 Evaluation

The program for visual inspection for possible contamination by alpha-emitting materials, in particular as cleanup and reclamation activities increase, will undergo additional development and documentation as activities evolve. Revised action levels and decontamination procedures must be established and documented within LC 11.2.

NRC Regulatory Guide 8.30 states that all clean areas of an active mill should be monitored weekly for removable alpha contamination as measured by a smear test. 1,000 dpm/100cm^2 removable alpha contamination should be the action level for decontamination. UCC/Umetco substitutes a meter survey for this, followed by decontamination if a level of 1000 dpm/100 cm^2 is exceeded. The alternative is acceptable.

Due to the abscence of ore dust or yellowcake production on-site the long term shutdown reduces the probability of the spread of alpha contamination and makes reductions in the monitoring program appear reasonable. LC 27.6.3 authorizes surveys to be monthly. Nevertheless, the reclamation activities and the frequent relocations and operations dealing with mill tailings indicate a significant protential for the spread of contamination.

Although the currently reduced frequency for surveys is acceptable the Department believes that the RSO should use every opportunity to reduce exposures to as low as reasonably achievable by determining action levels more restrictive than those used during the period of production and using smears as the method of survey. LC 27.6.3 will require this.

4.5.4.2 Personnel Contamination Control

Although alpha radiation on the skin or clothing is not a direct hazard because the particles do not penetrate the dead layer of skin, contamination must be controlled to prevent its spread to unrestricted areas and possible ingestion.

Normally such contamination is controlled through personal hygiene measures such as washing before eating and showering and changing clothes before going home.

All alpha contamination on skin should be considered removable so that the limit of 1,000 dpm/100 cm^2 applies. The value of 5,000 dpm/100 cm^2 is used as the limit for soles of shoes.

4.5.4.2.1 Description

Umetco's procedures for the prevention and control of personnel contamination are documented in LC 11.2.

For example, appropriate safety equipment, (coveralls, boots, respirators, and gloves), are prescribed. Eating or smoking is permitted only in clean areas and only after washing.

4.5.4.2.2 Evaluation

The personnel contamination control program is consistent with Department guidelines and is acceptable.

Departmental inspections of April 1983 (10-830412) and November 1981 (10-811116) cited Umetco for one employee smoking and one employee eating within non-approved areas. Management memos and employee training classes were used to correct the problem.

Proposed LC 27.6.1 requires quarterly spot surveys for alpha contamination at least quarterly on at least ten percent of the workers leaving the plant. Contaminant levels above 1,000 dpm/100 cm^2 shall require decontamination and investigation by the RSO as to the cause.

4.5.4.3 Contaminated Equipment

To prevent the spread of contamination, any equipment released from a restricted area should be surveyed prior to release and decontaminated if necessary.

The following limits apply:

Table 4 - 4

Contamination Limits

Average	5,000 dpm alpha per 100 cm2	averaged over no more than 1 m2
Maximum	15,000 dpm alpha per 100 cm2	Applies to an area of not more than 100 cm2
Removable	1,000 dpm alpha per 100 cm2	determined by smearing with dry filter or soft absorbent paper

4.5.4.3.1 Description

LC 11.2, Section 20 "Alpha Contamination" and Section 22 "Material Release Decontamination", contain procedures for checking the calibration of the alpha meter and for determining surface alpha contamination levels. The maximum average allowable surface contamination and the maximum average allowable exposure rate (gamma) is included.

4.5.4.3.2 Evaluation

Release of contaminated equipment, packages or materials from controlled areas for repair, reuse, resale or disposal may occur only after documented decontamination meeting Department requirements included as Annex C to the License, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Radioactive Material", as is required by Proposed LC 25.2. Since Department policy is more restrictive than DOT policy, Department limits will apply for final release.

4.5.5 PROTECTION EQUIPMENT FOR PERSONNEL

The control of personnel contamination was addressed in Section 4.5.4.2 in terms of personal hygiene and employee procedures. Additional protection is afforded workers by use of protective equipment such as coveralls, boots, gloves and respirators.

The use of repirators to reduce exposure to airborne dust is often necessary. Respirators are not used in place of other process controls to reduce dust but rather as supplement to them in areas of increased risk. In calculating job-weighted exposures, no credit is given for the protection afforded by respirators. RG 8.15, "Acceptable Programs for Respiratory Protection", (31G-761000) describes the procedures necessary for an acceptable program of respirator use.

4.5.5.1 Description

UCC/Umetco's respiratory protection program is described in Section 14 of LC 11.2.

Management policy is that routine usage of respirators will be held to a minimum in favor of engineering controls to reduce dust. The plant manager is responsible for ensuring that the program meets legal requirements, whereas the RSO is responsible for the implementation and operation of the program.

UCC/Umetco does not expect total exposure for any person to exceed routinely the 40 hr/week MPC. Respirator wear is implemented in some areas where airborne contamination levels inadvertently exceed the 40 hr/week MPC for short periods. UCC/Umetco follows the U.S. NRC Regulatory Guide 8.15, "Acceptable Program for Respiratory Protection" (31G-761000-01) and NUREG-0041, "Manual of Respiratory Protection Against Airborne Radioactive Materials" (31G-761000-02).

The selection and use of respirators at Uravan is carefully described within the procedures manual. NIOSH-OSHA-MSHA certified equipment is provided to workers and its proper use explained and regulated by the RSO. Employees receive training classes in respirator use and have their respirators individually fitted. A respirator facility is responsible for the maintenance, cleaning and sanitizing of all respirators used. Effectiveness of the program is determined by bioassay, to be described in Section 4.5.7.

4.5.5.2 Evaluation

The protective clothing program at Uravan is generally acceptable to the Department.

The respirator program as described by Umetco describes all factors as required by Departmental guidance in 6 CCR 1007-1-4.4.3.3 as well as those recommended by NRC Regulatory Guide 8.15. Procedures are described for air sampling, training, fitting, maintenance, control, bioassay, record keeping and medical status of users in relation to the program. The program is acceptable.

4.5.6 IN-PLANT AIRBORNE RADIATON MONITORING PROGRAM

An airborne radiation monitoring program is necessary to (1) demonstrate compliance with worker weekly and quarterly intake limits, (2) determine which areas require posting for airborne radioactivity as required by 6 CCR 1007-1-4.11.4 as defined in 6 CCR 1007-1-1.6, and (3) determine whether operating procedures such as engineering control, limitation on work time, and respirator usage are being used to best advantage to maintain exposures ALARA.

Licensees are required by 6 CCR 1007-1- 4.4.4 to use process and engineering controls to limit airborne concentrations in the mill to values below 25% of the maximum permissible limits. Work controls, such as setting a limit to employee work time or providing increased surveillance, are required if process and engineering controls are impracticable to apply.

The following are alternate values for Maximum Permissible Concentrations (MPC)

Uranium Ore Dust

$1x10^{-10}$ uCi/ml measured as gross alpha;
$5x10^{-11}$ uCi/ml natural uranium;
or 75 micrograms natural uranium per cubic meter of air.

Yellowcake

Studies show that yellowcake, a mixture primarily of ammonium diuranate and uranium oxide, is composed of materials with varying solubilities in body fluids. The temperature at which the yellowcake is dried appears to determine the proportions within this mixture.

Yellowcake dried at 400 °C or above is classified by NRC as insoluble (31-830619:2).

For compliance with weekly limits, yellowcake is assumed to be soluble (the more conservative case). The weekly intake limit is 9.6 milligrams (i.e., equivalent to breathing at a rate of 1.2 cubic meters per hour for 40 hours in air containing 200 micrograms per cubic meter or $1x10^{-10}$ microcuries of natural uranium per milliliter).

Enclosed yellowcake drying and packaging areas must always be considered airborne radioactivity areas because of the high radionuclide concentrations that can result if any equipment malfunctions.

Special attention is required in the case of a worker with tasks in areas with fractions of the Maximum Permissible Concentration from a combination of dust, uranium product, and radon progeny buildup.

In evaluating worker exposure, the term MPC-hours is used. The number of MPC-hours is obtained by multiplying the observed concentration (as a fraction of the maximum permissable concentration) for a given time period by the duration of the time period. For example, an 8-hour work day at an observed concentration of 0.5 MPC would yield (8 times 0.5=) 4 MPC-hours. An exposure in excess of 520 MPC hrs/quarter is considered an overexposure. An exposure over 40 MPC hours/week requires RSO investigation and documented corrective action.

Most airborne contaminants in the mill result from localized sources. Concentration gradients in the vicinity of point releases produce large variations in sample results, therefore, frequent measurements are needed to determine trends.

The airborne radiation monitoring program is based on the fact that the nature of airborne contaminants will vary from one part of the mill to another. During the initial stages of ore processing, uranium, thorium-230, and radium-226 are expected to be in equilibrium. During subsequent operations, this equilibrium is disturbed and the concentrations of individual radionuclides must be measured for the assessment of hazards. In the precipitation and product recovery sections, the airborne radioactive material is primarily uranium. The primary radioactive materials in the ore storage areas are radon and its progeny. Airborne effluents in one area may tend to influence radionuclide concentrations (and therefore exposures) in adjacent areas.

The Department requires that inplant airborne monitoring be performed under conditions typical of employee exposures and that, along with results of airborne activity surveys, records of the state of operation of both process and effluent control equipment, including ventilation conditions be kept.

4.5.6.1 Particulate Sampling

4.5.6.1.1 Description

Airborne particulates are sampled with Staplex LV-1 samplers which are calibrated and leak tested monthly. The calibration procedure is described in Section 17 of LC 11.2.

Samples are taken on a schedule depending upon the potential for contamination. A reduced program is currently in effect due to the mill shut down. Since the writing of the PELRS, sampling time has been increased to 30 minutes to meet Radiation Division requirements.

Results of the sampling are used to calculate job weighted exposures in the various mill activities.

4.5.6.1.2 Evaluation

Umetco's air sampling program meets Departmental requirements in most respects. The frequency and location of sampling appear acceptable. Procedures for use, calibration and maintenance of equipment are well described.

The absence of ore dust and yellowcake during the extended shut down indicate the need for a significantly different program than that described in the PELRS. Currently, monthly sampling is done in seven in-plant areas, an acceptable program. Employee operations at this time and in the future are and will be generally non-routine and the need for air sampling will be determined via the Radiation Work Permit program wherein the RSO determines the need for sampling in all non-routine situations.

The request for details on routine sampling locations, made in the PELRS, is no longer of importance due to the non-routine nature of employee activity during the shut down. A major program will be necessary again during construction activities as required by LC 11.1.

Umetco's respirable dust sampling program is responsive to proposed LC 27.5, which requires supplementary sampling using the framework in LC 27.5.1.

4.5.6.2 Radon-222 and Progeny Sampling

Significant concentrations of Radon-222 and its progeny may occur anywhere large quantities of radium-bearing materials are found and, therefore, the monitoring of these substances is essential to the maintenance of radiation safety.

NRC and Department regulations require the measurement of either radon itself or its progeny, although progeny concentration measurement is more appropriate as this is the best indicator of worker dose.

Radon progeny measurements are generally expressed in terms of "working levels" (WL) for which the limit is 0.3 WL.

Required monitoring frequency is dependent upon radon daughter levels as compared to the limit. Quarterly sampling is sufficient below .03 WL (10%). Monthly sampling is needed where levels fall between .03 to .08 WL (10-25%) and weekly sampling is required above this level.

4.5.6.2.1 Description

Radon daughter sampling is accomplished using an MSA Portable Permissible Pump and Gelman 25mm type A/E Glass Fiber Filter. Sampling is for 5 minutes at a rate of 2 l/min. All procedures including calibration are described in LC 11.2, Section 18.

Sampling was done monthly at locations where Rn-222 would be expected to accumulate. Both morning and afternoon sampling was done at each location. With the mill shut down sampling has been reduced to quarterly in most locations. Any area with radon progeny concentrations exceeding the appropriate action levels has been closed off to employees.

Working levels of radon progeny are determined by the modified Kusnetz method, with alpha counting using a Ludlum 2200 scaler. In August 1984, Umetco reached agreement with the Environmental Defense Fund (EDF) concerning radon monitoring at Uravan. The procedures were implemented pursuant to LC 11.4-1. LC 11.1, Addendum A, presumes that the Umetco/EDF framework will be continued and adapted during remedial action construction period to carry out the intent of paragraph 6 of the August 21, 1984 EDF-Umetco agreement letters (62-861203:2).

4.5.6.2.2 Evaluation

The procedures specified by Umetco are adequate. The closure of areas above 0.08 WL is commendable from an ALARA standpoint. LC 27.5.4 requires selected radon progeny measurements.

4.5.6.3 Exposure Calculations

4.5.6.3.1 Description

A time study of all employees is conducted quarterly by the RSO or under RSO review to determine the amount of time spent in each area of exposure. Monthly breathing zone samples using prescribed portable samplers are taken to assure reliability of general air sampling. Analysis of routine samples and the perceived likelihood of reaching the action level of 25% MPC determines where work areas require the use of personal breathing zone samplers.

When non-routine maintenance is performed, detailed, accurate records are kept to calculate exposure to airborne radionuclides (both time and concentration). Dust samples taken while work is performed are used in this exposure assessment. Periodic breathing zone samples using prescribed portable samplers and appropriate attachments for sampling airborne dusts, are used to assure accurate assessment of exposures during non-routine work assignments.

For each job category, work assignments are studied to determine those in which concentrations exceed 25% MPC. Actual time spent in each area is observed and documented at least semi-annually and the estimated amounts of time spent revised accordingly. The RSO will review exposure data at least weekly to ensure that exposures for each job category are ALARA.

If an employee reaches an action level of 25% of MPC based on Time Weighted Exposure (TWE) over a period of one (calendar) quarter, the RSO institutes an investigation of their work record and exposure history to identify the problem. Any problems noted are then studied and corrective action taken to ensure that exposures are kept ALARA.

4.5.6.3.2 Evaluation

Umetco's time-weighted exposure procedures generally meet Department requirements.

LC 27.5.5 requires that in certain cases additional procedures be established to maintain employee exposures ALARA. Such procedures are to explicitly include contributions from areas less than 25% of MPC. Proposed LC 27.5.5 states that in no case shall time-weighted studies be less frequent than quarterly.

4.5.6.4 Action Levels

Two types of action levels should be considered by a mill's radiation safety staff: the 40-hour control measure and administrative action levels.

The 40-hour control measure, specified in 10 CFR 20.103 (b)(2) and 6 CCR 1007-1-4.4.4.2 is an action level indicating that if an employee is subjected to an intake exceeding 40 MPC-hours during a week: the cause must be determined; corrective action must be taken; and a record of this action must be retained. If the sum of the ore dust and yellowcake exposures exceed 40 MPC-hours for 1 week, an overexposure has occurred.

Administrative action levels are established by management to maintain exposures ALARA and should be specified in the following areas:

1. Uranium Ore Dust. An action level somewhat above the levels existing within the normally operating mill should be set for each sampling station. Levels in excess of this should initiate investigation and action by the RSO.

2. Yellowcake. Action levels should be set in a similar manner for all sampling stations and maintenance operations. Excesses should be treated with investigation and action.

3. Radon Progeny. An action level for each sampling station should be set.

4. Time-Weighted Exposures. An action level of 25% of the exposure limits should be set based on the weekly limit for soluble uranium, quarterly limit for ore dust and yellowcake combined and an annual limit for radon daughters.

5. Gamma Dose Rates. An action level for each station at which gamma dose rates are periodically measured should be set.

6. Dosimeter Results. The RSO should set action levels for monthly dosimeter results.

7. Contamination on Skin and Clothing. The action level is 100 dpm/100 cm^2.

8. Low Airborne Radioactivity Readings. Abnormally low readings of airborne radioactivity should be investigated as they may indicate an equipment malfunction or procedural error. The RSO should establish action levels for low readings of airborne radioactivity.

4.5.6.4.1 Description

Although historical experience has shown UCC/Umetco to take action at appropriate levels, no specific action levels as discussed are presented within the LC 11.2.

4.5.6.4.2 Evaluation

The present shut down status makes comprehensive implementation of the above recommendations impractical in most cases. LC 27.7 requires that action levels be specified by Umetco and included within LC 11.2 for the parameters discussed above which are appropriate to the present situation.

4.5.7 BIOASSAY PROGRAM

The Department heavily emphasizes the importance of a competent bioassay program. The bioassay program is designed to determine the adequacy of air sampling data, dust suppression systems and respiratory devices. Bioassay methods for uranium mill workers typically include urinalysis and in vivo measurements.

Urine values over 15 ug/l indicate that investigative action be taken by the RSO. A 30 ug/l value is the limiting value above which chemical toxicity to the kidney may occur and therefore actions such as work restrictions for individual employees are considered when urinalysis values reach this level.

In-vivo analysis is used to determine the presence of insoluble uranium deposited within the lungs.

4.5.7.1 Description

Umetco's bioassay program is described within Section 21 of LC 11.2. Yellowcake workers or workers exposed to large quantities of ore dust are monitored every two weeks. Quarterly analysis is required of workers exposed to levels of 25-50% MPC and other workers are assayed annually.

Samples are normally taken between 48 to 96 hours of an employees last exposure to uranium bearing dusts except when shift schedules make this impossible. This is to assure the detection of uranium with longer lung retention times.

Samples having assays above the action limits (15 ug/l) initiate phone transmision of their results so that prompt action can be taken.

Action levels and possible actions are clearly spelled out by UCC/Umetco for specimens indicating the presence of problems.

4.5.7.2 Evaluation

The urinalysis program for the Uravan mill described in LC 11.2 indicates that assays are taken with sufficient frequency and the procedures are consistent with NRC Guidelines in Regulatory Guide 8.22, "Bioassay at Uranium Mills". Action levels are well described. Specimen collection and analysis is performed by the approved methods.

The failure to obtain a baseline urinalysis for one new employee was cited in the 1983 inspection.

LC 27.4 defines action levels and frequencies for the operations of the urinalysis program.

Although in-vivo measurements for the detection of insoluble uranium require sophisticated equipment not generally accessible to remote areas such as Uravan, an in-vivo program is recommended for Uravan workers. The decreased importance of a uranium urinalysis program in a situation in which ore-dust and yellowcake are not present on site is recognized. The increased importance of determining any intake and retention of uranium progeny (thorium, radium, etc.) from tailings exposure is concurrently noted.

4.5.8 QUALITY ASSURANCE PROGRAM

The aim of a quality assurance program is to (1) assure proper calibration of instruments and sampling equipment on a routine basis, (2) assure that lower limits of detection, sensitivity of instrumentation and analytical techniques are adequate to provide good quality data on worker exposures and effluent releases, and (3) allow reporting of results to include not only counting error, but all significant random uncertainties associated with the measurement. The quality assurance program should encompass both data generated by mill personnel and by contractors supplying analytical services.

Quality assurance comprises all those planned and systematic actions that are necessary to provide adequate confidence in the results of a monitoring program. Guidance for the establishment of a satisfactory quality assurance program is contained in RG 4.15 "Quality Assurance for Radiological Monitoring Programs" (31G-790200).

A satisfactory program will contain details of: organizational structure and responsibilities of managerial and operational personnel; qualifications of personnel; operating procedures and instructions; record keeping; quality control in sampling; quality control in the radioanalytical laboratory; performance checks of radiation measurement systems; analysis of intralaboratory and interlaboratory quality control samples; review and analysis of data; and audit procedures.

4.5.8.1 Description

The quality assurance program for Uravan encompassed both procedures for sampling, carried out by mill personnel, and the laboratory quality assurance policy which was applied by personnel at the UCC/Umetco Analytical Laboratory in Grand Junction. The UCC/Umetco laboratory has since been disbanded. Samples are processed by outside laboratories with their own internal quality assurance program.

4.5.8.2 Evaluation

The quality assurance program as described in LC 11.2 and the UCC/Umetco Laboratory manual met Department requirements. Sufficient information was received by the Department to indicate that the sampling program and the laboratory program operated within a set of guidelines ensuring the quality and accuracy of the resultant data.

Reevaluation of the outside laboratory analytical programs must now occur.

LC 11.1, Addendum A, provides the framework for quality assurance and quality control for all remedial actions at Uravan.

The Department recommends that use of a computerized system for data handling be investigated by UCC/Umetco to aid in the manipulation of the large volume of information related to the Uravan project.

4.6 ENVIRONMENTAL AND EFFLUENT MONITORING PROGRAM

Environmental monitoring enables the Department to estimate maximum potential radiation doses to individuals and populations near the site.

More specifically, this monitoring allows determination of compliance with LC 18.6 which prohibit off-site doses in excess of 25 mrem/yr to the whole body 75 mrem/yr to the thyroid, and 25 mrem/yr to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials, radon and progeny excepted, to the general environment from uranium mills (62-861203).

Monitoring must be performed to determine the release of radionuclides in or to the following forms or sources: air particulates, radon gas, ground water, surface water, soils, and vegetation.

4.6.1 AIR PARTICULATES

4.6.1.1 Description

Air particulate sampling is done both at the sources (stacks) and at sampling stations on or near the mill site. Procedures for equipment use and calibration, calculations and record keeping, and sampling frequency and quality assurance are described within LC 11.4-1.

The stack sampling program [LC 11.4-1(8)] encompassed the isokinetic sampling of the ten mill stacks which include: 1 yellowcake dryer stack, 1 yellowcake area general ventilation stack, 2 sample plant stacks, 4 aerofall mill stacks, and 2 ore storage bin stacks. No stacks are now in use. The two sample plant stacks are disengaged and cannot be used.

Air particulate samples are taken with General Metals Works high volume air samplers set at nine locations at or near the mill area boundaries. Samples are taken west of the Tailings Pile 2, on Spring Creek Mesa, at the Tabeguache No. 2 well (background), and at 5 locations within the San Miguel Valley from south to north of the town of Uravan. Sampling is done continuously except for down time for maintenance and monthly calibration, with filters being changed at least weekly. Filters are analyzed for U-nat, Th-230, Ra-226, and Pb-210.

4.6.1.2 Evaluation

The air monitoring program, as prescribed by LC 28.4, is acceptable.

4.6.2 RADON GAS

4.6.2.1 Description

Ambient radon gas monitoring was accomplished until 1984 with the use of Passive Environmental Radon Monitors (PERMs) manufactured by EDA Associates. These PERMs use TLD chips for determination of alpha and gamma levels.

The PERMs were distributed to 23 sampling locations and changed monthly. The locations include the air particulate sampling stations discussed previously plus others.

Calibration and analysis of the PERMs was handled by the Grand Junction Laboratory. Use of a track-etch detection system was begun in 1984. The radon calibration facility at the Bendix Corporation DOE Complex has been used. Umetco committed to EDF in 1984 to monitor ambient radon levels, with set contingent actions (00-840821; 62-861203).

4.6.2.2 Evaluation

The sampling locations and frequencies committed to for the radon sampling program, as augmented by LC 28.5, are acceptable.

UCC/Umetco data indicated a calibration problem with the PERM existed for several years from 1981-1983 leading to a large number of low results. The Department has concurred in the use of the track etch detection system instead of PERMs. No radon standard traceable to the National Bureau of Standards yet exists. Calibration is extremely difficult.

4.6.3 GROUND WATER

4.6.3.1 Description

Groundwater sampling is done to determine the extent of contamination originating from mill liquids. The two basic monitoring areas, described in LC 11.1, are at Club Mesa and along the San Miguel River.

The Club Mesa monitoring system includes wells located hydrologically both up and downgradient from the tailings and spray area and their depths range from 50 to 860 feet. Sample frequency and constituents to be analyzed are in Amendment A to LC 11.1. Seeps occurring on the Hieroglyphic Canyon rim and at the San Miguel Canyon rim above "C-Block" are monitored on a quarterly basis.

The San Miguel River monitoring system is necessary to assess contamination of ground water in the San Miguel Valley. Sample frequency and analysis is listed in Addendum A to LC 11.1.

Additional groundwater sampling occurs via the Uravan domestic water supply which originates from Tabeguache No. 2 well and Spring Creek No. 1 well. These wells are in locations and from depths precluding reasonable chances for contamination.

4.6.3.2 Evaluation

The locations and sampling frequencies acceptable for the Club Mesa and San Miguel River monitoring system, are described in LC 11.1.

The Department has concern over the monitoring of the seeps originating from the canyon walls. The licensee's program for identification and mapping of regular seeps will be augmented by the water flow and quality monitoring required in LC 11.1.

4.6.4 SURFACE WATER

4.6.4.1 Description

The San Miguel River is the major surface water in the Uravan area. Additionally, the Club Ranch Ponds and River Ponds containment release contaminated liquid near the river.

The San Miguel River has been monitored at 4 locations. One is upstream of the mill and 3 are downstream, with the last downstream sample being from the Dolores River which the San Miguel enters approximately two miles below the mill. The San Miguel River samples were taken daily and composited for a monthly analysis. The Dolores River samples were taken weekly for a monthly composite. Analyses are done for the radionuclides U-nat, Ra-226, Th-230, Pb-210 and Po-210. Stream flow is determined by the U.S. Geological Survey.

Each of the Club Ranch ponds is sampled semi-annually. A composite is analyzed for 35 separate parameters including the 5 above listed radionuclides.

4.6.4.2 Evaluation

The locations used for monitoring surface waters are described in LC 11.1, Addendum A.

Even though the tailings ponds constitute a "surface water", the Department concurs that routine sampling of the liquid within the ponds is not required.

4.6.5 SOILS

4.6.5.1 Description

Soil samples of 1.2×10^3 cm^3 (.041 cubic feet) volume have been collected annually near the 9 ambient air sampling stations and submitted to the laboratory for radionuclide analysis.

In order to more properly assess the effects of plant operations on soil content, deposition rate samples were also taken. The method involved mounting an open-ended container 2 meters above ground plane for a known time interval and then measuring the deposited contents. After acid dissolution of the contents, the resultant solution was submitted for radionuclide analysis.

4.6.5.2 Evaluation

The soil monitoring program, as described in LC 11.4-1, and augmented pursuant to LC 28.9, meets Departmental requirements. The inclusion of deposition rate samples added additional information which was helpful in evaluating current operations.

The 1983 Department inspection (10-830312) indicated an item of non-compliance in that UCC/Umetco failed to collect and analyze soil samples for 1982.

No mention was made by UCC/Umetco of collection and analysis of sediment samples from the San Miguel River. As plant operations are likely to cause addition of radionuclides to the river sediment which through leaching may effect river water quality for periods long after plant decommissioning. LC 28.8 requires sediment sampling be addressed. Any program should be consistent with the requirements of NRC Regulatory Guide 4.14.

4.6.6 VEGETATION

4.6.6.1 Description

The May 1984 procedures specified in LC 11.4-1(11) required the sampling of garden vegetables each growing season at four locations near the ambient air monitoring sites where such vegetation may exist. Forage vegetation was to be sampled at all nine monitoring sites [LC 11.4-1(11)]. Vegetation is to be analyzed for U-nat, Th-230, Ra-226, Pb-210, Po-210.

4.6.6.2 Evaluation

LC 18.6.3.1 prohibits the growth of garden vegetables on licensee-controlled property at Uravan. As the contribution of the ingestion pathway is a significant portion of the total dose, adequate monitoring of any vegetation, grown and consumed locally is important in the Uravan situation.

Studies undertaken by UCC/Umetco in the past included a 1982 (00-830927) garden survey and calculations of ingestion rates. Vegetation nuclide contents measured in previous years for a large number of species were used in calculating ingestion doses.

The 1983 Departmental inspection cited UCC/Umetco for failure to collect and analyze vegetation samples in 1982.

LC 18.2.3 in Amendment 20 to License SUA-673, and now LC 18.6.3.1 of license 660-02S, prohibits vegetable gardening in the town of Uravan. As stated in UCC/Umetco's May 7, 1984, letter, this eliminates the ability, and the need, for sampling of garden vegetables. The sampling of potential forage vegetation remains required by LC 28.11.

Although it is stated by UCC/Umetco to be an uncommon occurrence, the sighting of cattle grazing near the site boundaries during the April 1983 Departmental inspection, observations May 9, 1984, and subsequently, indicated that beef sampling might need to be undertaken until convincing evidence is provided that beef raised locally is not eaten locally. LC 18.6.3.2 obviated the need for beef sample collection.

Analysis of fish samples from the San Miguel River will be undertaken semiannually for radionuclide analysis as provided by LC 11.4-1 if the Radiation Division and WQCD agree such samples are necessary or as specified pursuant to LC 11.1 and LC 28.1.2.

4.6.7 EXTERNAL GAMMA MONITORING

4.6.7.1 Description

External gamma is monitored at the ambient air sampling sites using the spherical container TLD badges of Eberline. The containers, each containing five TLD chips, are mounted one meter above ground plane at each site with two containers per site. The containers loaded with TLDs are received the first of each month from Eberline and exchanged with those in the field. A background TLD is stored in a lead-lined container as a transportation control. The TLDs are returned to Eberline for processing [LC 11.4-1(11)].

4.6.7.2 Evaluation

The monthly determination of gamma exposures rates meets Department requirements. Storage of control badges in lead boxes will yield lower background readings and thus slightly elevated net readings in most situations, although a convenient control location may not be available in Uravan.

4.7 RESTRICTED AREAS AND ACCESS CONTROL

Any area with access controlled by the licensee for purposes of protection of individuals from exposure to radiation and radioactive material is defined as a "controlled area" in 6 CCR 1007-1-1.6 of the Radiation Rules. The mill and tailings area should be completely fenced to restrict access, and the fence should be posted with "Caution, Radioactive Material" signs. If the fence and all entries are posted and in addition contain the words "Any area within this mill may contain radioactive material", the entire area is posted adequately to meet Departmental guidelines (NRC RG 8.30 at 6). Additional posting of each room with "Radioactive Material" signs is not necessary.

"Radiation Areas" and "Airborne Radioactivity Areas" must be posted as directed by 6 CCR 1007-4.11.

4.7.1 Description

Observations made during past departmental compliance inspections (April, 1983) (10-830412) revealed the mill and tailings area were unfenced in most locations. Signs indicating the existence of a "Controlled Area" are posted near the plant boundaries. The Umetco letter of May 7, 1984 (00-840507) described a plan for fencing the controlled area boundary by which included gates at mill entrances but the lack of a complete site barrier. This fencing was installed in 1985.

4.7.2 Evaluation

Umetco must submit procedures for access control and security to be included in LC 11.2. The plan for fencing the controlled area is acceptable. A complete barrier will be required at the time of final reclamation.

4.8 EMERGENCY PROCEDURES

The possibility of accidents leading to environmental damage or personal injury is a reality in an industrial situation such as a uranium mill. Consideration of the types of accidents possible in and around the mill plus measures to deal with them are the responsibility of mill management.

4.8.1 EMERGENCY RESPONSE PLAN

4.8.1.1 Description

UCC's Emergency and Disaster Plan [LC 11.4-1(25)] describes the responsibilities of all supervisory personnel at Uravan in the case of an emergency. The plant superintendent is responsible for the preparation of the emergency plan.

Stated incidents for implementation of the disaster plan are earthquate, major floading, tailings dam break, major fire, major chemical or gas release, and a bomb threat or threat of war.

A system for alerting local residents and mill workers by public address, radio broadcast and sirens is described as is a generalized assembly procedure.

Specific procedures are described for tailings dam breaks, floods, earthquakes and bomb threats in which procedures for notification, assembly, evacuation if necessary, and action are described.

4.8.1.2 Evaluation

The described procedures are well organized and meet regulatory requirements.

LC 15.2.2 requires that plans be included for prompt retrieval of any radioactive materials released to uncontrolled areas.

LC 15.2.3 requires that equipment be available for emergency response.

4.8.2 TAILINGS IMPOUNDMENT

4.8.2.1 Description

Failure of the tailings impoundment retention system could lead to extreme hazards to mill workers and Uravan residents including flooding and deposition of tailings on the canyon floor, therefore every effort must be made to ensure stability of the tailings impoundment. Precautions to ensure impoundment integrity include inspections every shift [LC 11.4-1(1)] and maintenance of adequate freeboard, beach width and reserve capacity as required by LC 23.2. The emergency response plan for a tailings dam break includes [LC 11.4-1(25), p. 8-10] provisions for power shutdown, reporting to authorities, assembly points and evacuation plans.

4.8.2.2 Evaluation

Engineering design to prevent tailings impoundment failure is of prime importance. The tailings ponds have been buttressed to resist static and dynamic forces and designed to hold probable maximum precipitation events.

The emergency response plan described by the licensee meets regulatory requirements and was tested in the presence of the Division of Disaster Emergency Services staff. (23-800312) The licensee has complied with LC 15.2.2, which requires that emergency response plans be submitted to the Division of Disaster Emergency Services for comment and approval of a test of the plan.

4.8.3 FIRE PREVENTION

4.8.3.1 Description

Fire plans are routinely supplied to MSHA. The April 1983 Department inspection (10-830412) indicated that Umetco had its own fire department on the mill site. Local fire departments now provide service to the site.

4.8.3.2 Evaluation

Description of a fire prevention system will be required within LC 11.2 as required by present LC 15.2.2.

4.8.4 HIGH WINDS

4.8.4.1 Description

No specific plan for response in the event of high winds or a tornado has been submitted by UCC. The Uravan area should experience about thirty-five thunderstorms per year with July and August having the highest frequency of occurence. In this area, strong winds and hailstorms can accompany thunderstorm activity. No tornados were reported in the region from 1952 to 1963 and there is negligible probability of a tornado striking the area (00-820331-13:2-70).

4.8.4.2 Evaluation

Although Umetco has not described the upper wind velocity limit that mill structures are designed to sustain without damage, the cessation of operation leaves little of a hazardous nature to be dispersed in the case of a tornado or wind storm.

4.8.5 TRANSPORTATION ACCIDENTS

4.8.5.1 Description

Previously, the dry yellowcake end product of the milling operation was packaged in 55-gallon drums and shipped from Uravan to Grand Junction by truck and then by rail to its final destination. Although UCC/Umetco estimated the probability of an accident resulting in a major release of yellowcake at one for every 4500 years (LC 00-820331-13:Section 7), response plans have been devised and documented [LC 11.4-1(22)].

UCC/Umetco makes clear the fact that liability and clean-up costs are the responsibility of the carrier although due to knowledge of the product's hazards, UCC/Umetco is obliged to help.

The Manager of Plateau Operations is responsible for implementation of the response plan. Vehicle operators and emergency response personnel are given a basic indoctrination on transportation accident response whereas a field demonstration and exercise is conducted annually to assure preparedness.

A communications scheme including notification of the response team, company management, the DOT, NRC, the State of Colorado, and the Department of Energy (DOE) is described. Equipment necessary for use in spill cleanup is available with most of it kept at the Grand Junction office.

UCC/Umetco's accident plan describes the monitoring to be performed to establish the area of the spill. The area is roped off and posted with "caution radioactive materials" signs. The bulk spill is shoveled into lined metal drums and the residual material vacuumed.

Further decontamination methods are described including scrubbing with rags, brushes, or steel wool. The plan states that prior to abandoning the accident site, acceptable levels of surface contamination (5,000 dpm/100 cm^2 average) must be met. Procedures for personnel safety such as use of protective clothing and respirators are required while working at the spill site.

4.8.5.2 Evaluation

The plans made by UCC/Umetco for response in the case of a transportation accident and subsequent yellowcake spill are acceptable, with the admonition that the initial goal is always that background ranges be achieved by cleanup if at all possible, as provided by LC 32.2.1.

4.8.6 PROCESS SPILLS

4.8.6.1 Description

Numerous sources existed within the mill area during operations for spills of solutions including those with significant radionuclide content. Currently the inventory of such sources is minimal.

Nevertheless, LC 11.4-1(29) contains a description of the Uravan "Chemical Spill Prevention and Countermeasure Plan". Herein the Uravan site is analyzed as to drainage areas, flows, and existence and capacities of catchment basins. Catchment pond discharges are discussed in relation to possible alternatives in the event of a spill of any sort. Each process tank within the mill area is listed along with its primary, secondary and tertiary containment systems if existant.

The maintenance, inspection and disposal of any on-site equipment containing PCB's is described by UCC/Umetco in great detail in LC 11.4-1(26).

Although spill control programs are described, the primary responsibility of plant management is avoidance of spills. Umetco has equipped process tanks with level indicators that will sound an alarm if a tank is filled beyond its design capacity. Umetco inspects tanks and piping periodically for leaks or signs of weakness.

4.8.6.2 Evaluation

Although all process tanks are shown to have containment systems, the Department has had concern over their adequacy. The use of the hillside collection pond with an 18,000 gallon capacity as primary containment system for 80,000 gallons of the aerofall thickener liquor was unwise.

Historical data indicate a history of spills including 5 in which raffinate entered state waters between September 1979 and September of 1981 (11-810923). With construction of a new pipeline to the Club Ranch Ponds, spill incidents abated.

The use of ditches and containment ponds will generally prevent process spills from directly entering the San Miguel River, but they are not a state-of-the-art system, as was evident during recent CCD tank breaches. A spill containment plan was agreed upon between Umetco and WQCD on April 20, 1982. A revised spill prevention and containment plan was submitted February 8, 1984 to the WQCD and has been accepted.

4.9 MILL DECOMMISSIONING

4.9.1 Description

LC11.1, Section 4.6, prescribes the mill decommissioning framework. According to past UCC/Umetco documents (00-810922 and LC 11.2), mill site decommissioning is designed to return the area to essentially its original state and to allow unrestricted use of the site. In the past, UCC/Umetco has stated a commitment to ensuring a mill which follows the ALARA philosophy during its operation and thus will best minimize the mill site decommissioning cost. Salvagable items are to be removed from the site and unsalvagable items will be disposed as provided in LC 11.1, Section 4.6. The building and equipment to be salvaged would be cleaned with steam or high pressure water, with the liquid effluent being pumped to the evaporation ponds. The entire building would then be broken up, removed and buried in the tailings or other disposal area (00-810922 and 00-841009:20).

UCC/Umetco generally has proposed to scrape contaminated soil areas assessed by gamma survey, to remove the contaminated layer of soil to the tailings piles, and to place previously stockpiled material on the scraped areas (LC 11.1, see also 00-810922).

4.9.2 Evaluation

The Department's "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Radioactive Material", which are equivalent to the 1978 NRC guidelines cited by UCC/Umetco (00-810922 and LC 11.2), are incorporated as Annex C to the License. If applicable revisions are forthcoming, Annex C will be revised by license amendment.

Total decommissioning of the mill is not necessary for protection of public health and safety at this time in view of the activities authorized in LC 11.9 and the extensive remedial activities and compliance schedules required by the Consent Decree and LC 11.1.

LC 32.2.1 requires that, as provided in LC 11.1 and the Consent Decree, decontamination be based on statistically defensible tests of soil contamination with depth. Proposed LC 32.2.2 requires that dispersal by wind or water erosion of contaminated sediment, liner, or subliner material be minimized and reclamation of the solid and liquid waste areas be as prescribed in LC 11.1. Proposed LCs 31, 32 and 33 bind UCC/Umetco to establishing plans and financial assurance agreements for reclamation.

The plan described in LC 11.1 meets the Department criteria for long-term control of these waste materials.

Long term care and monitoring will be provided for by a fund established with the Department to cover costs of monitoring air, water soils and vegetation contamination, and to cover costs of erosion due to weather, animals and plants. See Section 5.7.3 of this FLS.

ENVIRONMENTAL ASSESSMENT

TABLE OF CONTENTS

5.0 SUMMARY ANALYSIS OF ISSUES

5.0.1 Outline of Section 5

This section is the written analysis of environmental impacts as required by the Uranium Mill Tailings Radiation Control Act and in accordance with RH 3.9.10.1 of the Radiation Rules.

Subsection 5.1 discusses siting aspects. Subsection 5.2 discusses the mill setting in sufficient detail to frame environmental review. Subsection 5.3 describes existing solid waste management and Subsection 5.4 describes existing liquid waste management. Subsection 5.5 evaluates radiological impacts. Subsection 5.6 completes discussion of new solid and liquid waste disposal design for continued operation (Spring Creek Mesa). Subsection 5.7 completes discussion of long-term containment in relation to criteria in the Radiation Rules. Subsection 5.8 considers land, cultural and socioeconomic impacts.

Unlike a National Environmental Policy Act (NEPA) Environmental Impact Statement, which is a "decision-informing" document, this FLS is a decision document. Throughout Section 5, as before in Section 4, reference to License 660-02S is intended to directly relate the staff analysis to recommended action.

Subsections 5.1 and 5.2 are primarily by W. Rane Junge, Section 5.5 is by Ken Weaver and Edd Kray, and Section 5.8 by Matthew K. Jones.

5.0.2 Summary of Environmental Impact Aspects and Remedial Action Plan

Uravan operations, as shown of Figure 5.2-1, included the disposal of tailings in Club Mesa Tailings Piles 1, 2, and 3 and the evaporation of liquid waste in the Club Mesa Spray Area and from the Club Ranch Ponds. Additional liquid waste was stored, treated, and released from the River Ponds. In addition to tailing material, two other forms of solid waste were produced at Uravan. Evaporation of liquid waste created a crystal residue. Water pre-treatment formed sludges. Crystal residue was deposited near Atkinson Creek and sludge at various locations on Club Mesa.

The complex disposal practices have resulted in:

- Wind and water dispersal of the tailing material and the uncontrolled release of radon from the tailings piles.
- Seepage of contaminated liquids from the spray area, tailings ponds, evaporation ponds, and treatment ponds into the San Miguel River via ground and surface water.

These conditions will be minimized during and after the reclamation of the existing facilities at Uravan. The Remedial Action Plan (RAP), incorporated into License 660-02S as LC 11.1, requires the control of radon emissions and blowing tailings, limits the amount of seepage, and requires the long term control of the solid waste material for thousands of years.

As stated in the introduction to LC 11.1, the Remedial Action Plan, the major areas containing contaminated solids are:

- ATKINSON CREEK CRYSTAL DISPOSAL AREA: This is a covered, unlined repository containing raffinate crystals, adjacent to Colorado Highway No. 141.

- CLUB RANCH PONDS: These are six (6) unlined evaporation ponds containing primarily raffinate crystals and ponded liquids located adjacent to and above the San Miguel River.

- RIVER PONDS: These are seven (7) settling ponds, containing settled solids and tailings, constructed adjacent to the San Miguel River.

- TAILINGS PILES: These are three (3) Tailings Piles containing over 10,000,000 tons of tailings located on Club Mesa.

- CLUB MESA AREA: This area includes two (2) clay-lined storage ponds, a neutralized sludge storage area, and area which was used for the spray evaporation of raffinate liquid and an adjacent area of soils contaminated by spray from the evaporation procedure.

- MILL AREAS: These areas consist of the A- and B-Plant areas, an ore stockpile area, a barrel storage area, a heap leach site, a yard (bone yard) for scrap equipment, and adjacent contaminated materials.

- TOWN AND ADJACENT AREAS: These areas consist of the Uravan town, town dump, adjacent drainageways (Atkinson Creek, San Miguel River, Hieroglyphic Canyon, and dry washes) and remnant waste materials previously used in near-site construction activities.

Ancillary areas which will be impacted by the remedial activities include:

- THE BURBANK QUARRY: This is a borrow pit for rock and random fill to be used during cleanup and reclamation activities, and is the designated final repository site for raffinate crystals.

- BORROW AREA ON CLUB MESA: This is the primary borrow source for clayey soils and random fill.

Contaminated liquids subject to cleanup and disposal include: tailings seepage (hillside and toe berm), tailings dewatering liquids, ponded liquids, surface runoff, and groundwater.

In additon to Section 5.2 of this FLS, details of the Uravan site and regional setting are found in Sections 2 and 3 of LC 11.1.

In general, the reclamation plan for the existing facilities at Uravan includes the removal of the Club Ranch Ponds, Atkinson Creek Disposal Area, and River Piles from the San Miguel River valley. Contaminated soil and substrate materials from these areas will be transported and placed on Club Mesa within the Tailings Piles. Crystals from the Club Mesa Spray Area will also be relocated to a new disposal area. All areas where contaminated material has been removed will be reclaimed. Tailings Piles 1, 2, and 3 will be reclaimed in place, with a cover designed to withstand wind and water erosion as well as reduce radon emissions. The tailings piles will be monitored for settlement and decrease of the phreatic surface. Seepage from the toe berm, seepage from the Club Mesa hillside and contaminated ground water will be collected and disposed of by evaporation.

The description of remedial activities in LC 11.1, the Remedial Action Plan, includes:

- A brief discussion of UCC/Umetco's operations at each contaminated area and observed impacts on the environment.
- A description of remedial activities and cleanup criteria. Remedial activities include cleanup and reclamation of affected areas where applicable.
- A description of requisite assessments and engineering activities.
- Schedule for implementation.
- Requisite quality control/quality assurance (QC/QA), monitoring, performance evaluation and inspection.

In accordance with the schedule in LC 11.1, UCC/Umetco shall provide prior to construction Final Plans and Specifications for all remedial activities and a Quality Control/Quality Assurance, Monitoring and Performance Evaluation Plan for approval by the State. The State will develop an Inspection and Certification Plan for remedial activities at Uravan. UCC/Umetco shall perform all remedial activities in accordance with the plans, specifications and procedures prescribed by these documents.

Immediately after UCC/Umetco completes remedial activities at each area, UCC/Umetco shall prepare and submit to the State a Final Construction Report. This document shall include as-built drawings, quality control surveys and test results, and construction surveillance information. State approval of the Final Construction Report for a given area shall signify completion of construction activities in accordance with Approved Final Plans and Specifications.

Prior to termination of the Consent Decree, UCC/Umetco shall prepare and submit to the State a Certification Report. The Certification Report shall contain an explanation and assessment of cleanup and reclamation activities conducted in accordance with applicable provisions. State approval of the Certification Report shall signify UCC/Umetco's completion of remedial activities in accordance with License 660-02S.

5.1 SITING, INCLUDING ALTERNATIVES

5.1.1 Natural Features Limit Disposal at Present Site

The existing tailings piles at Uravan were without additional capacity due to the geometry of the disposal area and pile configuration. Additionally, the liquid waste areas are not state-of-the-art. Because of these facts, the present disposal facilities at Uravan are not adequate for any additional operation. Therefore, by license condition, discharges to these tailings piles were to cease on or before July 1, 1985 per Amendment 20 to License SUA-673. Discharge of tailings did in fact cease November 15, 1984.

A new disposal area would have to be chosen if operations were to resume. Natural features, such as flooding along the narrow river valley, steep canyon walls, and limited flat areas on Club Mesa, preclude the use of areas directly adjacent to Uravan for disposal of large volumes of tailings. A detailed evaluation of sites around Uravan was conducted to determine the best alternative disposal area.

The site selection process was conducted in 1980 in support of UCC's long range plans for the operation of the Uravan mill. A site which would accommodate approximately nine million tons of tailings and approximately 350 gallons per minute of effluent over a seventeen year period was needed. Numerous sites within fifteen miles of the Uravan uranium/vanadium milling operation were investigated. The local topography of the Uravan area is such that the number of sites is limited. These sites fall primarily into two categories: basin systems where canyons with steep slopes would be blocked off with a retaining dam and subsequently filled with tailings and effluent; or mesas where the relatively flat topography is suited to the construction of diked retention structures.

Eight alternative disposal sites were identified and are discussed in this section. These are Spring Creek Mesa, Atkinson Mesa, Club Mesa, Saucer Basin, Long Park and three sites in Paradox Valley. Their locations in the Uravan area are shown on Figure 5.1-1.

5.1.2 Evaluation of Alternative Sites for New Tailings Disposal

Eight potential tailings disposal sites were evaluated and recommendations made to the Department as part of the licensee's long range operating plans for the Uravan mill. These evaluations were performed by various consultants according to the criteria in Schedule E, Part III of the Radiation Rules. These recommendations were in turn evaluated by a consultant to the NRC and by the Colorado Geological Survey, who corroborated the preference for the Spring Creek Mesa site. Other sites which were considered are Club Mesa, Saucer Basin, Long Park, Atkinson Mesa, and three sites in Paradox Valley. None of these sites were judged as suitable as the Spring Mesa site according to selection criteria. A synopsis of the site evaluations is presented in the following sections.

5.1.2.1 Paradox Valley Sites 1, 2, and 3

The three Paradox Valley sites are located up to seventeen miles south of Uravan. The Paradox Valley is about twenty-four miles long along a northwest-southeast axis and three to five miles wide. Although relatively isolated, the area is served by Colorado State Highway 90 and gravel surfaced Montrose County roads. The Paradox Valley has been subject to widespread faulting associated with salt flow and collapse of the original anticlinal structure. The displacement of salts could continue faulting which in turn could damage an impoundment structure or liner, thus risking the release of tailings or fluids. These sites were not given further consideration because they probably do not meet Criteria 1 and 5 of the Radiation Rules regarding long-term control and potential seepage.

5.1.2.2 Club Mesa

Club Mesa is within one-half mile of Uravan. This site is located primarily in Sections 32 and 33 of T48N, R17W, N.M.P.M. The proposed effluent and tailings impoundment area lies generally west of the existing UCC facilities. The site is accessible by County Road EE22 which crosses the sourthern half of the site. The land for the potential disposal sites is under partial control of Umetco. Part of the area is utilized for spray evaporation of raffinate effluents. The area has been mined for uranium and mine workings underlie the site. Subsidence is evident over some of the old mine workings and new subsidence is continuing to occur.

In addition to a relatively small area available for tailings disposal, there are two major disadvantages associated with tailings and effluent disposal at the Club Mesa site: 1) the existing underground mines would have a potential to subside causing leakage or affecting the long term stability of a large impoundment systems and 2) there is insufficient area for the impoundment.

This site was not given further consideration because it may not meet the long-term stability requirements of Criterion 1 and ground water protection requirements of Criterion 5.

5.1.2.3 Saucer Basin

The Saucer Basin site is located 2.8 miles west-southwest of Uravan. This site occupies portions of Sections 1 and 12 of T47N, R18N and portions of Sections 6 and 7 of T47N, R18W (all N.W.P.M.). Any tailings and/or effluent pipeline would be approximately 5.8 miles long and traverse land controlled primarily by Bureau of Land Management (BLM) and the Department of Energy (DOE) with some private parcels. The site is located in a relatively flat, intermittent drainage which opens onto the east side of the Saucer Basin.

The site satisfies a number of the technical criteria in Schedule E, Part III of the Radiation Rules. Saucer Basin is fairly isolated from population centers; Uravan, the nearest population center, is 2.8 miles away. The site is located in a topographic depression that is well protected from winds. However, being a depression, it may have ground water relatively close to the surface.

The major disadvantage of this site is that excessively high embankments would be needed to contain the tailings and effluents. Higher embankments have a greater potential for failure due to the greater weight of the structure, longer slope, and the greater exposure to attack by wind and water erosion. Also, this site is a catchment area which would require a large runoff diversion system which may not meet the criterion for no active maintenance after reclamation. Finally, a disposal capacity of this site may not be large enough to accommodate the requirements of the proposed facility.

5.1.2.4 Long Park

The Long Park site is an irregularly shaped 900-acre parcel located approximately five miles south of Uravan, Colorado. Site access is via the unpaved Long Park road which is maintained by Montrose County. The site can be reached via this road both from Uravan and from Colorado State Highway 90 through the Paradox Valley. The land on which the tailings and evaporation facility could be located is a mixture of ownership and jurisdictions including private, BLM and DOE land. The site is a northwest-southeast trending basin located on a relatively flat, high mesa flanking the Paradox Valley and is in the headwater region for an unnamed tributary to the San Miguel River. It has an upstrean drainage area of about 1.8 square miles and may be subject to minor local flooding.

Numerous abandoned and active mine workings are present at the surface and in the subsurface at the site. Existing mineral properties, headframes, ore bins and drill holes are located throughout Long Park. Most mine workings are reportedly 100 feet deep or more. It is estimated that twelve to eighteen shafts and adits presently exist throghout the entire Long Park area. These underg ound openings could pose stability problems for the embankment should they collapse due to the weight of the tailings or deterioration of underground support structures.

In addition, boring logs presented in a report by Dames & Moore (00-800530-04) indicate that portions of the site are underlain by sandstones and claystones which contain zones of highly weathered rock, soft rock, closely jointed rock, or clay seams which may constitute zones or planes of weakness in the impoundments foundations. Highly permeable zones coupled with underground mine voids could promote the migration of contaminated liquids.

While the Long Park site is generally acceptable in terms of some of the the criteria in Schedule E, Part III of the Radiation Rules, the presence of many mine shafts and adits of undetermined vertical and lateral extent beneath the site poses serious problems in terms of impoundment stability and hydrologic communication with potentially usable ground water sources.

5.1.2.5 Atkinson Mesa

Atkinson Mesa is a large tableland (3.8 miles by 3.5 miles), roughly circular with its center approximately four miles northwest of Uravan. Site access is via the gravel road maintained by Montrose County which originates in the Atkinson Creek drainage at Colorado Highway 141. From the county gravel road, access to the top of the mesa is by a steep unimproved road over the rim of the scarp. Land ownership consists of a combination of private, BLM, and DOE land. One of the larger uranium mines in the area is on the southwest rim of the mesa. On the upper surface of the mesa, just to the southwest of the site, a large shaft and headframe exists known as the Golden Cycle vent. Many waste dumps, prospect and drill holes pockmark the area and the extent of the underground working is great. The actual proximity of underground workings to the site has not been physically determined.

Atkinson Mesa is geologically and ecologically similar to Spring Creek Mesa. This site, however, offers no advantages over the Spring Creek site. Transportation and/or pumping distances are greater for effluent and tailings. Existing ore bodies on DOE land and numerous underground mines also make this site less desirable for safety and economic reasons. In addition, moving tailings and effluent to the site would entail crossing two major drainages and the disruption of more valuable wildlife habitat.

5.1.2.6 Spring Creek Mesa

The Spring Creek Mesa site is located about 2.5 miles northeast of Uravan, Colorado. Spring Creek Mesa is the most likely site based upon environmental and operation characteristics; however, the site is not in an optimal geologic and geohydrologic setting. The site is accessible by unimproved County Road U18 (Spring Creek Trail) and two jeep trails. This Spring Creek Trail passes through the site and provides access to the Uncompangre National Forest and Spring Creek Ranch. Access from the north is also available from Nucla via uninproved roads over Wild Cow Mesa and Third Park. Some mining exists to the west, but no mines are known to penetrate the site.

Criterion 1 from Schedule E, Part III of Radiation Rules gives the basic siting guidelines regarding tailings disposal. An evaluation of Spring Creek Mesa against these criteria follows.

CRITERION 1

(a) "In selecting alternative tailings disposal sites, the following site features which would assure meeting the broad objective of isolating the tailings and associated contaminants from man and the environment in the short term and for thousands of years without ongoing active maintenance shall be considered:"

(1) "Remoteness from populated areas";

There is no permanent human population on the Spring Creek site. Spring Creek Mesa is located 2.5 miles northeast of Uravan which is the nearest population center. The next nearest town is Nucla which is about eleven miles southeast of Spring Creek Mesa. This site is considered to be adequately remote from population centers.

(2) "Hydrogeologic and other environmental conditions conducive to continued immobilization and isolation of contaminants from usable groundwater sources;"

Depth to regional ground water is about 605 feet beneath the Spring Creek Mesa site. Contamination of this ground water is unlikely due to the depth of the ground water table and the intervening, relatively impermeable thick Brushy Basin Shale.

Above the Brushy Basin, perched water is present in the Burro Canyon Formation. Burro Canyon water is from 100 to 150 feet beneath the Spring Creek Mesa site and has historically been used for stock watering. Because thick, relatively impermeable shales do not separate this water from potential seepage from the disposal facilities, seepage from the proposed facilities could adversely affect this water supply.

(3) "Potential for minimizing erosion, disturbance, and dispersion by natural forces over the long term".

Spring Creek Mesa is a large flat erosionally-resistant mesa which is far above the local flood plains. Upstream catchment area is non-existant and no active faults are known to penetrate the site.

(b) "The site selection process shall be an optimization to the maximum extent reasonable achievable in terms of these features.

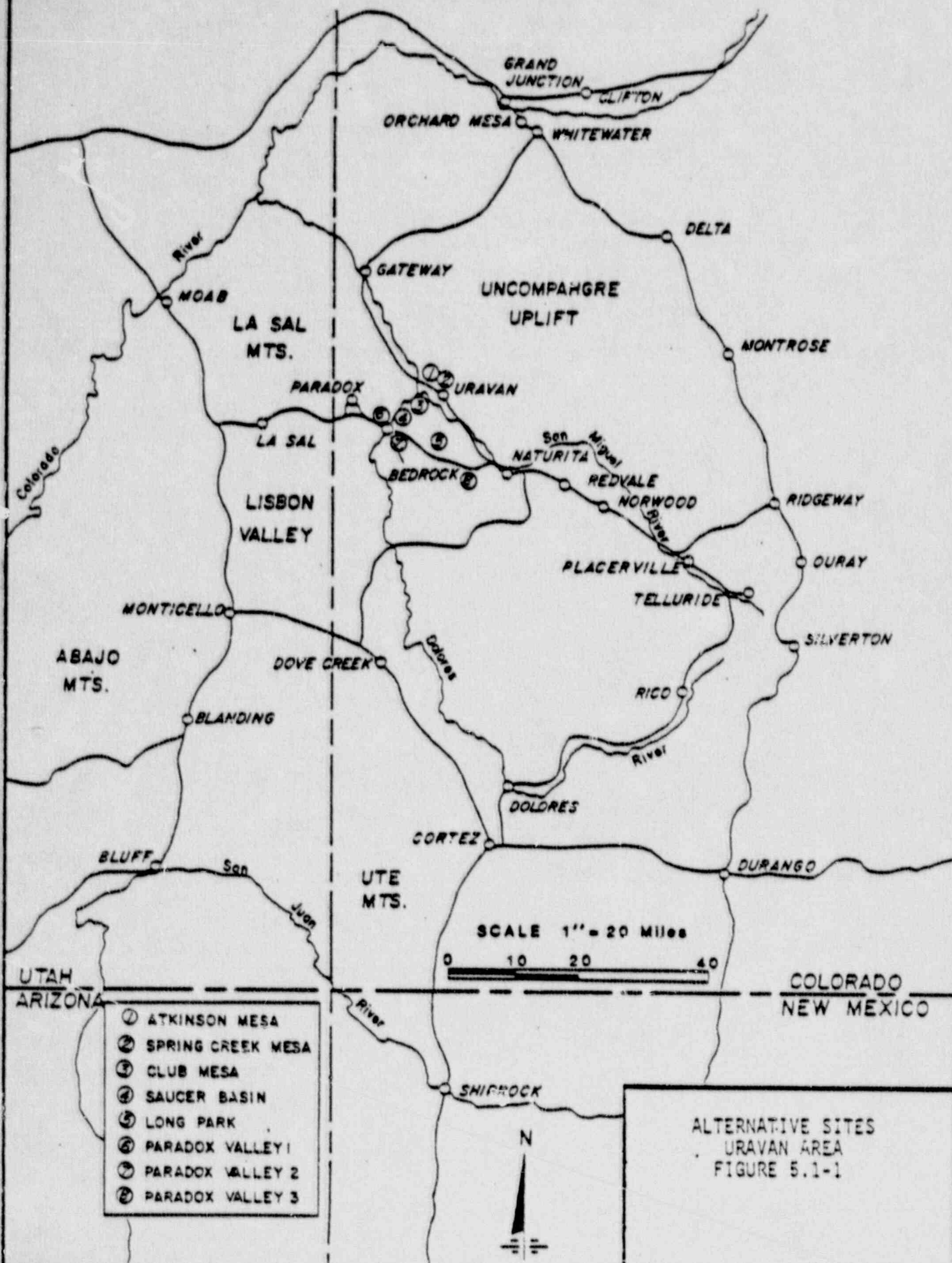
Spring Creek Mesa exhibits more properties necessary in a tailings and effluent disposal site, as compared to the other seven candidate sites. Spring Creek Mesa, however, is not located in an optimal geologic and geohydrologic setting.

(c) "In the selection of disposal sites, primary emphasis shall be given to isolation of tailings or wastes, a matter having long-term impacts, as opposed to consideration only of short-term convenience or benefits, such as minimization of transportation of land acquisition costs. While isolation of tailings will be a function of both site characteristics and engineering design, overriding consideration shall be given to siting features given the long-term nature of the tailings hazards".

Spring Creek Mesa offers the long-term erosional stability necessary to meet Schedule E, Part III containment criteria.

(d) "Tailings shall be disposed of in a manner that will require no active maintenance to preserve the condition of the site".

A design will be requisite for which active monitoring and maintenance will not be required at Spring Creek Mesa following reclamation.



ALTERNATIVE SITES
URAVAN AREA
FIGURE 5.1-1

5.2 REGIONAL SETTING AND LOCAL CHARACTERISTICS

5.2.1 PHYSIOGRAPHY

The existing Umetco Uravan tailings and mill effluent disposal facilities are located in the Club Mesa area to the west of the San Miguel River Canyon and along the river canyon floor as shown on Figure 5.2-1. A new disposal facility was proposed to the east of Uravan on top of Spring Creek Mesa.

Uravan is in the eastern part of the Canyonland section of the Colorado Plateau Physiographic Province. The topography of this region is primarily canyons and mesas. This landscape is the result of downcutting of the principal streams which drain the region and accompanying lateral cliff retreat along the canyon rims. Resistant sandstone units which cap the mesas in the Uravan area are the Dakota and Burro Canyon formations and the Salt Wash member of the Morrison Formation. Principal streams in the immediate area of Uravan have formed the mesa and canyon topography and include the San Miguel River, Spring Creek, Atkinson Creek, and Tabeguache Creek.

Geomorphic processes that have led to the present day landscape started during the Miocene or Pliocene ages, about 10 to 25 million years ago, as the result of regional uplift. River downcutting has resulted in local relief between the San Miguel River and the bordering mesas of about 900 feet. Downcutting has been more or less continuous during this time. However, several episodes of river aggradation, associated with Quaternary glacial periods, have also occurred, but have been relatively minor and short lived in comparison with the continued river downcutting.

5.2.2 METEOROLOGY

Meterologic conditions in the Uravan area are described in detail in Section 2.7 of the Dames and Moore environmental report (00-780831) and in Section 2.8 of the Gibbs and Hill environmental report (00-821206-01). Additionally, weather observations at Uravan have been performed by Umetco personnel since August 1972. Data records include daily maximum and minimum temperatures, daily precipitation, and continuous records of wind direction and wind speed. These records and data should be consulted if additional details are needed.

The monthly mean and extreme temperatures recorded at Uravan are indicated in Table 2.7-1 of the Dames and Moore report (00-780831). The annual mean temperature during the period of record was 52.2°F (11.2°C). The annual mean maximum temperature at Uravan was 68.4°F (20.2°C) and the annual mean minimum was 36.1°F (2.3°C). Extreme temperatures recorded at Uravan during the period of record show a minimum of -10°F (-23.3°C) which occurred in January 1974 and a record maximum of 106° F (41.1°C) which occurred in July 1976.

Annual and monthly mean and monthly and daily extreme precipitation values from Uravan are listed in Table 2.7-2 of the Dames and Moore report (00-780831). The annual average total precipitation received at Uravan from 1973 through 1977 was 10.1 in (25.6 cm). An annual maximum of 12.2 in (31.1 cm) of precipitation was recorded in 1975, and an annual minimum of 8.0 in (20.4 cm) was recorded in 1976. The maximum monthly precipitation recorded at Uravan was observed in October 1972 when 5.9 in (14.9 cm) of precipitation was recorded, and the minimum monthly precipitation was received in June 1974 when only 0.03 in (0.07 cm) was recorded. During the period of record, the greatest single daily precipitation amount was 1.25 in (3.2 cm), occurring on 24 July 1977.

The winds at Uravan are strongly influenced by the San Miguel River valley. The highest frequency wind directions generally parallel the river valley and are from the southeast. Winds from this general quadrant were observed 59 percent of the time during the period of record (00-780831). These winds represent the drainage flow of air that occurs generally during the night and early morning hours. Winds flowing up the river valley from the northwest were observed 24.9 percent of the time (00-780831). These winds generally occur during the late morning and afternoon or after a frontal passage. The annual mean wind speed is approximately 4.4 mph (1.95 m/s).

Over a thirteen year period, the mean evaporation rate at Grand Junction from April through October was 90.1 in (229 cm). Having a similar temperature regime, the evaporation rate at Uravan should be similar. Studies in the Uravan area show that the net evaporation rate for the entire year is 2.1 gallons per minute per acre or approximately 36 inches per year (91 cm/year).

Severe weather in the area is usually in the form of intense rainfall or hail, both resulting from thunderstorms. The ten-year storm is estimated at 1.3 to 1.5 inches of rainfall within six hours and the 100-year storm consists of 2.9 to 3.3 inches of rainfall within 24 hours (00-821206-01, Table 2.8-5). The thunderstorm season occurs during late spring and summer. Probable maximum precipitation (PMP) for a local six-hour event is estimated to be 9.7 inches. Strong winds and hailstorms could accompany any thunderstorm activity.

5.2.3 REGIONAL GEOLOGY

Regional geology and geologic history of the Uravan area are described in detail by Dames and Moore (1978) (00-780831), International Engineering Company, Inc. (1981)(00-810325) and Chen and Associates (1982)(00-821206-02). The 1982 Chen and Associates report is summarized in the environmental report prepared by Gibbs and Hill, Inc. (1982)(00-821206-01). These reports should be read if more detailed information is desired that is presented in the following summary.

Stratigraphy: About 18,400 feet of relatively flat-lying Paleozoic and Mesozoic age sedimentary rocks underlie the Uravan area. A stratigraphic column of the formations present at Uravan is shown on Figure 5.2-2. This sedimentary section consists of about 1,700 feet of mesozoic rock which is primarily sandstone, mudstone and shale of continental origins. The Mesozoic rocks are underlain by about 16,700 feet of Paleozoic rocks which consist of non-marine sandstones, and marine carbonates, evavporites and shales. This thick sedimentary section rests on Precambrian age crystalline rocks.

Surficial deposits are usually thin and are primarily colluvial, residual, and eolian deposits which are interspersed with bedrock outcrops along the canyon sides and on the mesa tops. Stream alluvium and small alluvial fans are present along the San Miguel River and its principal tributaries. Modern flood plain deposits are limited. In the Uravan area, these deposits are present upstream of the town. Downstream of the town for several miles, the San Miguel has incised a narrow canyon into the Kayenta Formation and underlying Wingate Sandstone and Chinle Formation. At Uravan, there is evidence of three former flood plain levels as indicated by thin terrace gravels. The three former flood plains lie about 10, 25 and 60 feet above the present incised river channel. These flood plain surfaces have been modified considerably by subsequent colluvial deposition from the adjacent canyon sides.

Structure: The principal structural elements in the Uravan area are shown on Figure 5.2-3. Uravan is located on the southwest limb of the northwest trending Nucla Syncline. This syncline is a relatively simple structural downwarp which lies between the structurally more complex Uncompahgre Uplift and the Paradox Valley Anticline. The Mesozoic strata at Uravan are gently inclined at about 2° towards the northeast. Folding of these major structural elements may have occurred during the late Cretaceous or Eocene Laramide orogeny, about 40 to 70 million years ago.

Faults with large displacements in the Mesozoic sedimentary rock are not present in the Nucla Syncline and major faults have not been recognized at the existing tailings or mill effluent disposal sites. Northwest-trending faults which may have been active in the Quaternary (Kirkham and Rogers, 1981) (55G-810000) are present along the western flank of the Uncompangre Uplift. Several northwest-trending normal faults which displace Quaternary deposits are present along the collapsed crest of the Paradox Valley Anticline.

Seismicity: The Uravan region is in an area which has experienced a relatively low level of seismic activity for about the last 125 years. Epicenters of earthquakes with magnitudes greater than 4.0 or modified Mercalli intensities greater than V, within 200 miles of Uravan, are shown on Figure 2.2-1 of the Chen and Associates report (00-831216-03). The more frequent and larger earthquakes in the region have occurred in the intermountain seismic zone which generally coincides with the Wasatch Mountain range in Utah. This zone of major seismic activity is located about 170 miles to the west of Uravan. Because of its distance from the site, the intermountain seismic zone will not have a major impact at Uravan. The historic seismicity from this zone probably has not caused site intensities at Uravan greater than IV and peak bedrock accelarations likely have not exceeded 0.02g.

Active Faults: Studies done by Kirkham and Rogers (1981) (55G-810000) indicate that there are several faults in the region which are suspected to be active faults. The locations of these faults are shown on Figure 5.2-4. Historic earthquake activity has not been associated with any of these faults but, geologic conditions indicate that fault movement may have occurred as recently as the Quaternary, within the last 1.8 million years. The suspected active faults are located either along the flanks of the Uncompahgre Uplift or along the flanks of the collapse Paradox Valley Anticline and other salt anticlines to the southwest.

The Paradox Valley Faults and other salt anticline faults are suspected to be actively moving at the present. However, because their movement is caused by salt flowage, they are not considered by researchers to be capable of generating moderate to large earthquakes.

The other potentially active faults northeast of Uravan are along the southwestern or northeastern flank of the Uncompangre Uplift. Detailed studies of the Uncompahgre faults would be required to establish if they actually have moved recently enough to be classified as capable faults in accordance with Nuclear Regulatory Commission criteria. Since such studies have not been made, these faults have been assumed to the capable faults and were considered in assessing the seismic risk at Uravan.

Design Earthquake: Two levels of seismic exposure, one for the short term operational phase of the project and the other for the long term post-reclamation phase of the project, have been determined for the Uravan area by Dames and Moore (1978) (00-780831). Their seismic source model accounted for both background seismic activity based on historic seismic records and potential seismic activity which could be expected if the faults bordering the Uncompahgre Uplift were actually active. For the short-term, operational phase of the facility, an earthquake exposure with an average annual recurrence interval of 1,000 years was considered. For the long-term post-reclamation phase of the facility, an earthquake exposure with an average annual recurrence interval of 10,000 years was considered. Analysis indicates that a peak bedrock acceleration of 0.12g is expected to be associated with 1,000 year recurrence interval and a peak bedrock acceleration of 0.23g is expected to be associated with 10,000 year recurrence interval.

Geomorphic Processes: Studies of geomorphic processes in the Uravan area have been made by Smith (1980) (00-810116) and by Chen and Associates (1982) (00-821206-02). The following is a summary of these studies:

Geomorphic features along the Colorado River and its principal tributaties, such as the San Miguel and Dolores Rivers in the Colorado Plateau, indicate that the Colorado River system has been downcutting during at least the last 10 million years. Long term average rates of river incision, from a variety of localities within the Colorado Plateau, range from 0.05 feet per thousand years to 1.4 feet per thousand years and average about 0.5 feet per thousand years.

(Hunt, 1956 (55G-560000); Larson and Others, 1975 (55G-770000); and Yeend, 19[illegible] (55G-690000). Canyon widening has also accompanied river downcutting during this period. Canyon widening is primarily the result of mesa rim retreat and mass wasting along the mesa flanks. Mesa tops are formed by resistant sandstone units and remain relatively unchanged during the erosional process. Slow erosion, primarily by mass wasting of the underlying weaker rock units, results in slow retreat of the rims. Although the regional geomorphology indicates that river downcutting and mesa rim retreat have been the predominant geomorphic processes, several episodes of river aggradation associated with Quarternary glacial periods have also occurred (Richmond, 1962) (55G-620000).

The past geomorphic processes of river downcutting and aggradation along with canyon widening have shaped the present landscape and are expected to continue in the future. Future long-term geomorphic rates are expected to be similar to those of the past. Since part of the existing facilities are on Club Mesa, which is about 400 to 700 feet above the San Miguel River, long-term impacts were assessed. The resistant sandstone cliffs which make up the mesa rims are actively retreating. Maximum rate for rim retreat adjacent to the San Miguel River estimated to be about 1.0 to 4.0 feet per thousand years. Retreat rates for the mesa rims adjacent to tributary drainages range from 0.4 to 4 feet per thousand years.

5.2.4 HYDROGEOLOGY

The regional ground water hydrogeology of the Uravan area has been described by Dames and Moore (1978) (00-780831), International Engineering Company (1981) (00-810325); and Envirologic Systems, Inc. (1983) (00-831216-05). These reports should be referred to for additional discussions. This summary includes a description of water-bearing zones, aquitards or confining layers, and their characteristics and interrelationships. These discussions draw upon the previous geologic descriptions given in Section 5.2.3.

Aquifers in the Uravan area, in general, are limited to the hydrostratigraphic units which have sufficient permeability to transmit ground water. These sandstone units generally have variable permeabilities due to grain size, sorting and secondary cementing (Table 5.2-1). Ground water in the region is transmitted via secondary (joint) permeability and primary (intergranular) permeability. Secondary permeability in the region tends to be directional and highly variable Mesozoic Formations capable of transmitting water in economic amounts include the Dakota and Burro Canyon Formations, the Salt Wash member of the Morrison Formation, and the Entrada, Kayenta, and Wingate Sandstones (Figure 5.2-2). Mesozoic strata which are not capable of transmitting water in economic amounts and therefore are considered aquitards include the Brushy Basin member of the Morrison Formation, the Summerville, Chinle, and Moenkopi formations (Figure 5.2-2).

TABLE 5.2-1

HYDROLOGIC PROPERTIES OF PRINCIPAL WATER-BEARING ZONES AND AQUITARDS

Formation	Position in Formation	Permeability (feet/year) Horiz.	Vert.	Storativity	Reference
Wingate	near top	220	55		1
	near middle	1	.4		1
	above base	40	1		1
Kayenta		740	6		2
		300			4
		2.4			4
Entrada	Slick Rock	30	20		1
	Moab-base	275	55		1
	Moab-top	1200	715	5×10^{-5}	1
Summerville	No data available				
Salt-Wash		55		3×10^{-5}	1
Brushy Basin		.62 to .01			3
Burro Canyon		827			3

References:

1. Lohman (1965) (55G-700000)
2. Envirologic Systems (1983) (00-831216-05:3)
3. Envirologic Systems (1983) (00-831216-05:4-14)
4. Dames and Moore (1978) (00-780831:C-10)

The Chinle Formation, which underlies the Kayenta-Wingate aquifer, is the first hydrogeologic unit of concern in the Uravan area (Figure 5.2-2). All geologic units below this aquitard, which underlies the deepest water-bearing zone of concern, should not be impacted by the migration of contaminated liquids. A description of the Chile Formation and hydrogeologic units above this formation follows.

Chinle Formation: The Chinle Formation is about 400 feet thick and consists predominantly of soft red siltstone. The Chinle does not produce water in the Grand Junction area (Lohman, 1965) (55G-650000:23) and most likely will not produce water in the Uravan area. Because of its lithogy, the permeability is probably very low and acts as an aquitard to vertical ground water movement.

Wingate Sandstone: The Wingate Sandstone is about 200 feet thick in the Uravan area and is composed of very fine-to fine-grained sand with minor interstitial clay and calcite cement. Portions of the Wingate are water-bearing in the region, despite its relatively low permeability. Laboratory tests on Wingate Sandstone samples for the coefficient of permeability indicate that the Wingate has a similar permeability to the Entrada except near its base (Table 5.2-1) (Lohman, 1965) (55G-650000:31). In the Uravan area, the aquifer is capable of producing up to 500 gallons per minute and well yields of over 100 gallons per minute are common. These high yields are probably due to high fracture permeability, rather than primary permeability of the formation (00-780831:2-57).

Regionally, Wingate ground water is a sodium bicarbonate water of relatively good quality, similar to that of the Entrada Sandstone. It has been used locally as the Uravan water supply.

In the Uravan vicinity, recharge to the Wingate sandstone probably occurs in two primary areas: 1) west of Uravan along the Dolores River and the flanks of the Paradox Valley and 2) northeast of Uravan along its exposed margin, bordering the Uncompangre uplift. Recharge occurs from both direct infiltration to Wingate outcrops and from vertical infiltration from overlying units. The Wingate is not exposed in the immediate area around Uravan, so discharge is either northwest along the trend of the synclinal axis (near the confluence of the San Miguel and Dolores rivers) and/or upward into the Kayenta through connecting fractures. Data is not adequate to quantify recharge and discharge rates in this system.

Kayenta Formation: The Kayenta Formation is approximately 180 feet thick in the Uravan area. The formation consists of lenticular to irregularly-bedded layers of fine to medium-grained sandstone, irregular lenses of siltstone and shale, and a few lenses of conglomerate or conglomeratic sandstone. The sandstones are generally harder and coarser grained than the underlying Wingate, particularly the lower beds of the Kayenta (Lohman, 1965) (55G-650000:32).

Regionally, the Kayenta is not considered to be an aquifer. Locally, it does contain water and is probably in hydrologic connection with the underlying Wingate and overlying Navajo and Entrada formations (Lohman, 1965) (55G-650000:36). Permeabilities are generally very low, but in the Uravan area Dames and Moore (00-780813:C-23) state laboratory values of horizontal and vertical permeabilities of 740 and 690 feet per year, respectively, for an upper sandstone. They also state a porosity of 26.9 percent. Recharge probably occurs along the flanks of the Dolores River and the Paradox Valley, west of Uravan, where the Kayenta is exposed. Northeast of Uravan, recharge may also occur along the exposed edge of the Kayenta on the margins of the Uncompangre uplift. Flow is most likely towards the San Miguel River canyon where the Kayenta is at its lowest exposed elevation. Therefore, flow is toward the San Miguel from both the northeast and southwest.

Navajo Formation: The Navajo formation in the Uravan area is actually an outlier of the main formation body which lies further to the west (Cater, 1970) (55G-700000:12). The Navajo is only 30 feet thick in this area and is composed of massive, fine-grained, very well-sorted, clean, nearly white sandstone. Because the areal extent of the Navajo in the vicinity of Uravan is small, ground water information is not available; however, it is thought to allow vertical hydraulic connection between water-bearing zones above and below it.

Entrada Formation: The Entrada Formation is 80 to 110 feet thick in the Uravan area and is composed dominantly of fine to very fine-grained sand, generally with small amounts of medium-grained sand and from less than 10 percent to as high as 30 percent silt (Lohman, 1965) (55G-650000:38). Some beds, particularly those near the base, contain a small proportion of well-rounded, frosted, and iron-stained coarse-grained sand.

Regionally, the Entrada is considered the most productive of the various bedrock water-bearing zones. Locally, however, the Entrada may be relatively dry due to dissection by various canyons. Flow tests made on Entrada wells have yielded transmissivity values of 150 gpd/ft and storativity of 5 X 10E-5 (Table 5.2-1).

Water quality tends to be good and of a sodium bicarbonate type and becomes increasingly soft at greater distances from the recharge area due to natural base exchange (Lohman, 1965) (55G-650000:47). Recharge probably occurs west and southwest of Uravan where the Entrada is exposed and northeast along the flanks of the Uncompangre uplift. Discharge probably occurs along the San Miguel River and in Hieroglyphic Canyon.

Summerville Formation: The thinly bedded Summerville Formation consists mainly of alternating beds of siltsone and sandstone with shale and mudstone near the top. In the Uravan vicinity, the Summervile is 80 to 100 feet thick and is considered to be an aquitard in this region. This formation generally does not yield water to wells, due to its low permeability. The Summerville Formation effectively confine water in the Entrada and lower units, however, the Summerville Formation is not an aquiclude. Evidence from Club Mesa suggests contaminated ground water may have penetrated the Summerville Formation.

Morrison Formation-Salt Wash Member: The Salt Wash Member is approximately 300 feet thick in this area and is comprised of alternating beds or lenses of siltstone or mudstone and highly lenticular sandstone, and near the base, a few thin limestone beds (Lohman, 1965) (55G-650000:51). The sandstone beds which are the dominant lithology consist mostly of fine, medium, and coarse-grained quartz sand.

Because of the lithology and lenticular nature of the Salt Wash Member, permeabilities tend to be relatively low and water availability highly variable. Flow tests on wells completed in the Salt Wash yield a transmissivity and storativity of 47 gpd/ft and $3E^{-5}$, respectively.

Salt Wash ground water tends to be sodium bicarbonate-sodium sulfate water of relatively good quality (Lohman, 1965) (55G-650000:57). Pyrite is suspected as the source of sulfate. High sodium levels suggest that water in the Salt Wash has undergone more natural base exchange than water in any of the other water-bearing units (Lohman, 1965) (55G-650000:57).

The Salt Wash Member is exposed over a wide area southwest of Uravan and is probably one area of recharge. As are the other formations, this member is also exposed along the flanks of the Uncompangre uplift and is receiving water. The San Miguel River Canyon, Hieroglyphic Canyon, and Atkinson Creek are probably areas of natural discharge.

Morrison Formation-Brushy Basin Member: The Brushy Basin Member is about 400 feet thick and composed dominantly of variegated mudstone with lesser amounts of sandstone, conglomeratic sandstone, and limestone (Carter, 1970) (55G-650000:44). This unit is considered to be an aquitard for the underlying water-bearing zone in the Salt Wash Member. Packer tests in the upper part of the Brushy Basin on Spring Creek Mesa showed permeabilities ranging from 0.62 ft/yr to less than 0.01 ft/yr (00-840124:3-2). Very small yields have been reported from wells completed in sandstone layers in this unit, but water availability is highly variable and for the most part poor to nonexistent.

Burro Canyon Formation: The Burro Canyon is up to 200 feet thick in this area and is composed of as much as 85 percent sandstone with individual sandstone beds up to 100 feet thick. Green shale or siltstone, red or purple shale, and locally, thin gray nodular limestone are also present in the formation (Lohman, 1965) (55G-650000:59).

Because the sandstones of the Burro Canyon are generally lenticular and tightly cemented, intergranular permeability is very low. However, locally, fracture permeability may provide fresh water to wells. Aquifer tests on well SCM-1 on Spring Creek Mesa showed a permeability of 827 ft/yr. (00-840124:4-14).

South of the San Miguel River on Club Mesa, the Burro Canyon exists as isolated erosional remnants, whereas north of the river it caps much of the area. The erosional remnants are most likely unsaturated. North of the river on Spring Creek Mesa, the lowest portion of the formation is saturated. Recharge occurs along the flank of the Uncompahgre uplift, exposed areas on the mesa tops, and possibly even through the overlying Dakota Sandstone. Discharge is through the walls of the various canyons which dissect the mesas and possibly vertical leakage.

Water quality in the Burro Canyon Formation on Spring Creek Mesa is somewhat variable. Total Dissolved Solids (TDS) measured in various monitoring wells on Spring Creek Mesa indicate a general pattern of increasing TDS towards the Mesa center and decreasing TDS near the margins. The TDS range is from 640 to 3,500 mg/l. This water has been historically used for livestock watering.

Dakota Sandstone: The Dakota Sandstone is up to 150 feet thick in the Uravan area and is composed of fine to medium-grained sandstone which ranges from non-cemented to well-cemented. Interbedded with the sandstones are carbonaceous shales and low-grade coals, and mudstone.

In the Uravan area, the Dakota may be water-bearing only locally. Generally, the erosional remnants of the Dakota on Spring Creek Mesa are unsaturated, but may allow recharge to the Burro Canyon.

5.2.5 GEOCHEMISTRY

Geochemical reactions occur in the Uravan area when acidic seepage comes in contact with soil, unconsolidated sediments, sedimentary rocks, or ground water. These geochemical reactions are complex and extremely dynamic. Some reactions tend to remove contaminants, other processes exchange one contaminant for another, and some reactions may add contaminants to the system. However, there is a certain predictability to these reactins because of the relatively consistent nature of the acid seepage and buffering capacity of the soil and rock.

The major geochemical reactions in the project area occur when an acidic liquid percolates from a source and travels downgradient. As the liquid proceeds downgradient, geochemical reactions between the liquid and host rock can be characterized by three zones: 1) acid zone, 2) neutralizing zone, and 3) neutralized zone. The acid zone consists of liquid very similar to that of the source. The liquid is characterized by low pH, very high sulfate ion concentrations, heavy metals and radionuclides. This acid zone represents an area where all calcite minerals have been dissolved because of ractions with the acidic liquid. The second conceptual zone, termed the neutralizing zone, is the site of active reaction between calcite in the sediments or sedimentary rocks and the acidic liquid. This reaction causes the formation of chemical pecipitates, including gypsum and metal hydroxides. Liquid in this zone has a more neutral pH but contains some dissolved metals and is high in total dissolved solids and sulfate ions. Radionuclides are generally in low concentrations because of the sorbtion by clay minerals. The leading and trailing boundaries of this zone are not sharp lines, but are gradational in response to the chemical reactions. Downgradient of the neutralizing zone is an area termed the neutralized zone. Although this zone is characterized by near-neutral pH, chemical contaminants remain in the liquid. The liquid is enriched in sulfate, chloride, sodium, magnesium, ammonnia and nitrate. Additionally, selected heavy metals may be present.

In general, geochemical reactions between the acidic liquid and the sediments and sedimentary rocks will remove most of the radionuclides and a majority of the heavy metals. However, the liquid after neutralization will contain elevated levels of certain contaminants, including some heavy metals.

Contaminant plumes are present beneath Club Mesa (000-831216-05) and the Club Ranch Ponds (00-831216-04). Geochemical reactions in these areas follow the general framework set forth above. On Club Mesa, seepage results from the infiltration of sprayed raffinate and from the infiltration of raffinate in the tailings ponds. Seepage migration is enhanced by mine voids that underlie the spray area. Seepage travels into the underlying sedimentary rocks and exits along the mesa rim. In the area of the Club Ranch Ponds, seepage infiltrates the surficial materials and Kayenta Formation directly from the base of the ponds. This seepage ultimately discharges to the San Miguel River.

Chemical analyses from perched liquid on Club Mesa indicate that some of the raffinate seepage has been neutralized by reactions with the sedimentary rocks (00-831216-05:18). These analyses also show that the perched liquid has elevated levels of sulfate, chloride, sodium, magnesium, ammonia, and nitrate. Some trace metals are also present. A similar geochemical situation is indicated in the area of the Club Ranch Ponds. These geochemical reactions may not fully neutralize the raffinate solution before it enters the San Miguel River. Radionuclides are, in large part, removed by the natural soils and bedrock and do not appear to enter the river in appreciable concentrations. High levels of total dissolved solids and some heavy metals are transported to the river.

5.2.6 SURFACE WATER HYDROLOGY

The San Miguel River provides the primary drainage of the project area. Headwaters of the San Miguel originate in the San Juan Mountains from which the river flows northwest to its confluence with the Dolores river, about four miles downstream from Uravan. Although the San Miguel is perennial, its hydrograph exhibits pronounced seasonal fluctuations. This streamflow pattern is characteristic of rivers whose flow is derived primarily from snowmelt runoff. Peak discharges on the San Miguel generally occur in late spring or early summer.

Three major creeks join the San Miguel River in the project area (Figure 5.2-1). Along the southeast edge of Club Mesa, a small intermittent creek drains Hieroglyphic Canyon. Near the downstream limit of the project area, Atkinson Creek enters the San Miguel River. Atkinson Creek borders Spring Creek Mesa on the northwest, has headwaters that extend back to the Uncompangre Plateau, and flows intermittently. Spring Creek borders the southeast side of the mesa and also flows intermittently.

In contrast to the snowmelt peak flows of the San Miguel, the annual maximum discharge in Hieroglyphic Canyon, Atkinson Creek, and Spring Creek are related to rainstorm runoff. Creek flows tend to be greatest during the spring and summer and lowest during the fall and winter. During the low flow season, the discharge of these creeks may be reduced to zero.

Numerous unnamed small ephemeral channels drain to the San Miguel River from the mesas surrounding the canyon. Due to their relatively small drainage areas and the arid climate, these channels carry water only during rainstorms.

Surface runoff during the operational period will be managed in accord with a surface runoff control procedure in LC 11.2 (see also LC 11.1, Section 5.3 and LC 24.3). Umetco's catchment system is designed to handle a 10-year, 24-hour storm, as well as collect, contain and treat hillside runoff.

UCC/Umetco has senior water rights for beneficial use of large quantities of water from the San Miguel River and use of several wells for town water supply or mill supply (00-820331-13). The Consent Decree addresses certain water rights by UCC/Umetco and the role of the State.

LC 11.1, Section 2.7 contains additional details on surface water hydrology.

5.2.7 LOCAL CHARACTERISTICS

The Uravan site is divided into two distinct areas for the purpose of describing the geology and hydrogeology. These areas are the San Miguel River Area and Club Mesa. The San Miguel River Area is defined as the valley bottom from the town of Uravan downstream to the Atkinson Creek Crystal Pile (Figure 5.2-1). Located in this area are portions of the mill facilities, the River Ponds, the Club Ranch Ponds, and the Atkinson Creek Crystal Pile (Figures 5.2-5 and 5.2-6). Club Mesa is directly southwest of Uravan and includes the upper part of the mill, the ore storage area, Club Mesa Tailings Piles and the Club Mesa Spray Area (Figure 5.2-5). Geologic and hydrologic descriptions of these two areas are in Sections 5.2.7.1 and 5.2.7.2 respectively.

These descriptions form a general context for the remedial activities discussed in LC 11.1, Sections 4 and 5. Section 3 of LC 11.1 can be consulted for further details.

5.2.7.1 SAN MIGUEL RIVER AREA

5.2.7.1.1 Geology-San Miguel River Area

Bedrock and surficial geology of the San Miguel River is shown on Figures 5.2-7 and 5.2-8 and companion cross-sections A-1, B-1, and C-1 (Figures 5.2-9, 5.2-10, and 5.2-11). At Uravan and for several miles downstream, the San Miguel River has downcut into the relatively resistant beds of the Kayenta Formation. In this area, the rim of the river channel is about 10 to 30 feet above the river level. Overlying the Kayenta Formation is the Navajo and Entrada/Carmel Formations. These units form the lower-most part of the canyon walls.

Formations present in the San Miguel River valley are inclined slightly (approximately 2°) toward the northeast. No faults have been identified in the area; however, joints are present in the Kayenta Formation and other sandstone units. The Kayenta Formation is cut by three prominant orthogonal joint sets. These nearly vertical joints strike north 45° west and north 45° east. In the Kayenta, these joints are spaced about 1 to 2 feet apart. This jointing probably provides secondary permeability in the bedrock units.

The valley bottom is mantled with relatively thin flood plain alluvium, terrace gravels, and colluvium. These units are shown on the geologic maps (Figures 5.2-7 and 5.2-8) and the geologic cross-sections (Figures 5.2-9, 5.2-10, and 5.2-11). In general, the flood plain alluvium is restricted to the present river channel.

Terrace gravels representing previous river flood plains, are present within the valley bottom at elevations of about 10, 25, and 60 feet above the San Miguel river. These terrace deposits are rounded gravel, cobbles, and small boulders in a relatively clean sand matrix. A wedge of colluvium and fan alluvium overlies these terrace deposits. The colluvium consists of angular rock fragments ranging from gravel to boulder size material in a sandy clay matrix. The alluvium is made up of subrounded boulders, cobbles, and gravel in a clayey sand matrix. Both of these deposits are thin near the river but increase in thickness toward the valley walls where over 50 feet of material is present.

The surficial deposits are the result of geological processes such as river aggradation and lateral migration, canyon erosion and widening, cliff retreat, and debris flooding. Some of these processes are active today. It is likely that slow downcutting into the Kayenta Formation will continue along the San Miguel River. The downcutting rate is not expected to greatly exceed 1.4 feet per thousand years. This downcutting will be accompanied by a valley widening. However, the river course will continue to occupy the same general course on the valley floor. Deepening of the San Miguel River will also result in a corresponding downcutting of tributary valleys such as Atkinson Creek and Hieroglyphic Canyon. In the event that the San Miguel River aggrades, the river could possibly migrate laterally across the valley bottom. There would also be a corresponding rise in the ground water table. Regardless of river incision or aggradation, other geologic processes will remain active. These include mainstream flooding, debris flows, cliff retreat, and canyon widening.

There are three main areas in the San Miguel River valley which were used for waste from the milling operations: River Ponds, Club Ranch Ponds, and Atkinson Creek Disposal Area. Geologic conditions vary slightly in each of these areas and are discussed as follows:

River Ponds. The River Ponds consist of seven small ponds constructed along the San Miguel River. Five of the ponds are on the west side of the river and two ponds are located on the east side of the river (Figure 5.2-5). These Ponds were constructed within old tailings piles by excavating into and, in some cases, through the tailings. The River Ponds are located on the lower river terrace adjacent to the San Miguel River. Thin gravels may underlie the ponds or they may rest directly on the Kayenta Formation. In any case, permeability of the underlying materials is estimated to be moderate to high.

Club Ranch Ponds: The Club Ranch Ponds consist of six ponds located downstream from Uravan (Figures 5.2-1, 5.2-6). These ponds are adjacent to the San Miguel River, which has eroded a 10 foot deep cut into the Kayenta Formation at this locality. General geologic conditions in this area are shown on Figures 5.2-8 and 5.2-10.

The Club Ranch Ponds are underlain by middle level colluvium and terrace gravels that have a combined thickness ranging from 8 to 30 feet. These deposits probably have relatively high primary permeabilities. Beneath these surficial deposits, are the sandstones of the Entrada/Carmel and Kayenta formations. The water movement in these formations results from both primary and secondary (joint) permeability.

Atkinson Creek Disposal Area: The Atkinson Creek Disposal Area is downstream from the Club Ranch Ponds and is adjacent to Atkinson Creek (Figure 5.2-6). This is the past disposal site for raffinate crystals that were excavated from the Club Ranch Ponds. The general geologic conditions in this area are shown on Figures 5.2-6 and 5.2-11.

The Atkinson Creek Disposal Area is not lined beneath the crystals, resulting in direct crystal contact on alluvial fan sands and gravels and terrace gravels. These materials are relatively thin (10 to 20 feet in thickness) and may have moderate to high permeabilities. The surficial materials are underlain by the Entrada/Carmel and Kayenta formations having both primary and secondary (joint) permeability.

5.2.7.1.2 Hydrogeology-San Miguel River Area

Historically, uranium and vanadium have been mined in the Uravan area for several decades. In the past, it was not required of the mining industry to determine background or premining conditions, including ground water. Because of this situation, it is virtually impossible to determine premining conditions at the present time.

Water-bearing zones which occur beneath the San Miguel River area are the bedrock formations and the unconsolidated sediments. Bedrock formations containing water are the Kayenta and Wingate formations, although some water may be present in the Entrada/Carmel. The unconsolidated sediments are relatively thin in the Uravan area and include three gravel terraces and associated colluvium. Ground water in these sediments is recharged from the underlying bedrock or from the sides of the canyon and then discharges to the river.

Consult Section 9 of the PELRS (10-840522) and Section 3.1 of LC 11.1 for further details.

5.2.7.2 CLUB MESA

5.2.7.2.1 Geology-Club Mesa

Club Mesa is directly southwest of Uravan and is about 400 feet above the San Miguel River. Bedrock and surficial geology of Club Mesa is shown on Figures 5.2-7 and 5.2-9. Bedrock units in the area are from youngest to oldest the Brushy Basin and Salt Wash Members of the Morrison Formation, Summerville, Entrada/Carmel, Navajo, and Kayenta formations.

A description of these units is included in Figure 5.2-2. Most of these formations are dominated by thick sandstone sequences. Two of these units are predominantly shale units: the Brushy Basin Member and the Summerville Formation. All of the units are inclined gently toward the northeast at about 2° to 3°. Faulting on Club Mesa has not been identified but an orthogonal joint set is present. One joint set parallels bedding and the other two sets are nearly vertical. These vertical joints strike north 45° west and north 45° east. The trend of these joints parallels the trend of the San Miguel River Canyon or its major tributaries. Secondary permeability is probably provided by this jointing.

Surficial materials are very thin on Club Mesa, generally less than 10 feet thick, and are composed of residium, colluvium, and alluvium. These surficial materials are thickest in the small, intermittent drainages and on small benches formed along the canyon walls. These materials are not shown on the geologic map (Figure 5.2-7) because of their limited thickness and lateral extent.

The resistant sandstone cliffs in the Salt Wash member of the Morrison Formation which make up the upper and lower Club Mesa rims are actively retreating. Based on long-term downcutting rates observed for the Colorado River system, it is estimated that incision of the San Miguel River through the lower Club Mesa caprock (the onset of mesa rim retreat) probably took place about 1.9 to over 3.0 million years ago. Geomorphic studies at Uravan (Smith, 1980) (00-810116) indicate maximum rates between 1.0 and 4.0 feet per thousand years which are similar to rates reported elsewhere in the Colorado Plateau. These average rates would be exceeded locally by gully erosion along drainages on the mesa rims.

Both tailings disposal and raffinate evaporation operations have occurred on Club Mesa. The location of these areas is shown of Figure 5.2-5 and 5.2-7. Geologic conditions particular to reach of these areas is as follows:

Club Mesa Tailings Ponds: The existing tailings ponds are likely underlain by a thin veneer of surficial materials that is less than 10 feet thick and sandstone bedrock. Bedrock is the Salt Wash Member which is about 100 feet thick and is composed of thick sandstone with interstratified lenses of claystone and silstone. Joints in the Salt Wash are similar to the three orthogonal joint sets described above. Beneath the Salt Wash is the shaley Summerville Formation and sandstones of the Entrada/Carmel, Navajo, and Kayenta formations. The sandstone units beneath the tailings ponds have both primary and secondary permeability.

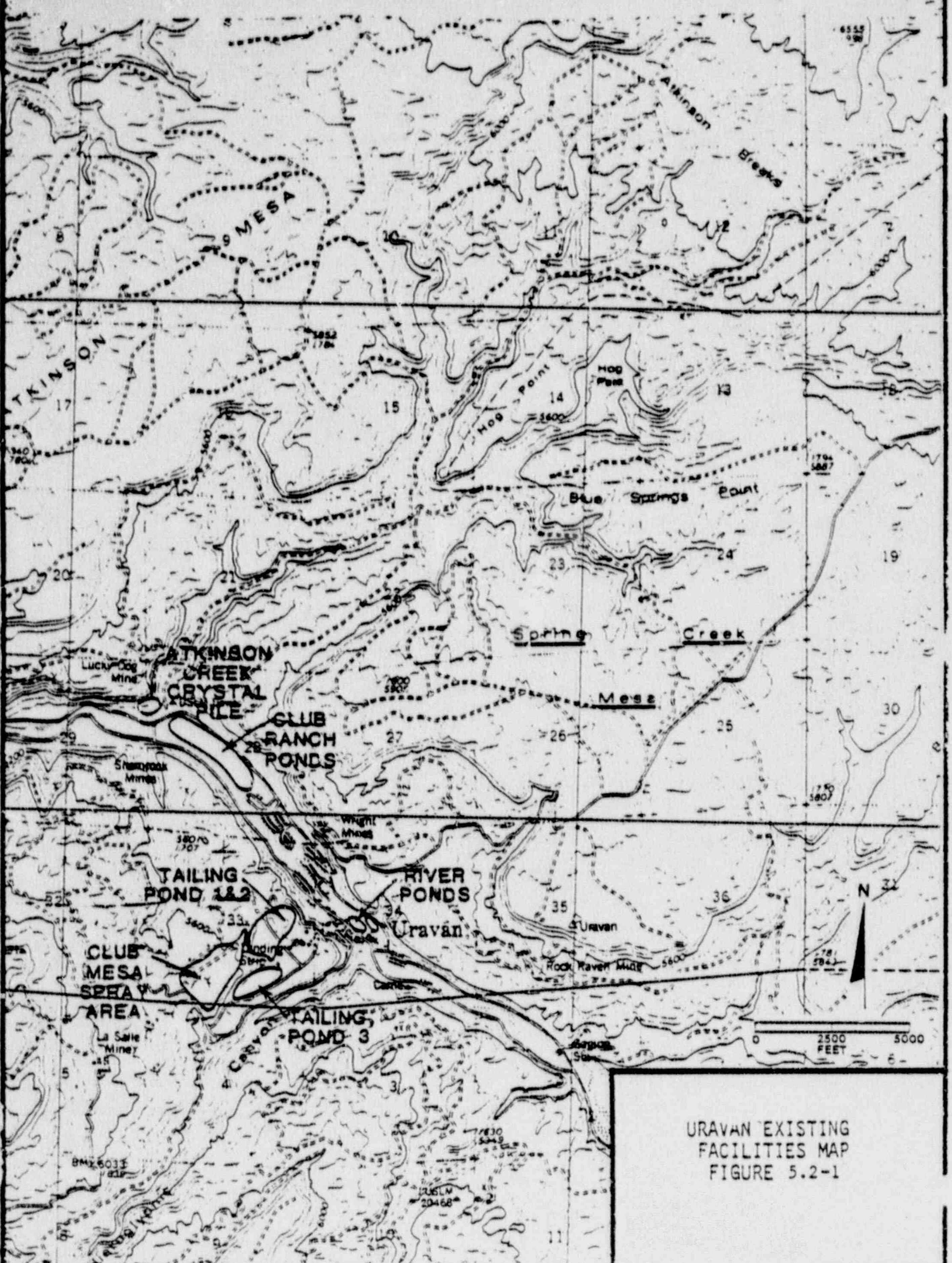
Club Mesa Spray Area: The raffinate evaporation area on the highest bench of Club Mesa is up-slope from the tailings piles and is underlain by the same bedrock sequence as the Club Mesa Tailings Ponds. The area is near the contact between the Salt Wash and Brushy Basin Members of the Morrison Formation. This stratigraphic horizon has provided much of the uranium ore in the Uravan mining district. The general outline of the abandoned mine workings which are presently inaccessible is shown in Figure 5.2-7. The extent of the mined out area shown is based on old mine maps on file with Umetco. Elevations on the mine maps indicate that the depth of mining is relatively shallow and ranges from 20 to 50 feet below the ground surface and that pillars exist throughout the mines. The Salt Wash is probably a relatively stable roof rock but there is some evidence of subsidence and soil piping into the abandoned mines. Judging from the relatively shallow depth of the mines and past subsidence, these abandoned workings represent a relatively high potential for future mine subsidence. It is reasonable to expect the development of additional subsidence pits at the ground surface over the long term. These pits could be several tens of feet in plan dimension and could be several feet to a few tens of feet deep.

5.2.7.2.2 Hydrogeology-Club Mesa

Uranium and vanadium have been mined in the Uravan area for several decades. In the past, it was not required of the mining industry to determine background or premining conditions, including that of ground water. Because of this situation, it is virtually impossible to determine at this time premining conditions for the Uravan area.

The same hydrostratographic sequence described in Section 5.2.4 occurs beneath Club Mesa. The uppermost water-bearing unit is the Salt Wash Member of the Morrison Formation and the deepest is the Kayenta-Wingate. Units younger than the Salt Wash have either been removed by erosion or exist as isolated erosional remnants.

For additional detail on Uravan site hydrology and other characteristics, consult Section 9 of the PELRS (10-840522) and Section 3 of LC 11.1, and the October 1986 report, "Drilling, Testing, and Completion of Observation Wells, Uravan Mill Site, Uravan, Colorado" (01-861000).



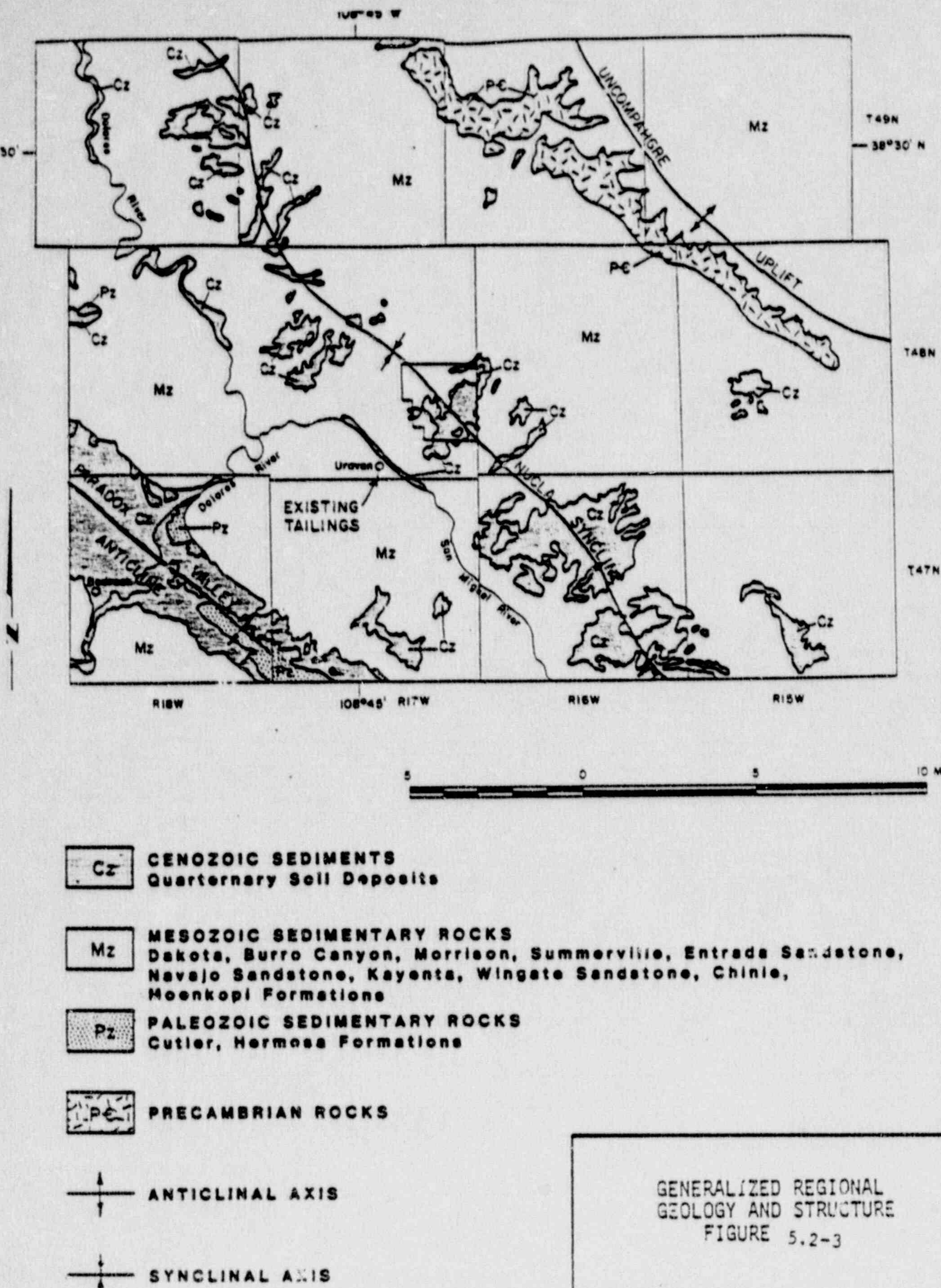
URAVAN EXISTING
FACILITIES MAP
FIGURE 5.2-1

Age		Stratigraphic Unit	Characteristics
MESOZOIC	JURASSIC	Morrison Formation	MORRISON FORMATION, BRUSHY BASIN MEMBER: Clay (bentonitic) shale with some interbedded sandstone and conglomerate lenses. Some thin limestone beds. White, gray, rusty-red and buff sandstone and varigated shale.
MESOZOIC	JURASSIC	Morrison Formation	MORRISON FORMATION, SALT WASH SANDSTONE MEMBER: Predominantly sandstone with some interbedded shale. Colors as above.
MESOZOIC	JURASSIC	San Rafael Group	SUMMERVILLE FORMATION: Thin-bedded mudstone and shale. Red, gray, green and brown.
MESOZOIC	JURASSIC	San Rafael Group	ENTRADA SANDSTONE/CARMEL FORMATION: Fine-grained, massive, crossbedded sandstone, orange, buff and white underlain by sandstone and mudstone, red.
MESOZOIC	JURASSIC	Glen Canyon Group	NAVAJO SANDSTONE: Discontinuous outlier lenses of fine-grained, crossbedded sandstone. Buff and gray.
MESOZOIC	JURASSIC	Glen Canyon Group	KAYENTA FORMATION: Irregularly bedded shale, siltstone, and fine to coarse-grained sandstone, red, buff, gray and lavender.
MESOZOIC	JURASSIC	Glen Canyon Group	WINGATE SANDSTONE: Massive, crossbedded, thick-bedded, fine-grained sandstone, reddish brown.
MESOZOIC	TRIASSIC		CHINLE FORMATION: Siltstone with interbedded lenses of sandstone, shale, and limestone-pebble, clay-pellet conglomerate, lenses of quartz-pebble conglomerate at base, reddish color.
MESOZOIC	TRIASSIC		MOENKOPI FORMATION: Upper Unit: ripple-bedded shale. Middle Unit: arkosic sandstone and conglomerate. Lower Unit: Indistinctly-bedded mudstone. Gypsum occurs in seams and veins and in beds near base, brown.
PALEOZOIC	PERMIAN		MOENKOPI FORMATION (continued).
PALEOZOIC	PERMIAN		CUTLER FORMATION: Mostly arkosic conglomerate and sandstone, some sandy mudstone and limestone, maroon, red, and purple.
PALEOZOIC	PENNSYLVANIAN		HERMOSA FORMATION, LIMESTONE MEMBER: Fossiliferous thick-bedded limestone with beds of shale and minor arkose, gray.
PALEOZOIC	PENNSYLVANIAN		HERMOSA FORMATION, PARADOX MEMBER: Interbedded gypsum, anhydrite, halite, limestone, sandstone on shale, white, gray and dark gray.
PALEOZOIC	M, D, C		OLDER PALEOZOIC ROCKS: Sandstone, limestone and dolomite.
PE			PRECAMBRIAN CRYSTALLINE ROCK

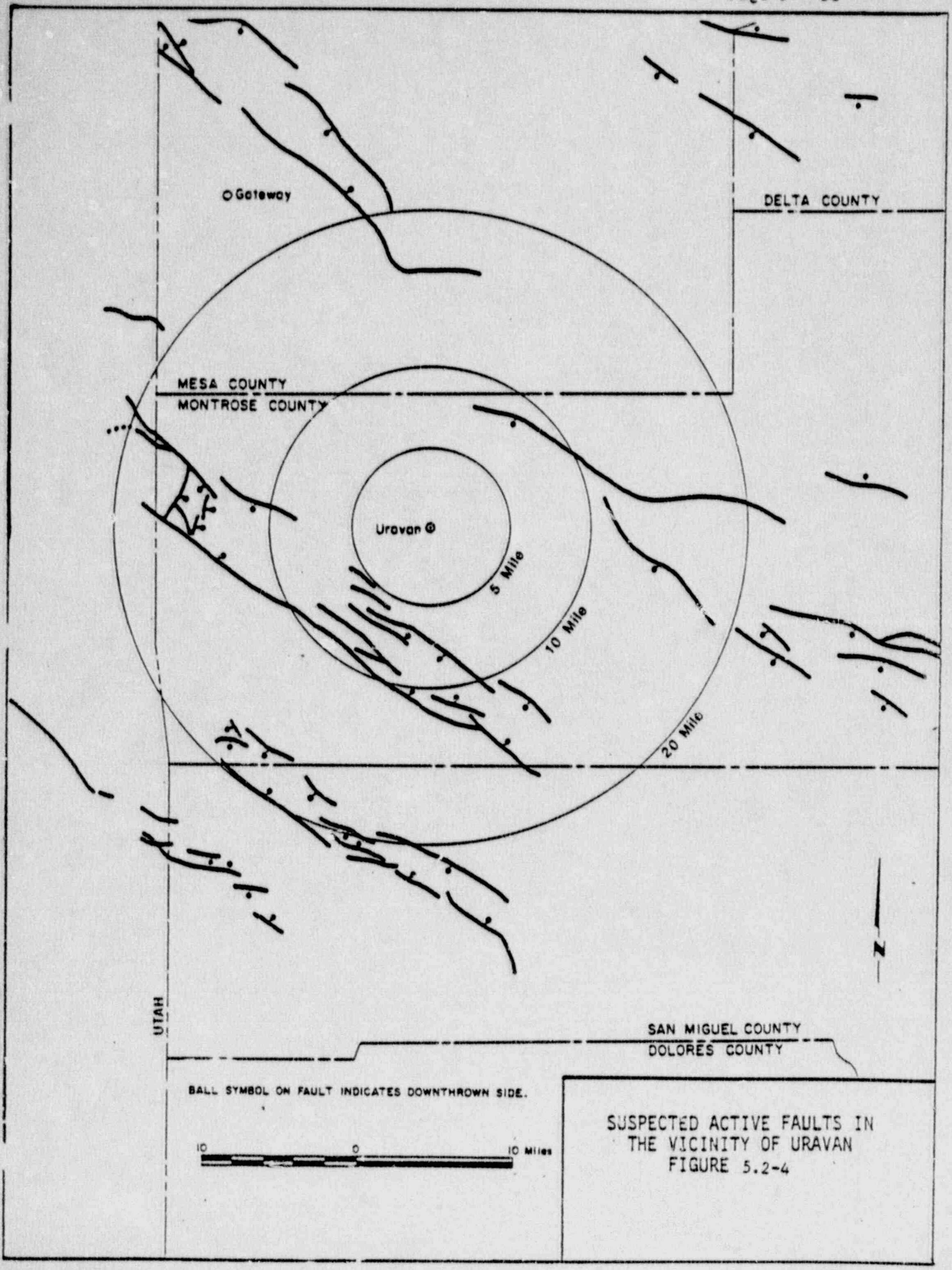
NOTES:

1. C - Cenozoic
2. M - Mississippian
3. D - Devonian
4. C - Cambrian
5. PE - Precambrian

URAVAN AREA
REGIONAL
STRATIGRAPHY
FIGURE 5.2-2

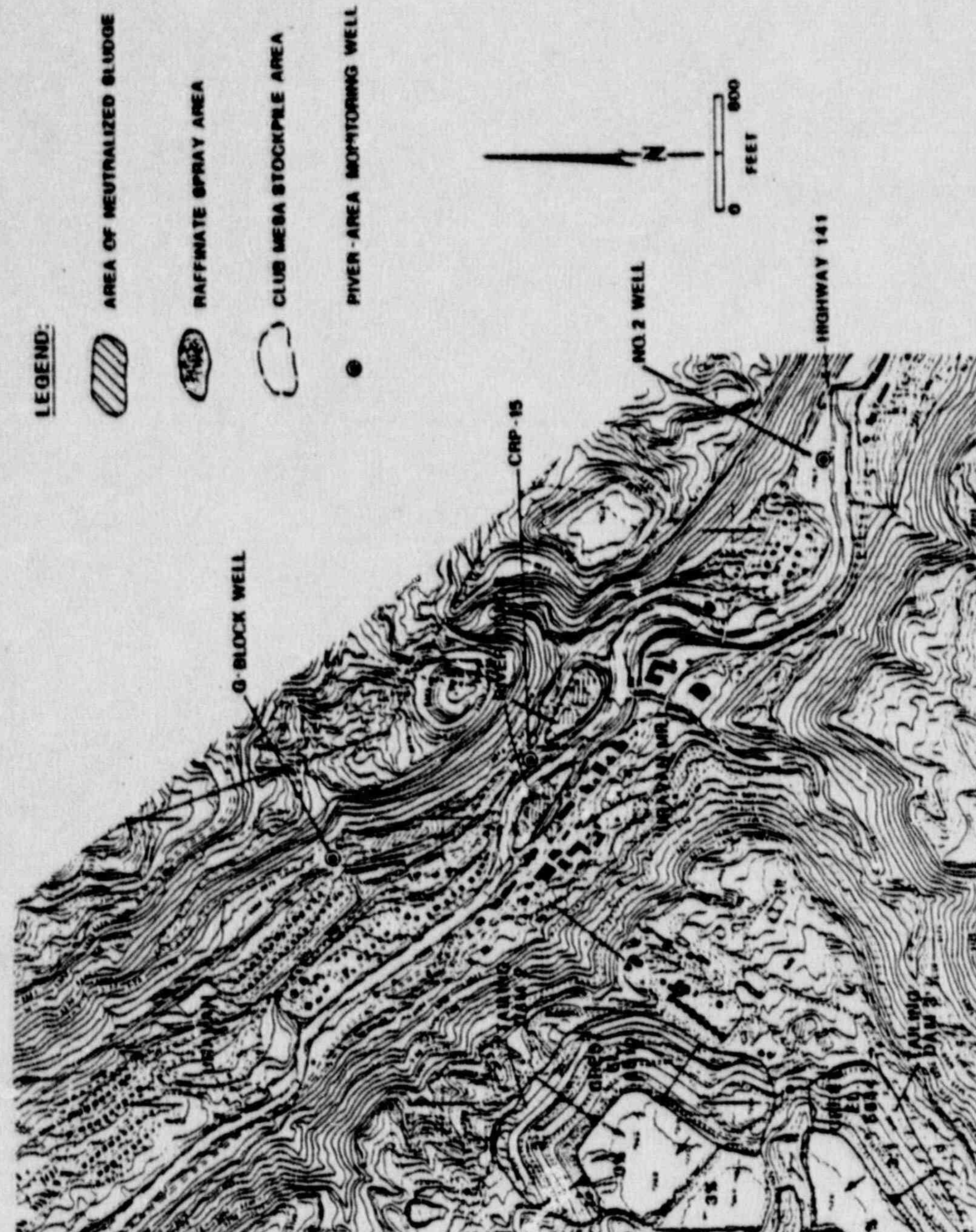


GENERALIZED REGIONAL GEOLOGY AND STRUCTURE
FIGURE 5.2-3

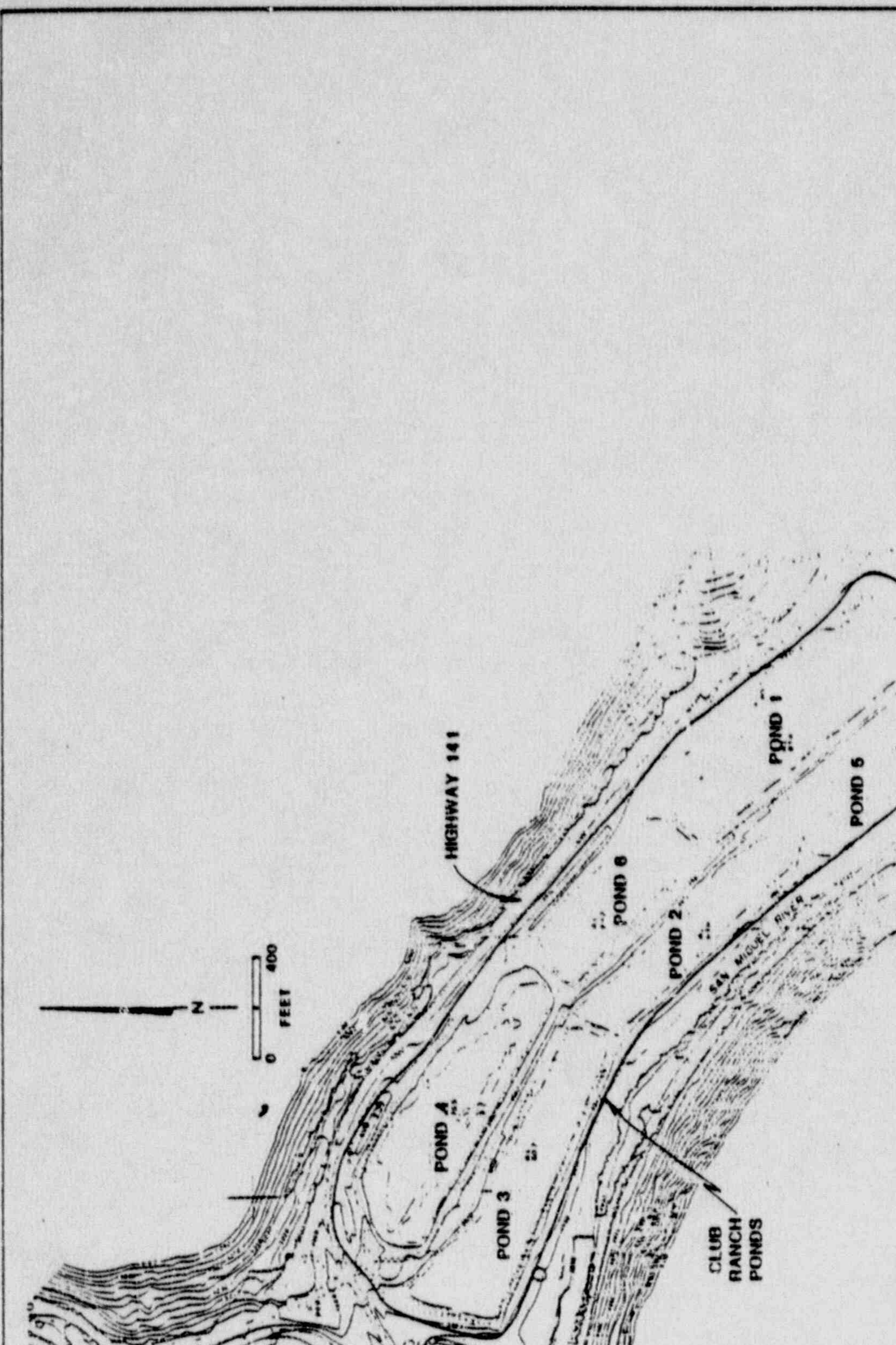


SUSPECTED ACTIVE FAULTS IN THE VICINITY OF URAVAN

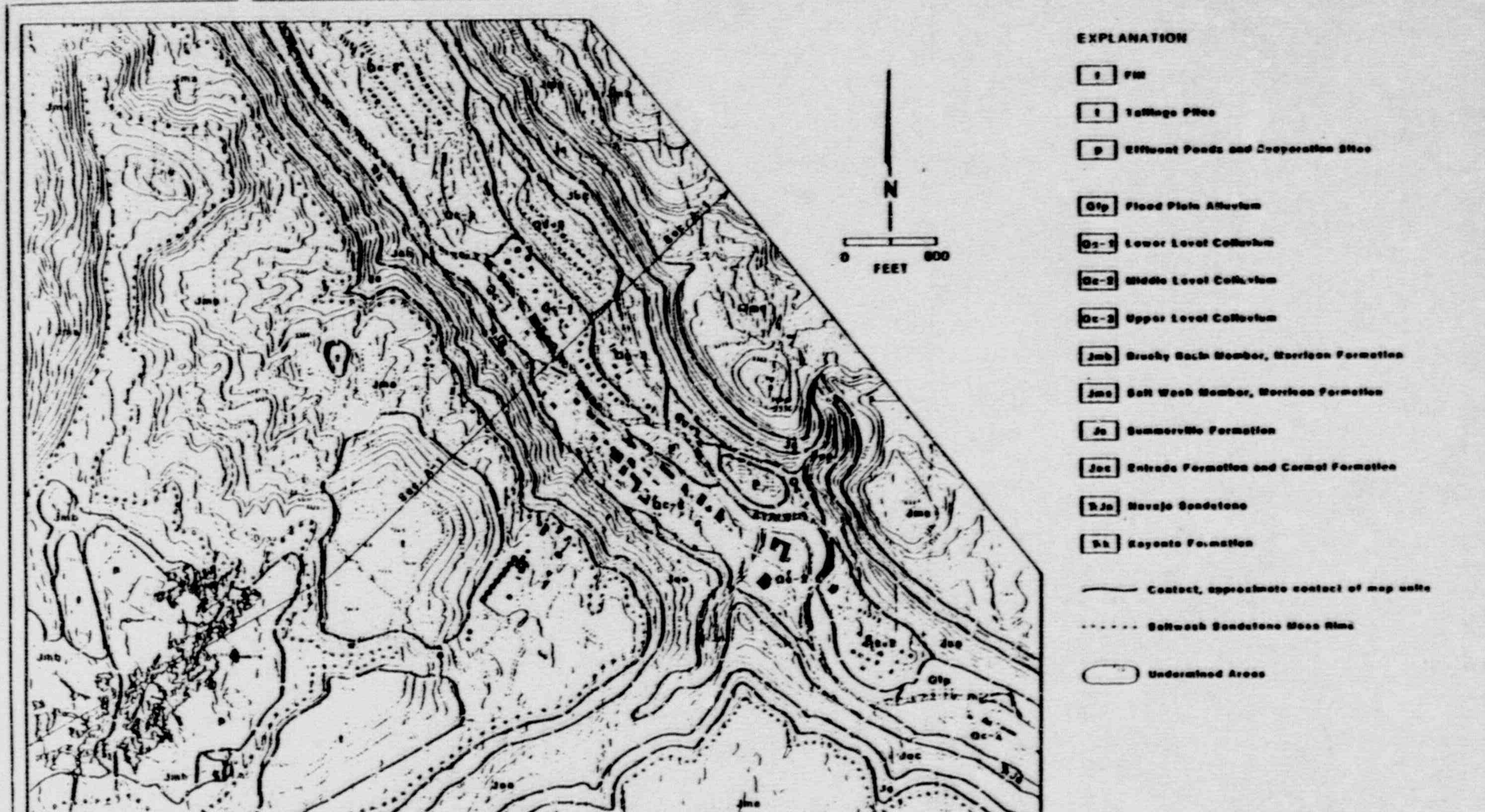
FIGURE 5.2-4



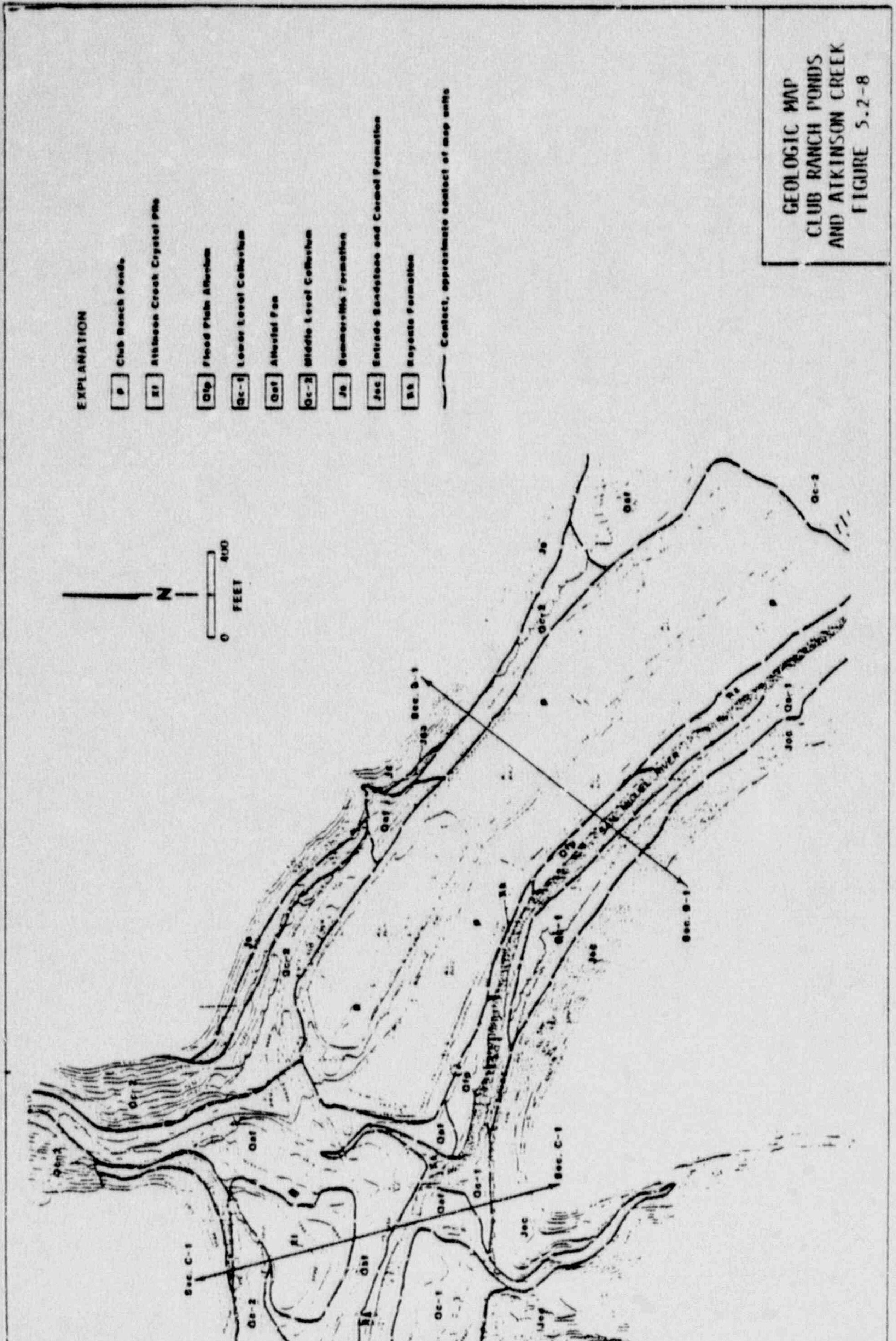
PLAN OF CLUB MESA AND MILL AREA
FIGURE 5.2-5



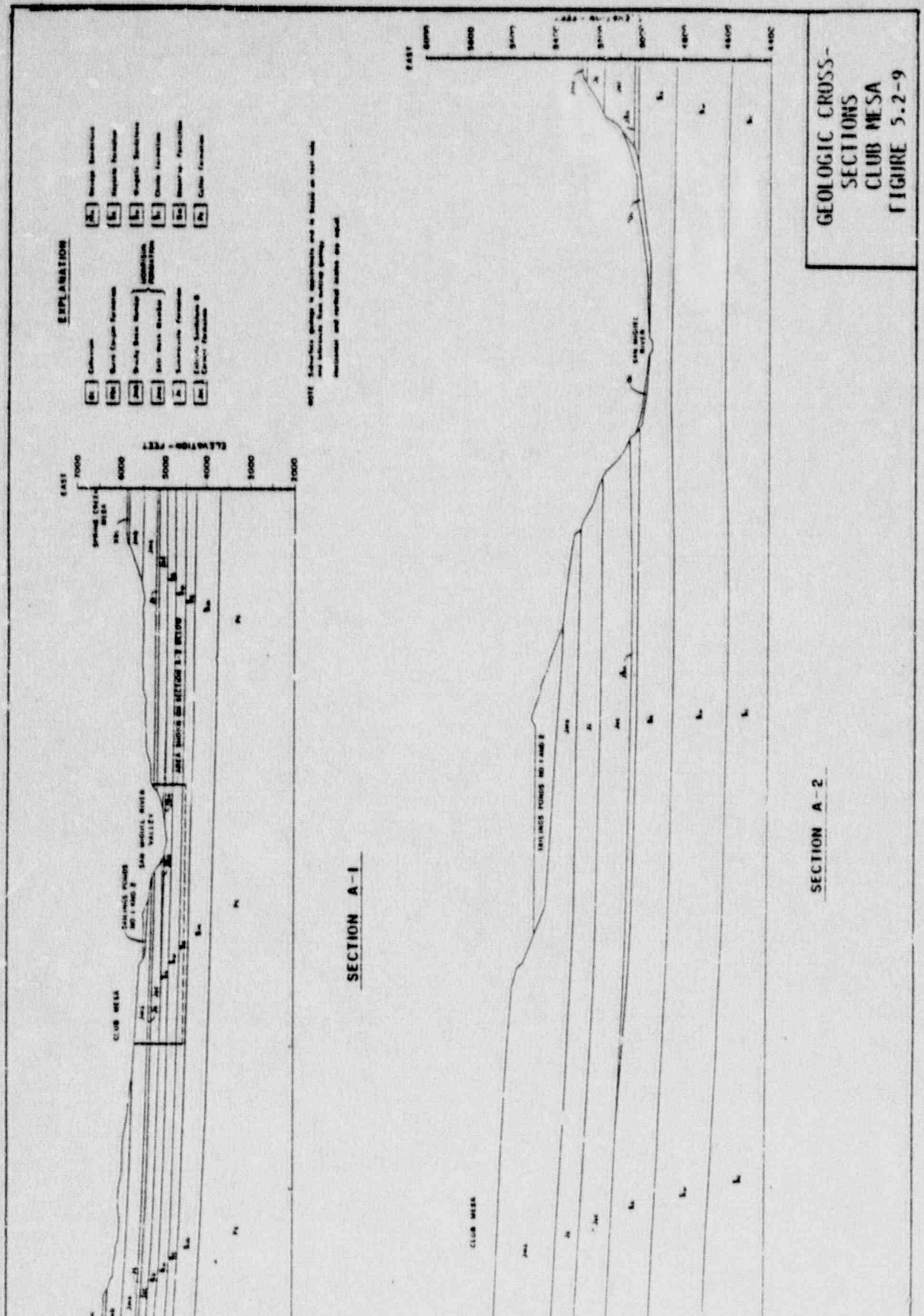
PLAN OF CLUB RANCH PONDS AND ATKINSON CREEK AREA
FIGURE 5.2-6

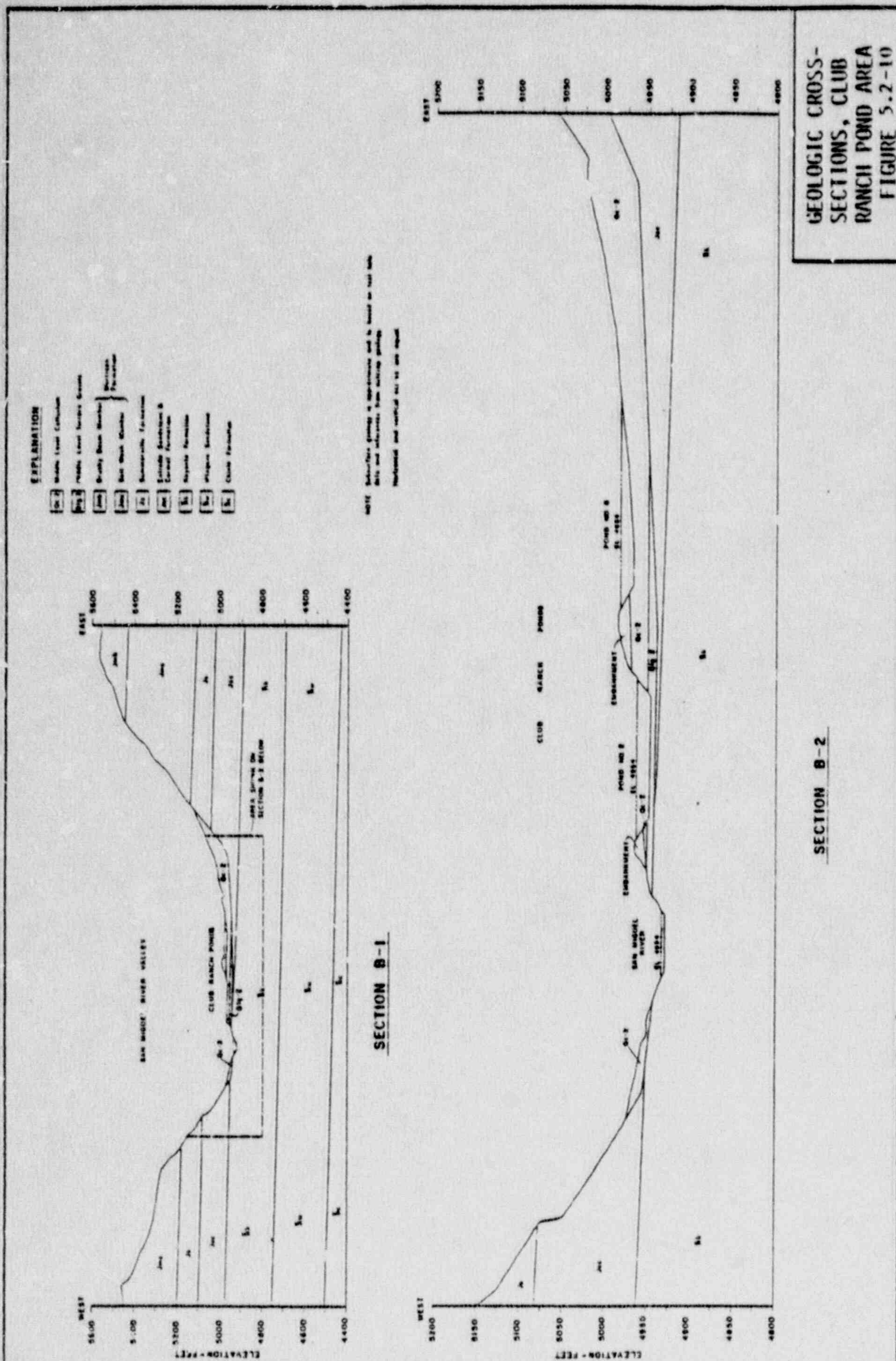


GEOLOGIC MAP
CLUB MESA
AND MILL AREA
FIGURE 5.2-7

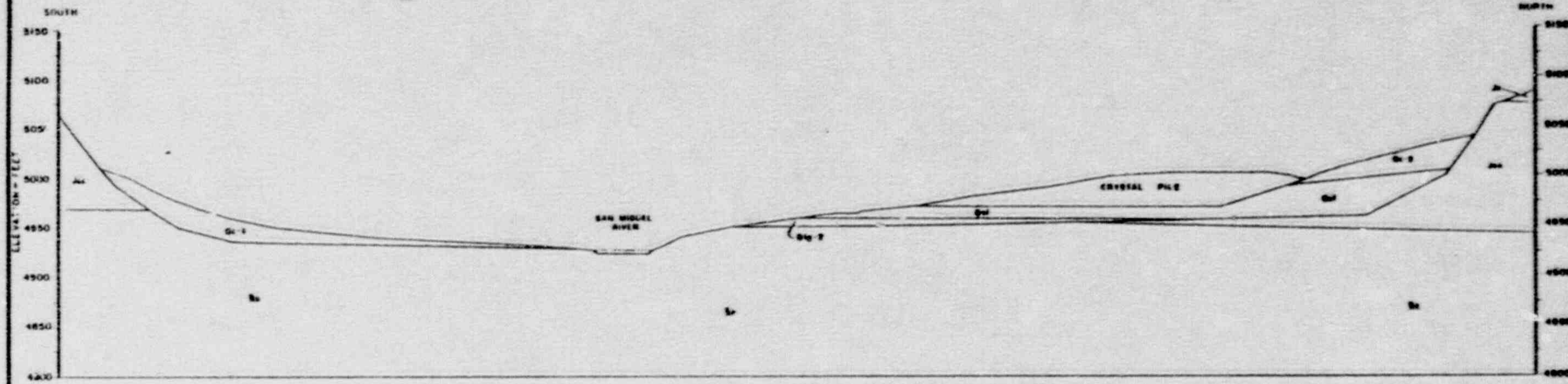


GEOLOGIC MAP
CLUB RANCH PONDS
AND ATKINSON CREEK
FIGURE 5.2-8


GEOLOGIC CROSS-SECTIONS
CLUB MESA
FIGURE 5.2-9
SECTION A-1
SECTION A-2
EXPLANATION
CLUB MESA
SAN MIGUEL RIVER VALLEY
TAILINGS PONDS NO 1 AND 2
ELEVATION - FEET
EAST
WEST



GEOLOGIC CROSS-SECTIONS, CLUB RANCH POND AREA
FIGURE 5.2-10



SECTION C-1

EXPLANATION

- Lower Level Colluvium
- Middle Level Colluvium
- Middle Level Terrace Gravels
- Summerville Formation
- Entrada Sandstone & Carmel Formation
- Kayenta Formation

NOTE

GEOLOGIC CROSS-SECTION, ATKINSON CRYSTAL PILE AREA
FIGURE 5.2-11

5.3 EXISTING SOLID WASTE

5.3.1 Description of Solid Waste Types by Area Impacted

The Uravan mill processed up to 550,000 tons of uranium ore per year and produces uranium concentrate (yellowcake) and a concentrated vanadium solution. From this process, solid waste was produced in the form of mill tailings, raffinate crystals, and sludge. These materials contain long-lived radioactive and potentially toxic materials. Radioactive materials include radium, uranium, thorium and lead. Heavy metals include various concentrations of selenium, vanadium, magnesium, molybdenum, copper, iron, zinc, arsenic, mercury, cadmium, lead and chromium. Potential mobility of these elements has been enhanced by physically and chemically altering the natural state of the minerals.

The radionuclides, heavy metals, and the various salts, depending on their concentration, represent a potential long-term health hazard because of their toxicity and persistance. Control of these materials is required by the Radiation Rules. Such control primarily regards seepage of the materials into ground or surface waters and dispersion of the materials by wind, rain, or man. Long-term control, for 1000's of years, of these materials is required.

Uranium mill tailings, raffinate crystals, sludge and contaminated soils and sediments, are present in several locations in the Uravan area (Figure 5.2-1). Tailings are present on Club Mesa (Piles 1, 2, and 3) and comprise some of the River Ponds. Raffinate crystals are located within the Club Ranch Ponds, Atkinson Creek Disposal area, and in the Club Mesa Raffinate Spray Area. Sludge is present in the River Ponds as well as in Club Mesa Raffinate Spray Area. Solid waste in the form of drums and construction materials is present directly north of Club Mesa Tailings Ponds 2. Past activities have dispersed contamination over wide areas. In the following sections, these areas will be discussed with regard to past operations and observed impacts.

5.3.1.1 Club Mesa Tailings Piles 1, 2, and 3

The Club Mesa Tailings Piles 1, 2, and 3 shown in Figure 5.2.7.1, contain the tailings from the operation of the Uravan mill since 1956. Since this time, approximately 10,000,000 tons of tailings were deposited in these piles. As of November 15, 1984, no newly generated tailings have been added to Tailings Piles 1, 2, or 3.

The ponds are constructed by the upstream method of tailings disposal. In this method, sands are deposited in a beach area from the spigoting of a tailings slurry around the edge of the piles. These sands are then used to form a dike that contains further discharge to the tailings ponds. A successive sequence of dikes and discharge has formed the present impoundments. The upstream method of tailings disposal at Uravan was common practice when disposal was initiated. At the present time, this disposal method is not state-of-the-art. Control of the tailings material, as well as seepage is difficult by this method. Extreme care must be taken in the discharge (spigoting) of tailings so that the dikes are not breeched allowing the uncontrolled releases of tailings material. Tailings materials are subject to wind and water erosion and past problems have existed with regard to stability of the piles.

Detailed studies of the static and dynamic stability of the tailings ponds were conducted. As a result of these studies, the stability of the piles was increased by the placement of a rock buttress and toe drain system at the base of the tailings piles. This toe drain system includes a series of horizontal drains for dewatering purposes. Detailed operating procedures for the discharge of tailings were also implemented.

Long-term containment of the tailings materials poses a special problem at Uravan. The tailings ponds are located on a sandstone bench and near the edge of the mesa. Major concerns for long-term stability of the piles includes cliff retreat, gully erosion, and sheet erosion of the steep side slopes of the piles. Other factors considered are drainage, settlement, seismic stability, riprap durability, radon control, root and animal penetration, and human intrusion. These factors have all been considered in the design of the final reclamation plan (LC 11.1, Section 4.4). This plan gives the appropriate details for in-place stabilization of the tailings ponds.

In the interim, erosion of tailings is being controlled by a one (1) foot cover prior to final reclamation; however, radon emanation and erosion for the long term will only be fully controlled when the final cover is placed.

5.3.1.2 Club Mesa Spray, Club Ranch Pond, and Atkinson Creek Disposal Areas

The Club Mesa Spray area, Club Ranch Ponds, and Atkinson Creek Disposal Site (Figures 5.2-5 and 5.2-6) contain crystals formed from the evaporation of waste liquid. Volume of these crystals and associated contaminated soils is about 1.2 million cubic yards. An additional 150,000 cubic yards of sludge removed from the River Ponds is located on Club Mesa.

These crystals are primarily composed of ammonium-aluminum sulfate with radium and trace heavy metals. The crystals are very soluble in water, making them a long-term pollution source. Their solubility also requires special care so that reclamation configuration will not be disrupted or destroyed in the future.

The present location of these materials poses a special problem for reclamation. The Club Ranch Ponds and Atkinson Creek Disposal Area are located in the physiographic flood plain of the San Miguel River. Potential flooding or river channel meandering possibly could disrupt these areas. Additionally, these areas are not lined with suitable impermeable materials. Dissolution of the crystals would cause continued contamination of the ground water and, ultimately, contaminates could discharge to the San Miguel River. The crystals on Club Mesa are underlain by abandoned, underground mine workings. Eventual collapse of these workings could disrupt disposal over them and cause the release of this contaminated material.

5.3.1.3 River Ponds

The River Ponds, shown on Figure 5.2-5, contain sludge, tailings, and associated contaminated material. These ponds were used primarily as settling ponds prior to river discharge. Some of the ponds have, however, been used to store raffinate liquid during the winter months. Sludge from the River Ponds in the past has been placed on Club Mesa. The volume of this sludge and the materials within and composing the River Ponds totals approximately 350,000 cubic yards.

The River Ponds are located in the flood plain of the San Miguel River. Flooding or future changes in the river course could displace the materials into the San Miguel River. Long-term control of these materials at the present location is not practical.

5.3.1.4 Dispersed Contamination in Soils and Sediments

LC 11.1, Section 4.7 describes remedial actions for dispersed contaminated materials to achieve federal and state criteria.

5.3.2 Conclusions for Present Circumstances

Use of the existing solid waste disposal areas at Uravan has been phased out effective July 1, 1985. Specifics regarding each of the areas is as follows:

- Club Mesa Tailings Piles:
  Discharge of solid waste (slurried tailings) was to and did cease on or before July 1, 1985.

- Club Mesa Spray Area:
  Process liquid discharge and, thus, crystals formation were to and did cease on or before July 1, 1985.

- Club Ranch Ponds:
  Process liquid discharge was to and did cease by July 1, 1985; however, evaporation and subsequent crystal formation will occur until the ponds are removed.

- Atkinson Creek Disposal Area:
  Future disposal of crystals or contaminated material in this area is not allowed and present materials will be removed from the area.

- River Ponds:
  Cessation of use has occurred.

- Construction Waste:
  Materials north of Tailings Pile 2 will be decontaminated or disposed of on Club Mesa in an appropriate manner and location.

- Dispersed Contaminants:
  Criteria have been established for cleanup of residual contamination, based upon Table 4.1.2-1 in LC 11.1.

5.3.2.1 Club Mesa Tailings Piles 1, 2, 3

Solid waste disposal in Tailings Piles 1, 2, and 3 must be contained both during operation and after reclamation so that uncontrolled release of the tailings materials does not occur. Studies indicated that large release of tailings could potentially have disastrous consequences (00-780831:7-1). To minimize this potential, strict control of tailings slurry discharge and careful monitoring of the stability of the tailings ponds was required during operation. Reclamation of the tailings ponds must also ensure that tailings material are not released to the environment and that radon emissions from the piles are controlled. The tailings pile side slopes have been covered to reduce dusting prior to final reclamation.

5.3.2.2 Club Mesa Spray Area, Club Ranch Ponds, and Atkinson Creek Disposal Area

The raffinate crystals and associated contaminated materials are a potential long-term source of pollution in the Uravan area. These materials must be removed from their present location and placed in an approved disposal area. The present sites must then be reclaimed and carefully monitored. Such a program has been incorporated into LC 11.1. This plan will ensure that the crystals are removed from areas of potential erosion, ground water contamination, and areas of potential human habitation to a secure disposal site. This will also reduce the number of disposal sites at Uravan.

5.3.2.3 River Ponds

The uranium tailings, sludge and associated contaminated materials possibly could be a source of pollution if flood waters or river meandering disrupts them. This potential impact is eliminated in the reclamation plan by removing the River Ponds and placing them within the Club Mesa Tailings Piles (LC 11.1, Section 4.3). Removal to the piles will ensure their long-term control and minimize the number of disposal sites in the Uravan area.

5.3.2.4 Dispersed Contamination

Town and dispersal deposits, remnant tailings, windblown material, and streamway and drainageway deposts will be cleaned up to acceptable levels as provided in LC 11.1, Section 4.7.

5.4 EXISTING LIQUID WASTE

Liquid waste from the milling operations at Uravan were either evaporated or treated and discharged to the San Miguel River. Evaporation areas include the Club Ranch Ponds and Club Mesa Spray Area (Figures 5.2-5 and 5.2-6). Evaporation also occurs on the top of the tailings ponds where raffinate separates from the tailings slurry. Liquid waste has also been located in the River Ponds.

Total generation rate of liquid waste approached a maximum of 510 gallons per minute when the plant was operating. This waste included raffinate, powerhouse backwash, yellowcake post precipitation thickener overflow, and hillside seepage. The largest volume to be handled was the solvent extraction raffinate solution. This liquid was generally evaporated; however, some of the raffinate was treated and released during winter months. Presently evaporation is used to dry the ponds.

Quality of the waste streams varies. Typical raffinate liquid has a very low pH, is high in total dissolved solids and contains numerous heavy metals and radionuclides, as shown in Table 5.3-3 (00-780831). Radionuclides include thorium, radium, lead, and uranium. Liquid with long-lived radioactive and other potentially toxic materials must be controlled according to the Radiation Rules.

5.4.1 Description of Wastes by Areas Impacted

Four areas contain waste liquids in the present Uravan operations. These are the Club Ranch Ponds, Club Mesa Spray Area, Club Mesa Tailings Piles, and the River Ponds (Figure 5.2-5 and 5.2-6). Each of these areas are described in the following sections.

5.4.1.1 Club Ranch Ponds

The Club Ranch Ponds, adjacent to the San Miguel River, were used for the storage and are now used for the final evaporation of raffinate liquid. These ponds are not lined and seepage from the ponds does occur. The rate of seepage from these ponds was estimated by Dames and Moore (00-780831:2-64) to be on the order of 70 gallons per minute. Later studies (00-831216-04) indicate that this seepage has formed a contaminated ground-water mound within the Kayenta Formation and surficial materials below the ponds. This contaminated ground water moves toward and ultimately discharges into the San Miguel River.

Quality of contaminated plume changes from almost "pure" raffinate liquid directly beneath the ponds to a neutralizing environment (see Section 5.2.5 for a discussion of geochemistry). Although some neutralizing effects are noted, the contaminated plume that discharges into the river is high in total dissolved solids (especially sulfate) and contains some heavy metals and radionuclides. Relatively high flows in the San Miguel River dilute this influx of contaminates so that there is not a marked change in quality of the surface waters (Table 5.3-5) (00-780831).

5.4.1.2 Club Mesa Spray Area

The Club Mesa Spray area, shown in Figure 5.2-5, enhanced the evaporation of raffinate by spraying. The spray area covers approximately 24 acres with an evaporative rate of 4.5 gallons per minute per acre as an annual average (00-780831:3-66). The spray system was used in the spring, summer, and fall. However, raffinate crystallizes in the piping system during the cold weather, thereby negating its use during the winter. When used, the system sprays raffinate into the air to a maximum height of fifteen feet which accelerates the evaporation process.

Chemical effects from the spray evaporation of raffinate include the formation of a crystalline precipitate in the ground with some airborne migration onto nearby restricted land. This precipitate is an ammonium-aluminum sulfate salt with certain heavy metals and radionuclides (see Table 5.3-7 for detailed crystal composition) (00-780831).

Seepage from the spray area was not controlled by liner or engineered containment systems. Raffinate from the spray system drained into the tailings ponds or seeps into the surficial materials and sandstone bedrock on Club Mesa. This subsurface migration is still enhanced by the presence of underground mines beneath the mesa. Spray area seepage, coupled with seepage from the tailings piles, has formed a contaminated plume within the Salt Wash Member of the Morrison Formation. Some seepage exits along the face of Hieroglyphic and San Miguel Canyons where it is collected and returned to the mill or River Ponds. Total seepage from the Club Mesa Spray area was estimated by Dames and Moore (00-780831:2-63) to be 25 gallons per minute.

5.4.1.3 Club Mesa Tailings Piles

Club Mesa Tailings Piles 1, 2, and 3 contain approximately 10 million tons of tailings in a 79-acre area (Figure 5.2-5). Raffinate liquid was used to pump the solids to this disposal area. The liquid is removed from the pile by four major processes: evaporation, liquid decanting in the slime area, embankment seepage, and seepage into the underlying bedrock. Raffinate solution is contained on top of each of the ponds and within the pore spaces of the tailings. Composition of this raffinate solution, similar to the Club Ranch Ponds, has a very low pH, is high in total dissolved solids, and contains heavy metals and radionuclides.

Seepage analysis of the tailings ponds was performed by Chen and Associates (00-831216-03:7). Their analysis included both (1) seepage through the embankments and (2) seepage into the underlying formations. Total seepage rate when the ponds were in use was estimated at 73 gallons per minute (00-831216-03:Fig. 3.3-5). This rate will diminish over time. Complete drainage of the piles was estimated to possibly occur 20-25 years after retirement of the piles (00-831216-03:3-8). At the present time, seepage from the embankment face is collected in a drain system at the rate of approximately 30 gallons per minute. Seepage into the underlying bedrock occurs primarily to the Salt Wash member of the Morrison Formation which is directly beneath the piles. Some seepage, however, may penetrate the Summerville Formation and migrate into the Entrada Formation. Seepage that migrates into the bedrock exits the cliff face along the San Miguel and Hieroglyphic Canyons. A hillside seepage collection ditch collects some of the liquid along the San Miguel cliff face and routes it to the mill or River Ponds.

5.4.1.4 River Ponds

The River Ponds are located on either side of the San Miguel River (Figure 5.2-5). Five ponds are on the west side of the River (00-780831:Plate 3.2-2) and two ponds are on the east side of the river. These ponds were used primarily as settling ponds for the CDPS discharge permit. However, the ponds on the east side of the river have historically been used to store neutralized raffinate prior to treatment during the winter.

When in use seepage from the River Ponds was estimated to be 10 to 40 gallons per minute by Dames and Moore (00-780831:2-63). This seepage would flow into the underlying surficial materials and bedrock of the Kayenta Sandstone and would ultimately discharge into the San Miguel River. Quality of this seepage is not known.

5.4.2 Conclusions for Present Circumstances

The liquid waste management system did not fully control contaminated liquids. Significant seepage is occurring in the Uravan area. This seepage is from the Club Mesa Tailings Ponds and Spray area as well as from the Club Ranch Ponds. Additional seepage may also occur from the River Ponds. The impact from seepage has been identified in ground waters along the San Miguel River and within the Salt Wash Sandstone on Club Mesa. Both operational and long-term control and monitoring is required by LC 11.1 so that seepage impacts are fully evaluated and mitigated.

Specifics regarding each of the areas is as follows:

- Club Mesa Tailings Piles:
  Discharge of liquid waste (slurried tailings) was to and did cease on or before July 1, 1985.

- Club Mesa Spray Area:
  Process liquid discharge and all spray evaporation were to and did cease on or before July 1, 1985.

- Club Ranch Ponds:
  Process liquid discharge to the ponds was to and did cease by July 1, 1985; the ponds will be cleaned out, redesigned for evaporation purposes and eventually removed.

- River Ponds:
  Process liquid discharge to the River Ponds was not permitted after July 1, 1985.

5.4.2.1 Club Ranch Ponds

After use for evaporation pursuant to LC 11.1, the area will be reclaimed after removal of all crystals and heavily contaminated material and the placement of these materials in an approved disposal area.

5.4.2.2 Club Mesa Spray Area

Spray evaporation was to and did cease on or before July 1, 1985 on Club mesa. Such a cessation eliminated a significant amount of liquid available for seepage into underlying soils and bedrock. The area will be reclaimed according to the plan set forth in LC 11.1, Section 4.5.

5.4.2.3 Club Mesa Tailings Piles

Liquid discharge to the Club Mesa Tailings Piles was to and did cease on or before July 1, 1985. Seepage through the embankments will be collected until seepage declines to a negligible rate and long-term seepage will be minimized by the placement of cover material that reduces infiltration.

The tailings piles will be reclaimed according to the plan described in LC 11.1 and will be monitored according to Addendum A to LC 11.1 and Annex E to the License. This monitoring program includes piezometers, surface movement monuments, erosion monuments, visual inspection, aerial photography, and monitoring wells. The reclamation plan and monitoring program should insure the safe, long-term containment of the tailings material.

5.4.2.4 River Ponds

Use of the River Ponds was to be and was discontinued by July 1, 1985. Embankment material (tailings) and sludge will be removed and placed on Tailings Ponds 1, 2, and 3 as described in LC 11.1, Section 4.3. These actions will eliminate seepage from the ponds and any potential for long-term impacts.

5.5 EXISTING RADIATION HAZARDS

5.5.1 Introduction

The radioactive elements released into the environment both presently and in the past at the Uravan mill are a significant risk. The nature and degree of the potential health effects are discussed below.

5.5.1.1 Risk to the Public

First, the risk of an ill effect to human health near a uranium mill is defined by the nature of uranium decay series radioactivity. The most hazardous uranium decay series elements emit alpha radiation, which must build up over time inside the human body to have the most effect. A few uranium decay products emit beta and gamma radiation, which are a hazard both internal and external to the body.

Second, observation of an ill effect is a matter of probabilities (statistical odds). Near most uranium mills only one person in hundreds or thousands is likely to show effects which might be due to other than the natural radioactivity already present in the environment.

Third, good radiation protection practice is based on minimizing any chance of ill effect, whatever the source of exposure--whether from "acute" i.e. shorter-term, intense radiation or from "chronic" longer-term lower level exposure to the relatively low specific activity materials found at uranium mines and mills.

A uranium mill receives raw ore, which contains a range of particle sizes from chunks to fine dust. The ore is ground up to the average size of fine sand, so that the uranium can be leached off the surface of the grains. The grinding makes some particles very fine.

Both coarse and fine ore contain dust particles of sizes which if breathed into the lung are not readily breathed back out. The "tailing", or solids left after extraction of uranium, are of these same respirable sizes and contain 95-98% of the original ore radioactivity, including thorium, radium, and other uranium decay series radionuclides.

Once in the lung, some of these particles are engulfed and carried away by the lymph system. Some dissolve and are carried way in the blood stream. Some particles, and thus the radioactive atoms bound into them, remain in the lung and eventually undergo radioactive decay.

Each decay gives off radiation which has a very, very small but definite chance of hitting and affecting a living cell in the host tissue. Most affected cells are repaired or die with no consequence. Over a person's lifetime, if enough radioactive atoms are present, the chance of a cell becoming cancerous and prevailing against the body's combat mechanisms is small, but can be significant compared to other natural or human-activity-caused disease incidences.

Potential radiation risk from a uranium mill is a matter of how much increased radioactivity is available around a given individual for how long. Stated in other terms, in view of the random, statistical nature of radiation risk and effects, "What is the chance that one or more members of a whole population will show a radiation-induced ill effect?"

To estimate the relative risks, radiation "doses" are calculated for "receptors" from mill sources, using local meteorological conditions and summing up various pathways of exposure. Figure 5.5-1 is a schematic of sources of radioactive effluents and exposure pathways.

Air dispersion and airborne pathways typically dominate significant dose contributors (10-821230:5). The inhalation dose calculation procedure requires air concentration data for U-238, U-234, Th-230, Ra-226, and Pb-210 broken down according to source. For example, "What fraction of the measured Pb-210 air concentration is contributed from each of the following: uranium ore dust, yellowcake dust, five tailings particulates, coarse tailings particulates, and radon decay products?" Generally, direct external radiation is less significant near uranium mills than inhalation or ingestion doses (10-821230:5). Also, ingestion of milk or other foods may cause calculated doses for adults to differ from calculated doses to children and teenagers (10-821230:74, 00-831130-03:6).

All dose calculations rely heavily on the set of assumptions made concerning source terms, wind transport, people's breathing rates, average body metabolism for a given radionuclide, relative biological effect when radioactivity is held in the body, etc. Elaborate calculation methods have been developed to estimate such doses and risks. The equations in NRC's Regulatory Guide 3.51, "Calculational Models for Estimating Radiation Doses to Man from Airborne Radioactive Materials Resulting from Uranium Mill Operations" (31G-820300), were used in the Department's 1982 detailed analysis of off-site doses at Uravan (10-821230:14-19). Computer codes such as UDAD (Uranium Dispersion And Dosimetry model) and MILDOS have been used in NRC's evaluation of individual and population doses at Uravan (31-811230) and in UCC's analyses (00-831130-03). Computer models are the only way to readily do the 80 km (50 mile) population dose estimate or calculate the 100-year environmental dose commitment.

The computer codes enable systematic evaluation, radionuclide by radionuclide, body organ by body organ. They enable evaluation of cumulative impact over a person's lifetime, comparison between adult and child doses, or analysis by geographic sector with distance from the site.

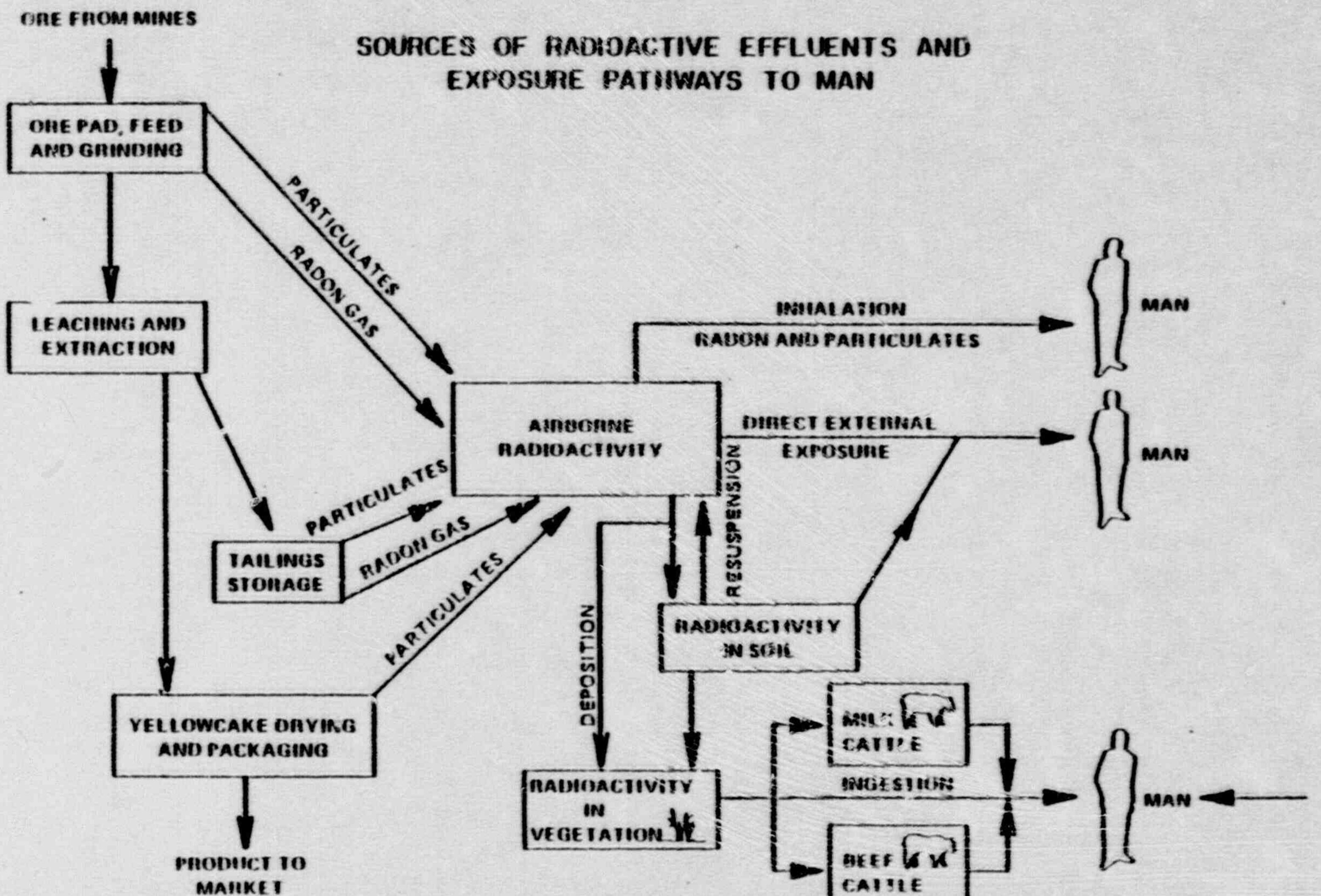


Figure 5.5-1

RADIOACTIVE EFFLUENTS FROM THE URAVAN MILL AND EXPOSURE PATHWAYS TO HUMANS

Standard practice is to be cautious, "conservative", i.e. to choose assumptions likely to be most protective of the individual or population. For example, UCC/Umetco assumed for its base analysis a particle size of one micron (1 um), which is in the "worst" range in terms of greatest lung deposition, thus greatest potential ill effect (00-831130-03:47). Similarly, for purposes of calculating mass average lung dose, the Department assumed for its analysis that all tailings are fine, not coarse (10-821230:79).

The calculational methods and assumptions used by the Department are generally well accepted and proven, are scientifically defensible, and represent best technical judgement of qualified staff. Both field measurements and mathematical calculations are used in determining compliance with basic radiation protection standards.

5.5.1.2 Standards and Rules

The Colorado Department of Health has broad authority and discretion to act, to protect workers and the public from radiation hazards, including to:

Issue licenses [25-11-103 (2)] to all persons who receive, possess, use, transfer, own, or acquire any source of radiation in order to achieve "such uses of all applicable sources of ionizing radiation, radiation machines, and of radioactive materials as will ensure the maximum protection of the public health and as will effect the maximum safety to all persons at, or in the vicinity of, the place of use, storage, or disposal thereof" [RH 1.5];

Issue orders suspending a license upon finding that an emergency exists relating to any source of ionizing radiation which endangers the public peace, health or safety [25-11-103 (5)] (01-800522).

If an applicant meets all statutory and regulatory requirements, the Department must issue the specific radioactive materials license. The fundamental requirements of RH 3.9 are summarized in Section 10. Specific requirements for uranium mills are in RH 3.10.6 and Schedule E of Part III. Both are excerpted in Section 10.

Colorado's "Rules and Regulations Pertaining to Radiation Control", the "Radiation Rules", incorporate the basic international and federal radiation protection framework described in Section 4.1 of the FLS.

The general authority and framework are implemented for off-site situations through specific on-the-ground standards of several types which are measured or assessed near each facility or site. Part 4 of the Radiation Rules contains, in addition to the primary radiation protection standard for all users of radioactive materials (maximum allowable rem per year--a first tier of protection), certain secondary standards (maximum permissable concentrations in emissions to air or effluent to water--a second tier of protection).

The following highlights from the Radiation Rules and related discussion apply to how a fully-operating facility must adequately protect the public and comply with the standards in Part IV (10-831017-04).

RH 4.7.1 states:

> A licensee shall not possess, use or transfer licensed material so as to release to an uncontrolled area radioactive materials in concentrations which exceeds the limits specified in Appendix A, Table II of this part...

RH 4.7.4 states:

> ...the concentration limits in Appendix A, Table II of this part shall apply at the boundary of the controlled area. The concentration of radioactive material discharged through a stack, pipe or similar conduit may be determined with respect to the point where the material leaves the conduit. If the conduit discharges within the controlled area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion or decay between the point of discharge and the boundary.

RH 1.6 States:

> "Controlled area" means any area access to which is controlled by the licensee or registrant for purposes of protection of individuals from exposure to radiation and radioactive material. "Controlled area" shall not include any areas used for residential quarters, although a separate room or rooms in a residential building may be set apart as a controlled area.

After subtracting out natural background, the limits for a controlled area are not exceeded at Uravan, but a major fraction of the Appendix A, Table II, values is attained for certain radionuclides, unless a component of the measurement is attributed to "extraneous" or non-mill sources. The Department takes a cautious and most protective approach in such situations.

The interrelationship of past operations and the nature of "extraneous" sources in the San Miguel River Valley also poses a question of control: "Do past site boundaries at Uravan permit meaningful determinations of compliance with concentration limits?" Division staff determined that either the relative contribution of mill and non-mill activities would have to be clearly demonstrated prior to relicensing or boundary conditions must be modified to permit a clear determination and guarantee of compliance with Appendix A limits for both controlled and uncontrolled areas (10-840522). The definition of Uravan Facility in the Consent Decree and in LC 11.1 clarifies the facility boundary question by including within the facility all areas where remedial actions are to occur.

Significance is added by RH 4.7.5, noted in the Department's August 31, 1983 letter to UCC (10-830831):

> In addition to limiting concentrations in effluent streams, the Department may limit quantities of radioactive material released in air or water during a specified period of time if it appears that the daily intake of radioactive material from air, water, or food by a suitable sample of an exposed population group, averaged over a period not exceeding one year, would otherwise exceed the daily intake resulting from continuous exposure to air or water containing one-third (1/3) the concentration of radioactive material specified in Appendix A, Table II of this part.

This was and is interpreted by the Department as a requirement that whole body dose to a population subgroup (e.g. residents of a block in the town of Uravan) not exceed 170 millirem per year on the average i.e. 1/3 of the annual limit of 500 millirem whole body dose for a member of the public. In addition, the maximum permissable concentration for radon gas at the site boundary adjacent to a population subgroup would be one (1) picoCurie per liter of air at 100% equilibrium.

Also, RH 4.5.1 states:

> No licensee or registrant shall possess, use, or transfer sources of radiation in such a manner as to cause any individual within a controlled area, who is under 18 years of age, to receive in any one period of one calendar quarter from all sources of radiation in such licensee's or registrant's possession a dose in excess of 10 percent of the limits specified in RH 4.2.1.

A third tier of protection--that exposures, effluents, and emissions be kept "As Low As Reasonably Achievable" (ALARA)--is required by RH 4.1.2 of the Rules which states:

> In addition to complying with the requirements set forth in this part, every reasonable effort should be made to maintain radiation exposures, and releases of radioactive materials in effluents to unrestricted areas, "as far below the limits specified in this part as practicable" means as low as is reasonably achievable taking into account the state of technology, and the economics of improvements in relation to benefits to the public health and safety and in relation to the utilization of ionizing radiation in the public interest.

Actual data, so-called "empirical" information, is the basis for determining compliance with each of the three tiers of the standards (31-811230:1). For example, emission rates are measured at the pipe or stack outlet and extrapolated to give an estimate of air concentrations at the controlled area boundary. Another technique is to measure air concentrations at representative off-site locations and back-calculate to estimate concentrations at the controlled area boundary.

By license condition, the Department imposes an additional standard for nuclear fuel cycle facilities, not in Colorado's Rules but from the EPA's Title 40, Code of Federal Regulations, Part 190. LC 18.6.1 states that:

> The licensee shall conduct operations in such a manner as to provide reasonable assurance that the annual radiation dose equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public is not exceeded as the result of exposures resulting from planned discharges of radioactive materials, radon and its progeny excepted, to the general environment.

This limit of 25 millirem per year to the whole body or other organ for any actual nearby individual is both a direct health protection standard and ALARA-based. The 25 millirem standard is unlike the 500 millirem per year limit, which is the most basic standard not to be exceeded in protecting the public from any source of radiation. The 25 millirem standard includes dose to other organs by various pathways and excludes radon. Compliance determination is more complex. While actual measured data are preferred by NRC (31-811230:1), calculational methods are intimately involved.

Because radon is not included in the federal 25 millirem per year limit on uranium fuel cycle operations, summary tables in the following subsections may variously include: (1) total dose, or (2) doses excluding natural background, or (3) doses excluding Pb-210, Po-210 and background. The following distinctions are made in typical calculations.

When the inert gas, radon, is released, its decay results in the "ingrowth" and decay of radon progeny during transport. The progeny then deposit as particulates.

The U.S. Environmental Protection Agency (EPA) excluded radon and radon progeny from the 25 mrem/y off-site dose limit. This exclusion was intended to apply strictly to radon, its short-lived progeny, and its long-lived progeny (Pb-210 and Po-210) which are produced by decay after radon has been released.

The EPA analyses includes release of Pb-210 and Po-210 directly from ore in stockpiles, ore being processed, or from tailings disposal areas. The distinction was made due to the fact that there is no practicable way to capture radon in an operational situation since it is an inert gas.

The U.S. Nuclear Regulatory Commission (NRC) has in the past excluded radon and <u>all</u> its progeny from its offsite dose assessments, stating that in the real world there is no way to distinguish between radon progeny which are produced by decay before or after release from the mill. Although predictive models could be used to differentiate between progeny produced by decay before and after release, the NRC prefers to take the same approach with both environmental data assessments and predictive assessments, excluding radon and progeny from offsite dose consideration.

The Radiation Division has used a conservative approach by attempting both approaches and then basing the choice of necessary actions on best technical judgement for a particular set of circumstances.

5.5.1.3 Summary

To summarize this Section 5.5.1, various categories of individuals may be "at risk": (1) radiation workers in controlled areas where radioactive materials are used, (2) non-radiation workers in controlled areas, (3) day occupants in or near controlled areas, (4) nearby ("nearest" and "maximum-potentially-exposed") residents, and (5) more distant residents.

Populations "at risk" include: (1) the former townspeople, (2) persons residing by geographic sector between 0.5 and 80 km (50 miles) distant, persons living in the region of the country, and (3) the continental population (these latter two are applicable to Rn-222 only).

The standards now in effect apply principally to individuals: directly (500 millirem per year absolute limit, off-site dose ALARA-based limits on whole body, lung, bone and thyroid dose) and indirectly, by control of effluents at the pipe mouth or site boundary (Maximum Permissable Concentrations in Air or Water).

5.5.1.4 Compliance

A final topic for this section is "What does the Department do when a licensee is not meeting a standard?" Such non-compliance may become apparent during annual facility inspection, from required licensee reports, or from investigating a particular incident.

Basically, the Department's response depends on an estimate of the relative hazard involved. At uranium mills, potential health effects are from long periods of exposure to elevated levels of radioactivity. The Department does not regard the typical hazards as imminent, requiring an emergency order to act.

The Department--by letter, order, or license amendment--requires prompt cleanup, housekeeping, or whatever other control measures can be devised to bring the levels of radioactivity into compliance with the standards under the ALARA philosophy. For example, the Uravan facility has been and continues to be on a "compliance schedule" for meeting both the 25 millirem per year limit and the radon maximum permissable concentration at the controlled area boundary limit (62-861203).

If non-compliance is willful or repeated, the Department can fine a licensee under civil penalties provisions of the Radiation Rules approved by the Colorado Board of Health on May 16, 1984 and effective July 1, 1984.

5.5.2 UCC Description, Evaluation and Recommendations

This section will present Umetco's data and conclusions about off-site dose at Uravan. The following Section 5.5.3 presents the Department's independent assessment of the situation.

5.5.2.1 Estimates of Natural Background Radioactivity

Based on data summarized to the Department in November, 1983 (00-831130-03:8), UCC equates the Tabeguache monitoring station, during periods of low facility activity, to regional background for air particulates (00-830707:2, 00-831130-03:8)

Table 5.5-1

Umetco Estimates Of Natural Background

Tabeguache #2 Station		Range: All "background" Stations
Radionuclide	pCi/m^3	pCi/m^3
U-nat	.0006	.0006 to .0050
Th-230	.0009	.0002 to .0010
Ra-226	.0004	.00005 to .0008
Pb-210	.02	.01 to .02

Ambient airborne Rn-222 is considered by UCC to be 0.6 ± 0.3 pCi/l (00-831130-03:8,10).

Some Rn-222 flux, soil and vegetation radionuclide measurements are also presented (00-831130-03:11ff).

Background external gamma dose (TLD) was estimated as 97 ± 5 mrem per year (00-831130-03:74)

5.5.2.2 Source and Receptor Measurements

Emission rates to the environment of airborne and waterborne radionuclides were described in Sections 4.5.1 and 4.5.2, respectively.

The mill history, as described in Section 4.3.1, included numerous past activities in and around the town which contribute to airborne particulate and Rn-222 levels. As discussed in Section 5.5.3, these are only partially identified.

"It is estimated that the overall housing area soil contamination to levels over 5 pCi/gram exists in eighty percent of the housing area" (00-831130-03:32).

Figure 6.0 of the UCC "Radiation Dose Commitment Assessment" (00-831130-03:38) identifies several discrete town tailings sites.

Another potential source of regional radioactivity is from mine waste rock and uranium mines (e.g. Spring Creek Mesa monitoring site D Rn-222 and Pb-210 (00-831130-03:8).

The chronology of recent periods of full operations has been:

Table 5.5 - 2

Periods of Full or Partial Operations

Year	Period	Degree
1980	1/1 - 12/31	Full
1981	1/1 - 3/5	Full
	3/6 - 9/23	Part
	9/24 - 12/31	Full
1982	1/1 - 4/23	Full
	4/24 - 12/31	Part
1983	1/ 1 - 6/ 6	Part
	6/ 7 - 11/ 5	Full
	11/ 6 - 12/31	Part
1984	1/ 1 - 4/30	Part
	5/ 1 - 11/15	Full
	11/15 - 12/31	None
1986 & 1986	1/ 1 - 12/31	None

A replacement yellowcake drying and packaging unit was brought on-line March 5th, 1981. Prior stack emissions were estimated by NUS Corporation (00-800530-07) and UCC staff. Umetco maintains that a reduction (by about a factor of 80) in uranium emissions occurred after the installation of the new yellowcake dryer and dust collection system (00-820331-01:1).

During periods when uranium extraction and tailings discharge was not occurring, ore continued to be received. During 1982, the Environmental Engineer arranged that ore receiving, sampling, crushing, and stockpiling would be halted for 5 periods of two weeks each. Roads were wetted, stockpiles wetted and traffic kept to a minimum (00-831130-03:17). Five control periods were used for comparison.

During these periods, tailings dust and town fugitive dust would be prime potential sources of airborne particulates. The yellowcake stack, leach fume stack, and ore grind circuit would not be sources.

Umetco's Environmental Engineer used data from the various categories of operation to infer the relative strength or importance of the various sources in projecting doses for town receptors (00-831130-03:47).

Umetco believes the principal facility source of airborne radioactivity is fugitive dust from the ore pad and sample plant operation (00-820331-01:2).

Such inferences are complicated by the fact that dispersion model calculations, as generally used by meteorologists, are for flat terrain in a homogeneous wind field at some distance from a single source. At Uravan, the terrain is complex. The wind field is complex, yielding a multilayer profile. Available meteorological data are difficult to interpret (00-800530-08, 00-800530-09) and correlate e.g. between the A-Plant, B-Plant, Spring Creek Mesa, Grand Junction, and Pioneer Nuclear Slick Rock meteorological stations.

Umetco's 1983 wind roses (00-840509) indicate up-valley, down-valley, and cross-valley winds (Figures 5.5-2 to 4). Umetco's 1983 stability data are tabulated below.

Table 5.5-3

Valley (A-Plant) Station

Pasquill Stability Distribution from 1/ 1/83 to 12/31/83

Pasquill Stability	Wind Sigma (o)	Percent Occurence
F Extremely Stable	3.8	8.2
E Slightly Stable	3.8- 7.4	0.2
D Neutral	7.5-12.4	1.6
C Slightly Unstable	12.5-17.4	2.4
B Moderately Unstable	17.5-22.5	5.8
A Extremely Unstable	22.5	81.8

The Club Mesa station is more like the Spring Creek Mesa station in reflecting general (synoptic) patterns.

Table 5.5-4

[UPDATE?]

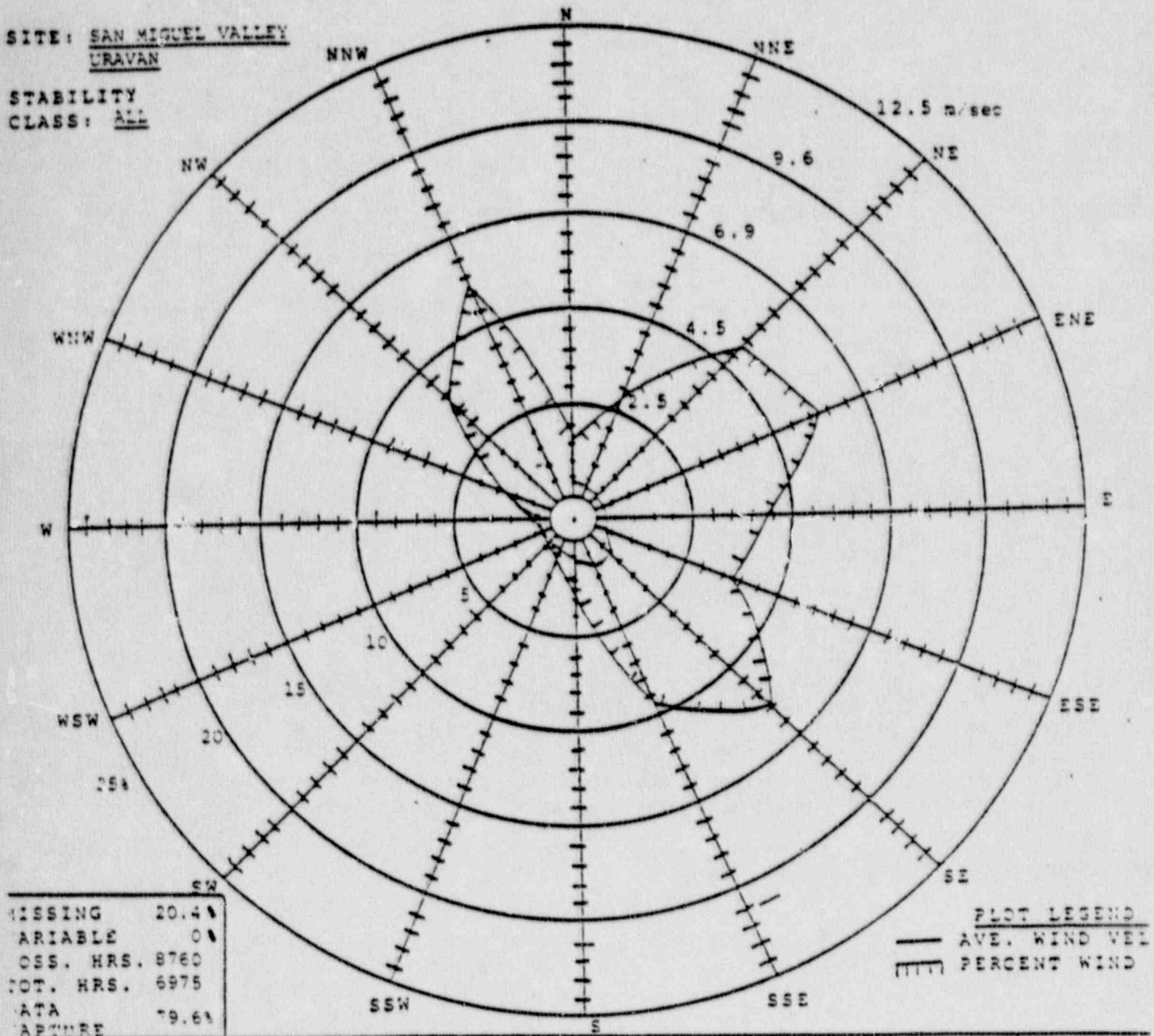
Club Mesa (B-Plant) Station

Pasquill Stability Distribution from 1/ 1/83 to 12/31/83

Pasquill Stability	Wind Sigma (o)	Percent Occurence
F Extremely Stable	3.8	8.8
E Slightly Stable	3.8- 7.4	0.4
D Neutral	7.5-12.4	6.5
C Slightly Unstable	12.5-17.4	13.3
B Moderately Unstable	17.5-22.5	12.2
A Extremely Unstable	22.5	58.8

Figure 5.5-2

VALLEY (A-PLANT) WIND ROSE

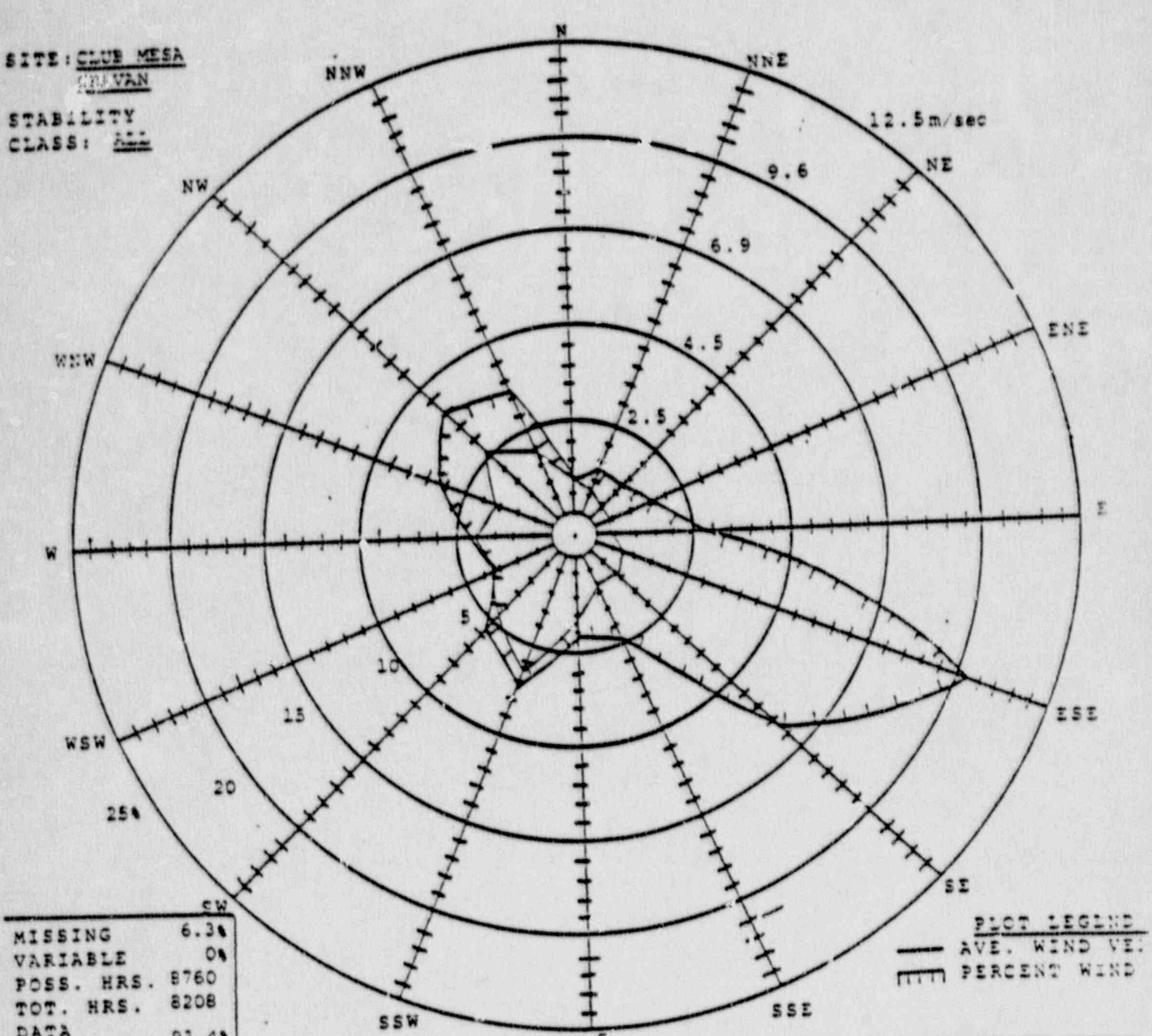


CALM	0.67	2.5	4.3	6.9	9.6	12.5		
11.4%	77.2%	10.2%	1.2%	0.01%	0.0%	0.0%		

METERS PER SECOND MEAN WIND VECTOR VELOCITIES

Figure 5.5-3

CLUB MESA (B-PLANT) WIND ROSE



CALM	0.67	2.5	4.5	6.9	9.6	12.5		
12.7%	54.9%	18.6%	9.7%	4.2%	0.02%	0.0%		

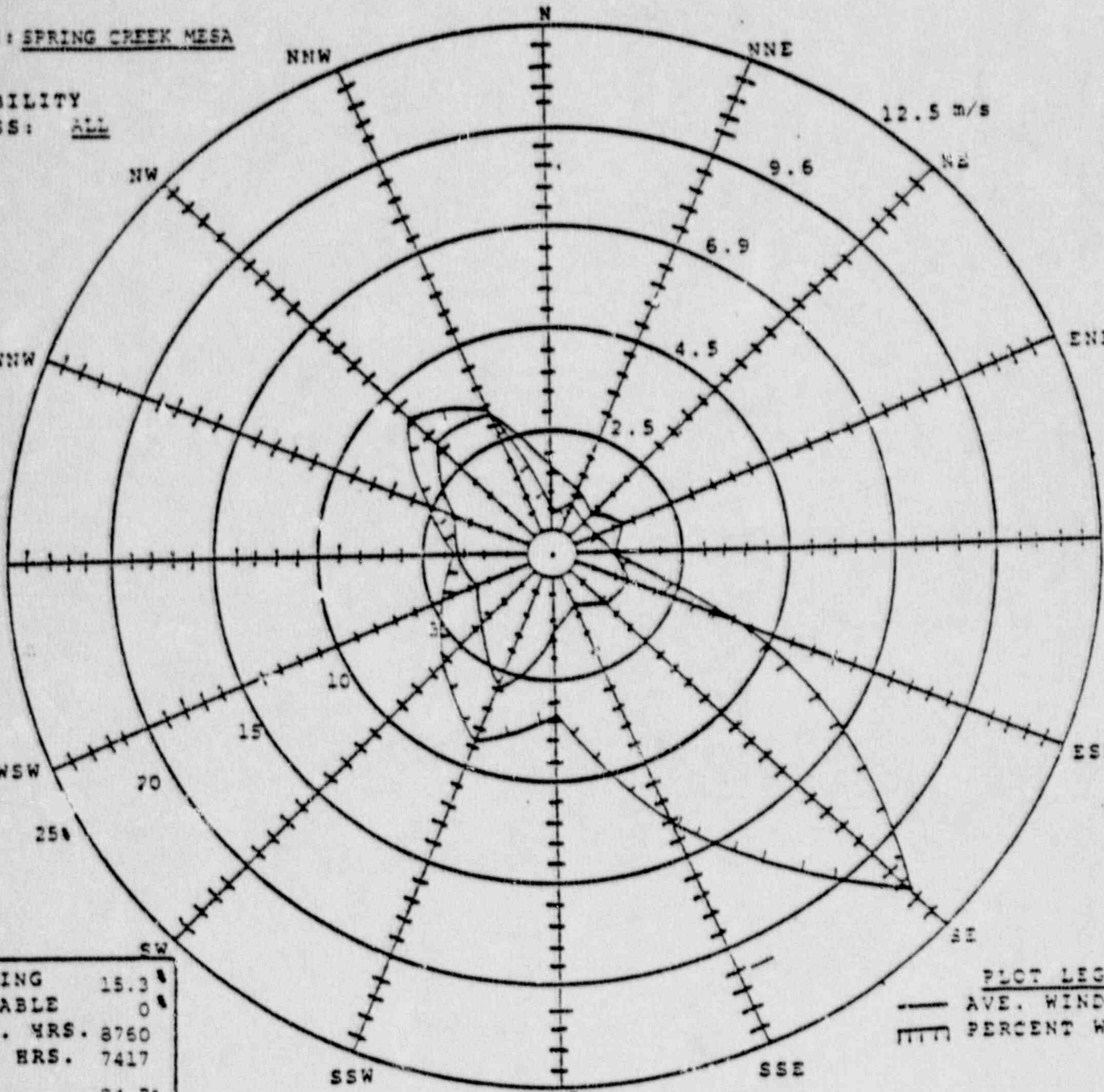
METERS PER SECOND MEAN WIND VECTOR VELOCITIES

Figure 5.5-4

SPRING CREEK MESA WIND ROSE

SITE: SPRING CREEK MESA

STABILITY CLASS: ALL



PLOT LEGEND
AVE. WIND VEL
PERCENT WIND

MISSING	15.3%
VARIABLE	0%
POSS. HRS.	8760
TOT. HRS.	7417
DATA CAPTURE	84.7%

CALM	0.67	2.5	4.5	6.9	9.6	12.5		
14.2%	48.3%	18.4%	11.5%	5.6%	1.4%	0.2%		

METERS PER SECOND MEAN WIND VECTOR VELOCITIES

Table 5.5-5

Spring Creek Mesa Station

Pasquill Stability Distribution from 1/ 1/83 to 12/31/83

Pasquill Stability	Wind Sigma (o)	Percent Occurence
F Extremely Stable	3.8	18.2
E Slightly Stable	3.8- 7.4	4.6
D Neutral	7.5-12.4	12.1
C Slightly Unstable	12.5-17.4	14.7
B Moderately Unstable	17.5-22.5	11.1
A Extremely Unstable	22.5	39.3

Local winds and dispersion patterns are strongly influenced by the local and regional topography and San Miguel River valley, with the highest frequency of wind directions corresponding to cold air drainage down the valley (from the southeast) during the night and early morning hours. Results of a study (31-810601) of dispersion patterns using smoke tracers show that thermal inversion from sunset to sunrise reduces the mixing height, trapping mill effluents in a shallow volume between the ground and inversion ceiling; elevated concentrations of emissions remain in the canyons during these periods (10-821230:40, 00-831130-03:5).

Inversion or neutral conditions are present about 75%-80% of the time (00-820331:2-113, 00-840509).

Section 4.6 of this PELRs describes the routine monitoring points, which include 5 locations for air particulates in the San Miguel Valley and includes 23 Passive Environmental Radon Monitors (PERMs) although recent data from these PERMs have required correction by a factor of 3.

Additional monitoring was conducted for the Spring Creek Mesa baseline studies (00-831216-05) and is discussed in the ALARA, Inc. evaluation of Spring Creek Mesa doses (00-821206-06).

5.5.2.3 Radiation Dose Estimates

NUS Corporation, UCC/Umetco's consultant, provided a preliminary evaluation of radiological doses in January 1980 (00-800417), a more complete evaluation in May 1980 (00-800530-06), and an updated evaluation in March 1982 (00-820407-02). These evaluations focussed on facility emissions.

Finally, in November 1983, the full Radiation Dose Commitment Assessment, Town of Uravan, Colorado, was provided (00-831130-03).

Basically, four cases are calculated for the equivalent of a full-year operation (00-831130-03:47):

1. The present design.

2. Ore stockpile and tailings dust control sufficient to reduce airborne particulates to 10% of prior estimates.

3. Road dust control and a new scrubber at the ore sampling plant, resulting in a 50% reduction in off-site particulates at affected stations.

4. Improvements in efficiency at other ore handling stacks to achieve an additional 50% reduction in observed air particulate levels.

Several subcases were also postulated using various particle size distributions. Generally, UCC/Umetco followed the February 1982 NRC publication "Compliance Determination Proceedures for Environmental Radiation Protection Standards for Uranium Recovery Facilities..." Figure 5.5-5 outlines UCC/Umetco's dose calculation methodology.

Umetco has stated that the adult whole body dose at the fusion building and west of the #2 pile is approximately 250 millirem per year (00-831130-03:6). Both locations are within the controlled area.

Umetco has acknowledged that for off-site areas its data indicate the facilities "exceed the limits for inhalation and ingestion in a number of locations" (00-820331-01:2).

Current mill design, full-year operations do not meet the <u>25 millirem per year criterion</u> at any location within Uravan (00-831130-03:79).

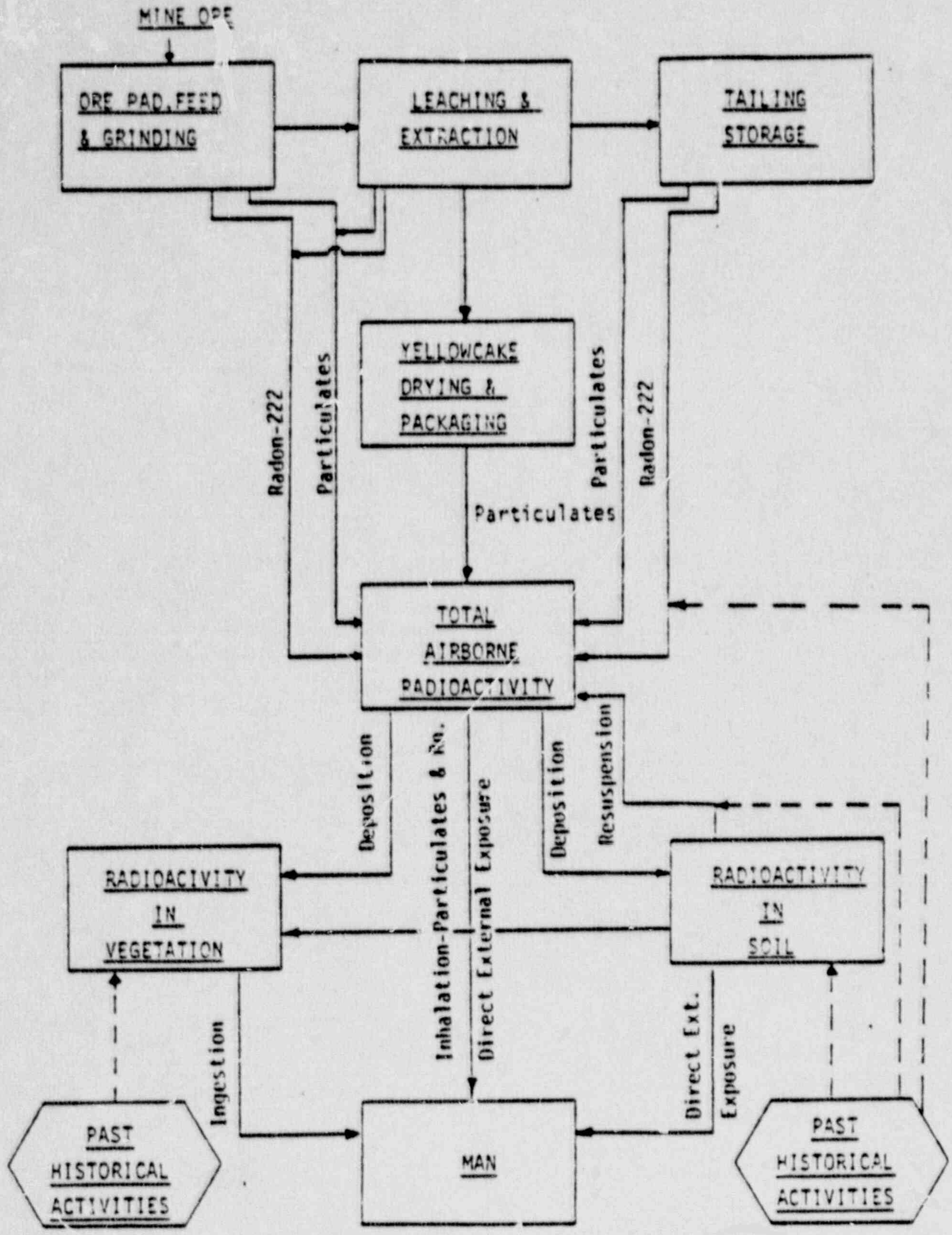
For current mill design (unimproved) and 17 years of operation (new disposal area available), the maximum individual 50-year dose commitment was estimated as 146 millirem per year to the lung.

The maximum total 50-year whole body dose (Rn-222 and progeny thus included) was estimated as 430 millirem per year for a single individual (compared to the 500 millirem per year limit), over 340 for A-block (compared to the 170 millirem per year limit) (00-831130-03:6).

Umetco's summary table for total whole body dose is provided here as Table 5.5-6, and was calculated for each housing unit and block.

Figure 5.5-5

SOURCE OF RADIOACTIVE EFFLUENTS AND EXPOSURE PATHWAYS TO HUMANS



Solid lines -- 40 CFR 190 Doses

Dotted lines-- Total Doses

TABLE 5.5-6

UMETCO WHOLE BODY TOTAL DOSE ANALYSIS
(mrem/year)

Site	1 Ext. Gamma (TLD)	2 Ext. Gamma Survey	3 Ingestion Base Dose	4 17th yr MILDCS Add.	5 17th yr Backgd Added	6 Total With Background	7 Total Without Background
A-Block	312	378/473	10.2	49.4	4.7	442/538	338/434
B-Block	---	255/368	10.6	[illegible]	4.7	320	216
C-Block	209	---	----	49.1	4.7	263	159
E-Block	---	242/385	----	49.4	4.7	296/439	192/335
F-Block	112	152/201	8.0	5.7	4.7	170/219	66/115
G-Block	---	202/350	10.2	49.4	4.7	266/414	162/310
H-Block	133	131/201	7.5	19.5	4.7	163/233	59/129
J-Block	159	151/262	7.5	19.5	4.7	183/294	79/190
OTC	---	247/324	10.2	49.4	4.7	311/288	107/284
NTC	133	133	7.5	11.0	4.7	156	52
Background	97	96	2.6	----	4.7	104	---

FOOTNOTES:

Col. 2 is from Housing Survey. First number is mean for the block/Second number is the maximum for any one dwelling area. This column is not additive to column one. Background is included.

Col. 3 is the dose caused by the current buildup of radionuclides in annual garden vegetation. Background is included.

Col. 4 is the additive dose of 17 years of operation with the current mill design for all pathways. Background is not included.

Col. 5 is the additive dose for 17 years of no mill operation at a background site. Added only in Col. 6.

Col. 6 is the total environmental dose including background.

Col. 7 is the maximum dose due to the existence of the Uravan operations including all past construction activity which contribute extraneous doses from gamma, radon gas release, and vegetation uptake.

OTC - Old Trailer Court - located next to A-Block

NTC - New Trailer Court - located next to Swimming Pool.

Total doses to various organs of the body from inhalation and ingestion of airborne radionuclides were calculated and are presented in Appendices to Umetco's November 1983 Uravan Assessment. "The bone and lung doses prove to be the critical organs with ingestion and inhalation as the critical pathways; thorium-230 and Radium 226 concentrations are the principal contributor". The outcomes were such that Umetco stated that the vegetable "garden-to-humans" patoway and grazing "meat-to-human" pathways (Umetco regards the latter as negligible) (00-820331-13:2-91) must be eliminated to meet regulatory requirements.

The 1980 census listed 510 people residing in the Uravan townsite. In the 1983 operating period, this number had been reduced to 321. Currently, 152 dwellings or trailer sites are occupiable (00-831130-03:76). Umetco's population-at-risk estimates are presented here as Table 5.5-7 (00-831130-03:86), based on the population estimate in Table 5.5-8. The dose analysis represents a worst case, current operations design with 17 years additional processing capacity and the 50-year dose commitment from exposure for 1 year during the last year of operation.

5.5.2.4 Radiation Dose Reduction

In the past, UCC has followed the Surgeon General's guidelines (codified at 10 CFR 712) on a house-by-house basis in evaluating occupancy of residences and has vacated several blocks, removing several houses.

UCC/Umetco has in the past variously committed to a program which could include (00-831130-03):

1. Additional dust control for the ore stockpile area.

2. Additional dust control for the tailings area.

3. Additional road dust control.

4. New scrubbing capability for the ore sampling plant.

5. Improved efficiency for other ore handling stacks.

6. Eliminating gardens in the Old Trailer Court, A, B, and G-blocks (00-831130-03:79)

7. Selective housing elimination (00-831130-03:1,6).

By changing the operation design, UCC believes a maximum individual 50-year bone dose commitment of 25 ± 5 millirem per year and lung dose of 27 ± 5 millirem per year are achievable. By not occupying certain houses, "maximum dose levels drop to mid-teen levels" (00-831130-03:6).

TABLE 5.5-7

URAVAN POPULATION ESTIMATE*

AREA	# of Houses	# of Adults	#of Teens	#of Children	Total Population
A-Block	9	18	6	6	30
B-Block	20	40	13	13	65
C-Block	0	0	0	0	0
D-Block	0	0	0	0	0
E-Block	2	4	1	2	7
F-Block	15	30	9	10	49
G-Block	31	62	19	20	101
H-Block	19	38	12	12	62
J-Block	23	46	14	15	75
OTC	3	6	2	2	10
NTR	30	60	19	19	98
Total	152	304	95	98	497

*Based upon maximum predicted population and age distribution (00-831130-03).

TABLE 5.5-8

POPULATION-AT-RISK DOSE ESTIMATES
(person-rems) (00-831130-03)

PATHWAY	Whole Body	Bone	Kidney	Liver	Mass Average Lung
Inhalation	12.5	28.2	8.22	1.74	1240
Current Ground	44.2	44.2	44.2	44.2	44.2
Predicted Ground & Cloud Exposure	4650	4650	0.00465	0.00465	0.00465
Total Ingestion	1.13	13.7	5.26	1.42	0.00
TOTAL	5.78	86.1	57.7	47.4	1220

Umetco's letter mid-May 1984 commits to:

1985: Cover tailings with 6-12 inches of earth. Install sample plant emission control system prior to operations past June 30, 1985.

1986: Monitor and evaluate source effects (if operating).

1987: Design, obtain approval, and install ore grinding circuit modifications if shown necessary from 1986 study.

1988: Monitor and evaluate source effects (if operating).

After 1988, or at any other time during the above schedule that Umetco chooses, the town of Uravan could be phased out to meet the 25 millirem per year limit.

5.5.3 Radiation Division Evaluation and Conclusions

Section 4, the Radiation Control Division (Radiation Division) Safety Evaluation Report for the Uravan mill, provides discussion of emissions sources and controls, primarily from the point of view of worker protection in controlled areas. The discussion in the PELRB, Section 4 (10-840522) was condensed for this FLS.

This section is the Radiation Division's assessment of the impact of facility effluents and emissions, both from present and past operations at the site, outside the perimeter of the present "controlled area".

Focus will be on three aspects of off-site radiation dose to the public:

1. Compliance with the limit of 25 millirem per year dose to the whole body, lung and bone for emissions from routine operations;

2. Concern about total dose to nearby residents from the incremental effect of present mill operations and past operations of various types; and

3. Concern that radon gas concentrations to the population subgroup in Uravan not exceed one (1) picoCurie per liter of air; and

4. Action steps to control occupancy and complete cleanup of town areas where excessive exposure to radiation is occurring.

Paralleling the headings in Section 5.5.2, this Section 5.5.3 begins with the question "What is baseline or natural background near Uravan?" and then discuss available source and receptor measurments, radiation dose estimates, and radiation dose controls.

5.5.3.1 Estimates of Natural Background Radioactivity

Table 5.5-9 (31-800900:6-63) presents NRC estimates of natural radioactivity for the Colorado Plateau region. Similar values were used in NRC's independent radiological assessment (31-811230). In 1982, the Radiation Division used the UCC/Umetco estimates presented by Dames and Moore (00-780831) and Nuc Corp. (00-820331-08) for its initial 25 millirem/y limit comparisons (10-C21230:20; see also Table 12 in the same reference).

TABLE 5.5-9

RANGE OF TYPICAL NATURAL BACKGROUND TOTAL AIR CONCENTRATIONS
(pCi/m3)

						WL Concentrationsa	
	U-238	Th-230	Ra-226	Pb-210	Rn-222	Outdoors	Indoors
From	.00007	.00002	.00004	.001	10	.00006	.0015
To	.00017	.00007	.00007	.03	1000	.008	.015

(31-800900:6-63)

Close examination contradicts Umetco's assumption that the Tabeguache station represents regional background. The impact of mill operation on uranium in air particulates is apparent (00-831130-03:9). U-238 averages for the Tabeguache station samples are 2.4 x 10-15 uCi/ml overall for 1980-83, but .3 x 10-15 uCi/ml for a period in 1982-83 when mill activity was limited. Umetco measurements for the Tabeguache station (00-831130-03:24) during ore operations (only) indicate impacts for U-nat and Th-230 but not Ra-226.

It was not fully clear from Umetco's Uravan radiation dose commitment assessment exactly which Tabeguache values were used in subsequent calculations.

Data from 4 stations on Spring Creek Mesa, in particular Spring Creek Mesa A and B, provide an alternative basis for estimating background to be subtracted in later dose calculations. As stated by Umetco (00-831130-03:8) Pb-210 at Spring Creek Mesa Site D is impacted by a nearby mine vent. Estimates of regional background by other companies are cited by Umetco (00-831130-03:9).

Based on Umetco's local data, and recognizing that annual average particulates and radon for the San Miguel River Valley floor will exceed mesa-top estimates, the Radiation Division considers the following to be more reasonable:

Table 5.5-10

PARTICULATE BACKGROUND FOR CALCULATIONAL PURPOSES

Radionuclide	pCi/m^3
U-nat	.0005
Th-230	.0003
Ra-226	.0001
Pb-210	.0150

Umetco will be required to recalculate compliance with the 25 millirem per year off-site dose limit (LC 18.6) using these values as background to determine the sensitivity of compliance projections to choice of natural background radioactivity estimates.

For Rn-222, the Radiation Division believes 0.5 pCi/l to be a more acceptable value than Umetco's 0.6 ± 0.3 pCi/l. These "outdoor" values compare to the 1 pCi/l average Rn-222 concentration accepted as representative world-wide (55-770000). An equilibrium factor of 0.5 (ratio of Rn progeny concentration to their expected concentration in radioactive decay equilibrium with Rn gas) is also taken as representative. Table 5.5-11 presents a recent tabulation of radon values (32-830300:8-9) in the region of a model mill.

Umetco's estimate of background soil radioactivity is on the high side (3 pCi Ra-226/g soil). The Radiation Division considers a "conservative" baseline soil Ra-226 to be between 1 and 2 pCi/g. New data will be used to set the appropriate background level area by area.

Natural radioactivity in vegetation is highly variable. Umetco's data (00-831130-03:39) are of marginal use. Since vegetation and meat ingestion pathways are to be eliminated under present circumstances at Uravan, better vegetation background data are not being required at this time. For purposes of calculation, background values from the scientific literature, not the Uravan site, have generally been used by the reviewers (10-821230).

Umetco is presently required by LC 18.6.3.2 to preclude growing of garden vegetable for human consumption on its property at Uravan.

TABLE 5.5-11

REGIONAL AIR CONCENTRATION OF RADIONUCLIDES FROM MODEL MILL
BY DISTANCE AND PARTICLE SIZE (OPERATIONAL PHASE)
(Ci/m3)

Distance (meters)	Average(a) 5 um	Average(a) 35 um	Maximum(b) 5 um	Maximum(b) 35um
		^{238}U, ^{234}U		
600	3.7 x 10-16	6.5 x 10-17	6.3 x 10-16	1.5 x 10-16
1000	1.1 x 10-16	1.8 x 10-17	2.2 x 10-16	5.6 x 10-17
2000	2.8 x 10-17	3.5 x 10-18	6.3 x 10-17	1.3 x 10-17
3000	1.2 x 10-17	1.4 x 10-18	2.9 x 10-17	5.5 x 10-18
4000	7.0 x 10-18	6.9 x 10-19	1.7 x 10-17	2.8 x 10-18
5000	4.6 x 10-18	6.5 x 10-17	1.1 x 10-17	1.7 x 10-18
10000	1.2 x 10-18	7.5 x 10-20	3.0 x 10-18	3.1 x 10-19
20000	3.2 x 10-19	1.3 x 10-20	8.8 x 10-19	5.4 x 10-20
		^{230}Th, ^{226}Ra, ^{210}Pb, ^{210}Po		
600	5.2 x 10-15	9.3 x 10-17	9.0 x 10-15	2.2 x 10-15
1000	1.6 x 10-15	2.5 x 10-16	3.1 x 10-15	7.9 x 10-16
2000	3.9 x 10-16	5.0 x 10-17	9.0 x 10-16	1.9 x 10-16
3000	1.8 x 10-16	2.0 x 10-17	4.2 x 10-16	7.8 x 10-17
4000	1.0 x 10-16	9.8 x 10-18	2.4 x 10-16	4.0 x 10-17
5000	6.6 x 10-16	6.0 x 10-18	1.6 x 10-16	2.4 x 10-17
10000	1.6 x 10-16	1.[illegible] x 10-18	4.2 x 10-17	4.4 x 10-18
20000	4.6 x 10-16	1.9 x 10-19	1.3 x 10-17	7.7 x 10-19
		^{222}Rn		
600	1.3 x 10-09		2.0 x 10-09	
1000	4.4 x 10-10		7.7 x 10-10	
2000	1.4 x 10-10		2.7 x 10-10	
3000	7.0 x 10-11		1.4 x 10-10	
4000	4.6 x 10-11		9.5 x 10-11	
5000	3.4 x 10-11		6.9 x 10-11	
10000	1.3 x 10-11		2.6 x 10-11	
20000	5.6 x 10-12		1.1 x 10-11	

(a) Value averged over all directions.
(b) Value for direction of greatest risk from model mill
(32-830900:5-11)

5.5.3.2 Source and Receptor Measurements

The Nuclear Regulatory Commission's classic concerns at a uranium mill have been: (1) uranium oxide product emissions in the relatively soluble form of yellowcake; (2) fugitive tailings dust; (3) fugitive dust from the grinding and crushing areas; and (4) radon added to particulates in the mill work area. "The primary means of meeting exposure limits must be control" of these sources (31-811230:1).

As can be seen from Table 5.5-12, which lists the principal parameter values used by NRC in assessing radiation dose at Uravan, quantifying general concerns into specific releases and doses require either knowing numerous facts or making reasonable estimates.

The Radiation Division's 1982 assumptions concerning air concentrations used to calculate inhalation dose commitments (10-821230:79-82) update certain of the NRC parameter values. Table 5.5-13 lists the air concentrations used in the Radiation Division's 1982 evaluation.

The NRC and Radiation Division approaches to the relationship of Uravan source radioactivity concentrations to receptor location concentrations are somewhat different. NRC used the MILDOS computer code to estimate air concentrations of radionuclides at the nearest known resident (0.18 km i.e. 0.1 mile southeast of the mill) and the nearest known resident in the prevailing wind direction (0.5 km i.e. 0.3 miles northwest of the mill). The Radiation Division used observed air concentrations at 5 air particulate monitoring stations, which were taken to be representative of nearby residences. (Once airborne concentrations were established for the purposes of dose calculations, the basic dose calculation methods used by NRC, the Radiation Division, and Umetco are similar.)

For the Radiation Division, several questions were most significant concerning the sources.

1. What improvement was achieved by installation of the new yellowcake drying and packaging equipment, with superior emissions control?

2. Could the NUS Corporation conclusion--that uranium decay series radionuclides from tailings dust are only a small component of air particulate loadings in the valley--be correct?

3. What additional emissions controls in the ore receiving, sampling, grinding, crushing, and stockpiling area are necessary or desirable?

4. What contribution to airborne radioactivity originates from spray evaporation of raffinate?

These questions, and the question of Rn-222 and its progeny from various sources, have been examined in the Radiation Division's 1982 assessment of a full year operation at the 1981 impact levels in Table 5.5-4 (10-821230:14) and in recent work on Rn-222 from both the mill facility and town sites.

TABLE 5.5-12

PRINCIPAL PARAMETER VALUES AS OF 1981 USED BY NRC
IN THE RADIOLOGICAL ASSESSMENT OF THE URAVAN MILL
(31-811230)

Parameter	Value*
Average ore grade, % U_3O_8	0.17
Ore concentration of U-238	562.5
Th-230	542.
pCi/g Ra-226	595.
Pb-210	617.
Ore Processing rate, MT/year	432,000
Operation Schedule, days/year	360.
Ore storage pile	
Actual Area, ha	1.42
Annual average dust loss rate, g/m2-year	269.2
Dust-to-ore activity ratio	2.5
Release rate for truck dumping and other ore pad activities, %	.0055
Specific radon flux from ore piles, pCi/m2-sec per pCi/g Ra-226	1.0
Tailings impoundment system	
General parameters	
Tailings area activities, pCi/g	
U-238	83.
Th-230	485.
Ra-226	573.
Pb-210	666.
Annual average dust loss rate, g/m2-year	2692.45
Dust-to-tails activity ratio	2.5
Dusting reduction factor for water cover, moisture, and chemical agents, %	80.
Specific radon flux from exposed beach, pCi/m2-sec per pCi/g Ra-226	1.
Tailings areas	
Pile 1 & 2, ha (1ha = .4 acre)	23.0
Pile 3, ha	9.3

TABLE 5.5-12—continued

Parameter		Value*
Evaporation ponds and spray areas		
TDS, g/l		140.
Concentrations in discharge to ponds, pCi/l		
	U-238	3459.
	Th-230	148,300.
	Ra-226	1004.
	Pb-210	1004.
Concentrations in solids in ponds, pCi/g		
	U-238	24.7
	Th-230	1057.4
	Ra-226	7.2
	Pb-210	7.2
Evaporation pond and spray areas, ha		
Club Ranch ponds		13.0
Club Mesa spray area		13.0
Emergency ponds		0.5

*Parameter values presented here are those selected by NRC staff after review of submittals through mid-1981. In instances where available data have been sufficient and/or not specific, reasonably concervative estimes were made.

TABLE 5.5-13

SUMMARY OF 1981 ANNUAL AVERAGE AIRBORNE RADIONUCLIDE CONCENTRATIONS AT URAVAN MILL OFFSITE SAMPLING LOCATIONS

Sampling Location b	U-238 c	U-234 c	Th-230	Ra-226	Pb-210
	Airborne Concentrations (pCi/m3) a				
1	1.25×10^{-2}	1.25×10^{-2}	6.98×10^{-3}	8.86×10^{-3}	3.68×10^{-2}
2	1.93×10^{-2}	1.93×10^{-2}	4.52×10^{-2}	7.21×10^{-3}	2.62×10^{-2}
5	2.67×10^{-2}	2.67×10^{-2}	7.04×10^{-3}	4.45×10^{-3}	3.77×10^{-2}
8	6.54×10^{-3}	6.54×10^{-3}	5.80×10^{-3}	7.40×10^{-3}	3.65×10^{-2}
9	4.50×10^{-3}	4.50×10^{-3}	9.50×10^{-4}	3.82×10^{-3}	1.67×10^{-2}

a Concentrations were measured during mill operating periods 1-1-81 to 3-5-81 and 9-23-81 to 12-31-81. Measurements performed by Umetco.

b Sampling locations are listed in Section 2.1. Air stations are operated continuously; filters are changed twice weekly and composited for analysis bi-monthly. Stations 1, 2, and 8 are low volume samplers, 5 and 9 are high volume samplers.

c Uranium activity collected is assumed to be 50% U-238 and 50% U-234.

Several conclusions which should be discussed at this point.

First, while reduction of emissions from the yellowcake filtration, drying and packaging area stack was substantial, offsite U-238 and U-234 concentrations did not decrease proportionally (only a factor of 6). A significant source of off-site U-238 and U-234 concentrations, other than the new yellowcake facility, was thus indicated (10-821230:21).

Second, Umetco's estimates of the fraction of annual activity releases from the tailings piles are low. Table 5.5-8 indicates that tailings contribute approximately 80% of the Th-230, 60% of the Ra-226, 40% of the Pb-210, and 75% of the Rn-222 which is attributable to either ore, yellowcake or tailings area emissions. Close examination of Umetco's scenarios for improvement in emissions control indicates 25-100% particles being of tailing sizes (i.e., for Th-230 and Ra-226 at housing area receptor locations, for example, 78% at the swimming pool area by the new trailer court). (00-831130-03:56)

Third, cross-comparison of ore handling area dust loadings during 1982, in practice, (00-831130-03:24) and Umetco's projections for improvement, using hypothetical but plausible scenarios, (00-831130-03:48-54), unequivocally demonstrate that for mill operation to resume with emissions as low as reasonably achievable, numerous improvements must be made. Extensive Department review will be required prior to any future authorization to handle or process ore.

TABLE 5.5-14

FRACTION OF ANNUAL ACTIVITY RELEASES FROM DIFFERENT SOURCES a

Release	U-238 b	Th-230	Ra-226	Pb-210 c	Rn-222
Ore	0.198	0.213	0.394	0.600	0.237
Yellowcake	0.722	0.006	0.001	0.005	0
Tailings	0.079	0.783	0.606	0.395	0.763

a Fractions were calculated from data (31-811230).

b The same fraction applies to both U-238 and U-234.

c Release rates of Pb-210 and Po-210 are assumed equal to that for Ra-226.

Fourth, most salts entrained by windblow of spray evaporation area mists were deposited relatively near the evaporation site, [illegible] no data are available.

Finally, the question of sources of Rn-222 raises the general issue of "extraneous sources" of radioactivity, that is, sources such as resuspension of dust from scattered contamination in off-site areas from past vanadium milling or Army Corps of Engineers (ACOE) activities or such as Rn-222 from the ACOE tailings deposits. The issue was touched upon in Section 5.5.1.2.

Adequate differentiation of mill and non-mill sources has not been achieved to date at Uravan (for example, the 1980 NUS correlation analysis was inconclusive; data in 1982 for five periods during leaching shutdown when grinding and crushing were also shutdown are also inconclusive). Currently observed radionuclide levels, from a total dose and regulatory process standpoint, must for now be attributed to mill facility operations under Department requirements until definitive analysis proves the contrary (10-831017).

Whatever the source, Table 5.5-15 lists outdoor radon levels observed at Uravan.

Data for indoor radon within the Uravan housing area exist in terms of Working Levels (WL) of radon daughters.

Table 5.5-16 is constructed in accordance with the guidelines set forth by the Surgeon General for remedial action in Grand Junction (10 CFR 712) in which: remedial action was indicated for dwellings above .05 WL, remedial action was considered for dwellings in the .01-.05 WL range and no remedial action was considered necessary below .01 WL. A background correction of .005 WL was added to the above figures in establishing the 3 categories used on the table based on average U.S. indoor figures.

The history, house-by-house or block-by-block, of past activities has not been pieced together (00-831130-03:41). (The Radiation Division proposed to require by LC 16.5.4.4 of Amendment 20, subsequently appealed, that the present status of each building be evaluated by Umetco no later than December 31, 1984.) LC 11.1, Section 4.7 provides for excavation and removal of all discrete, identified deposits of tailings-like materials.

Table 5.5-15

OUTDOOR RADON DATA (1980-1983)

B-Plant (above valley on mesa)

3.4 pCi/l	northeast rim
1.8 pCi/l	north rim
1.3 pCi/l	north-northwest rim
1.1 pCi/l	south boundary of sprays

A-Plant (in valley)

7.8 pCi/l	clinic

Housing Area (in Valley)

7.1 pCi/l	A block
5.8 pCi/l	trailer court
4.3 pCi/l	B block
3.2 pCi/l	sewage plant
2.4 pCi/l	business district
2.1 pCi/l	swimming pool
2.1 pCi/l	G block
2.0 pCi/l	J and H block
1.4 pCi/l	F block
1.3 pCi/l	school

(00-831130-03)

Table 5.5-16 INDOOR RADON LEVELS

Area	Total Housing Units	Greater than .055 WL	.015-.05 WL	Below 0.015 WL
A Block	11	1	10	0
B Block	22	0	19	3
C Block	(13)*	(4)*	(8)*	(1)*
D Block	(4)*	(2)*	(2)*	(0)*
E Block	7	0	3	4
F Block	20	0	3	17
G Block	32	3	17	12
H Block	19	1	7	11
J Block	23	0	5	18
Trailers and Misc. Units	10	0	4	6
Totals	144	5	68	71

*1. C and D block dwellings were not included in the total as all units in these blocks were discontinued or torn down as early as 1969 and all by 1980.

2. Starting in 1980 and through early 1984, Umetco has discontinued use of all dwellings with Rn levels above the Surgeon General's .05 WL guideline.

3. As dwellings in the last column (less than .015 WL) are associated with Radon below the 3 pCi/l level (at 100% equilibrium) they should not be of immediate concern.

4. The 68 dwellings in the .015 to .055 WL range are those where habitability is presently in question.

5. License No. SUA 673, Amendment 20, issued 3/28/84, specifies that the licensee shall not permit vacant residences in the "A", "B", "C", "E", and "G" blocks to be reoccupied after May 31, 1984. Of the dwellings in the 0.015-0.055 WL range, 49 are thus required not to be reoccupied if vacant.

6. The figures listed are based on the 1977-1978 population (approximately 500) and housing data. The present population is closer to 150 and housing occupancy, of course, reduced. Current figures will be obtained as part of any specific action planned.

7. Average indoor Rn progeny concentrations within the occupied blocks together with outdoor Rn values when available are:

A	.034 WL indoors	7.1 pCi/l outdoors
B	.024 WL indoors	4.3 pCi/l outdoors
E	.013 WL indoors	not measured outdoors
F	.012 WL indoors	1.4 pCi/l outdoors
G	.022 WL indoors	2.1 pCi/l outdoors
H	.013 WL indoors	2.0 pCi/l outdoors
J	.013 WL indoors	2.1 pCi/l outdoors
Trailers	.017 WL indoors	5.8 pCi/l outdoors

5.5.3.3 Radiation Dose Estimates

The Radiation Division's 1982 analysis, oriented toward a compliance determination regarding the 25 millirem per year limit, used the "monitoring data approach" to evaluating off-site radiation doses. Radiological impact during post-operational and reclamation phases was not assessed, nor were population doses. For its independent population dose evaluation, the Radiation Division has relied upon NRC's 1981 projections.

Offsite doses calculated by the Radiation Division were in reasonable agreement with NUS Corp. results (see figures).

The locations (see Figure 2.0-1) in the following Figures 5.5-6 through 5.5-10 are:

TABLE 5.5-17

LOCATIONS FOR DOSE ESTIMATES

Station	Location
1	003 Discharge East of A-Block
2	Sewage Plant
5	C-Block by the River
8	North of New Trailer Park at Swimming Pool
9	F-Block Pumphouse

The Radiation Division results, excluding background, show whole body, bone and lung doses each exceeding 25 mrem/y at location one, the 003 discharge point. At this location doses to the bone and lung from the inhalation pathway each exceed 25 mrem/y, calculated to be 284 and 106 mrem/y respectively. This is the only location where whole body doses exceed 25 mrem/y, and this is largely due to the hypothetical ingestion pathway. Bone doses are largely due to inhalation of Th-230 from ore and tailings and ingestion of Ra-226 and Pb-210 contaminated vegetables. Lung doses result from inhalation of Ra-226 and Th-230 in uranium ore dust and, to a lesser extent, from uranium in yellowcake dust.

At location 2, the sewage plant, bone and lung doses are calculated to be 71 and 116 mrem/y respectively. Bone doses are again primarily due to inhalation of Th-230 from ore and tailings and ingestion of Ra-226 contaminated vegetables. Lung doses result from inhalation of uranium in ore dust and yellowcake dust and from Th-230 and Ra-226 in ore dust and tailings.

At location 5, C block by the river, bone and lung doses are 73 and 116 mrem/y respectively, with bone ingestion doses dominating bone inhalation doses more than at location 2. Bone ingestion doses are due to consumption of Ra-226 and Pb-210 with vegetables; bone inhalation doses are due to Th-230 in ore dust and uranium in yellowcake dust. Lung doses from the inhalation pathway are caused by uranium in yellowcake dust and Th-230 and Ra-226 in ore dust.

Location 8, the swimming pool, has bone and lung doses of 29 and 76 mrem/y respectively. The bone dose due to inhalation of radioactive material is about the same as at location 5 and caused by Th-230 from ore dust. Bone dose attributed to the ingestion pathway results from Ra-226 and Pb-210 contaminated vegetables. The lung dose results from inhalation of uranium in yellowcake dust and Th-230 and Ra-226 in ore dust.

The bone dose of 10 mrem/y at location 9, F block, is due to ingestion of vegetables contaminated with Ra-226 and Th-230. The lung dose of 41 mrem/y is largely from inhalation of uranium in yellowcake dust and Th-230 and Ra-226 in ore dust.

The data by pathway and by body organ are in Table 1 of the Radiation Division's 1982 assessment (10-821230:30-32).

Annual inhalation doses from the observed air concentrations due to Rn-222 and progeny are estimated in Table 5.5-9. Whole body doses due to Rn-222 and progeny are estimated in Table 5.5-10.

Radon progeny are the primary contributors to dose to the lungs (10-821230:20, 00-831130-03:85). A dose conversion factor (from NRC) of 0.625 mrem/y per pCi/m3 of Rn-222 in outdoor air is used to calculate doses to the bronchial epithelium, the critical lung tissue. The conversion relates exposure to Rn-222 and progeny at outdoor air levels to an equivalent exposure indoors assuming 100% occupancy (31-811230:B-11, 31-800900). (The previous section listed values representative of 1980-1983 inclusive, not just the values used in evaluating a full year's operation at 1981 concentrations of Rn-222 and progeny).

The most useful conversion when speaking in terms of dose from Radon and its progeny is that which relates the Working Level Month (WLM) to the dose (in rads or rems) resulting from an exposure (where 1 WLM equals exposure to 1 WL for a period of 170 hours). A conversion of 5 rem per WLM seemed to be most widely accepted in 1984 and is used by NRC in its Regulatory Guide 3.51 dealing with calculational models for dose estimations. The National Council on Radiation Protection and Measurements (NCRP) uses 14 rem/WLM.

Figure 5.5-6

ANNUAL DOSES ABOVE BACKGROUND AT LOCATION 1
(mrem/y)

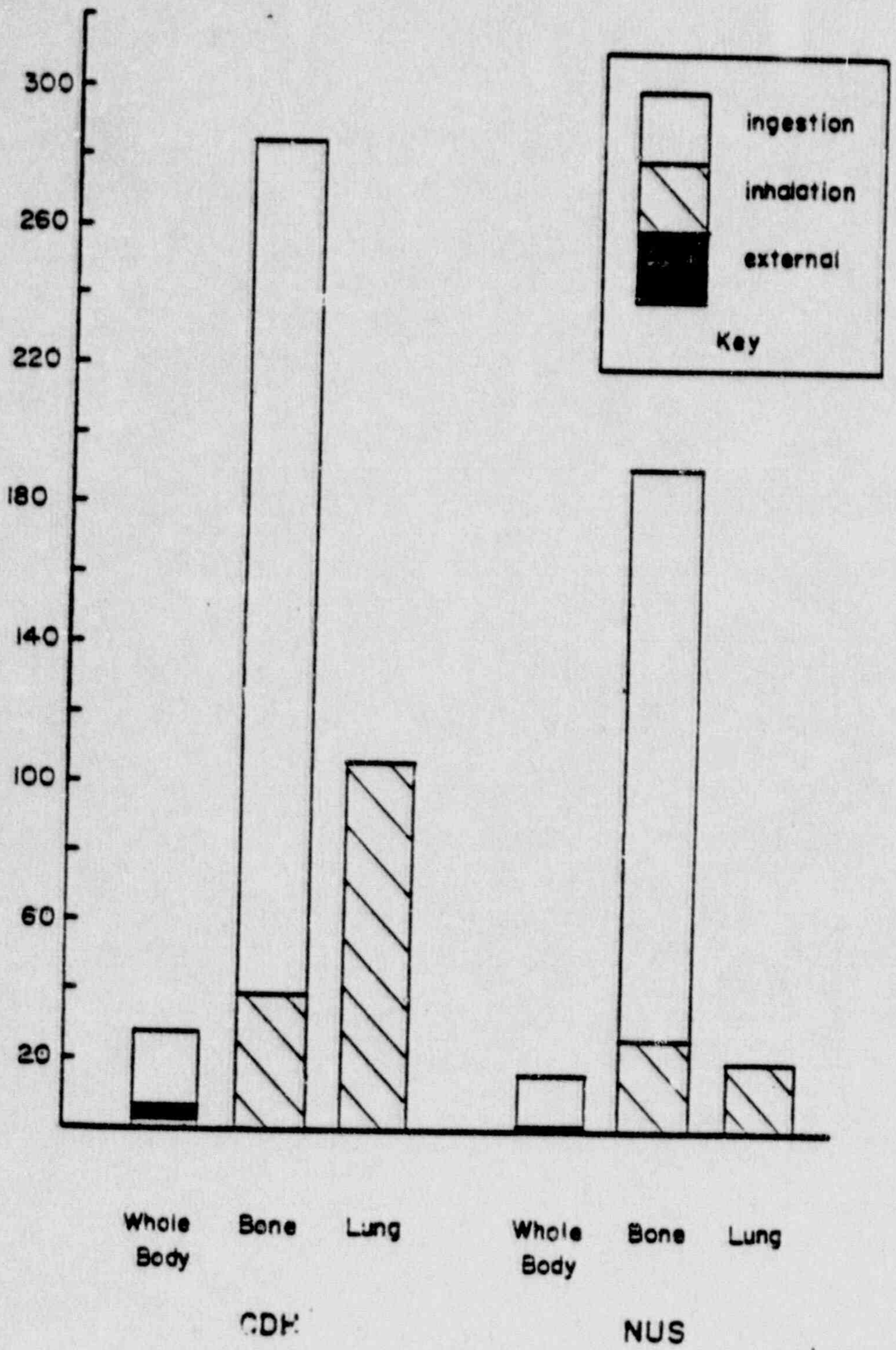


Figure 5.5-7

ANNUAL DOSES ABOVE BACKGROUND AT LOCATION 2
(mrem/y)

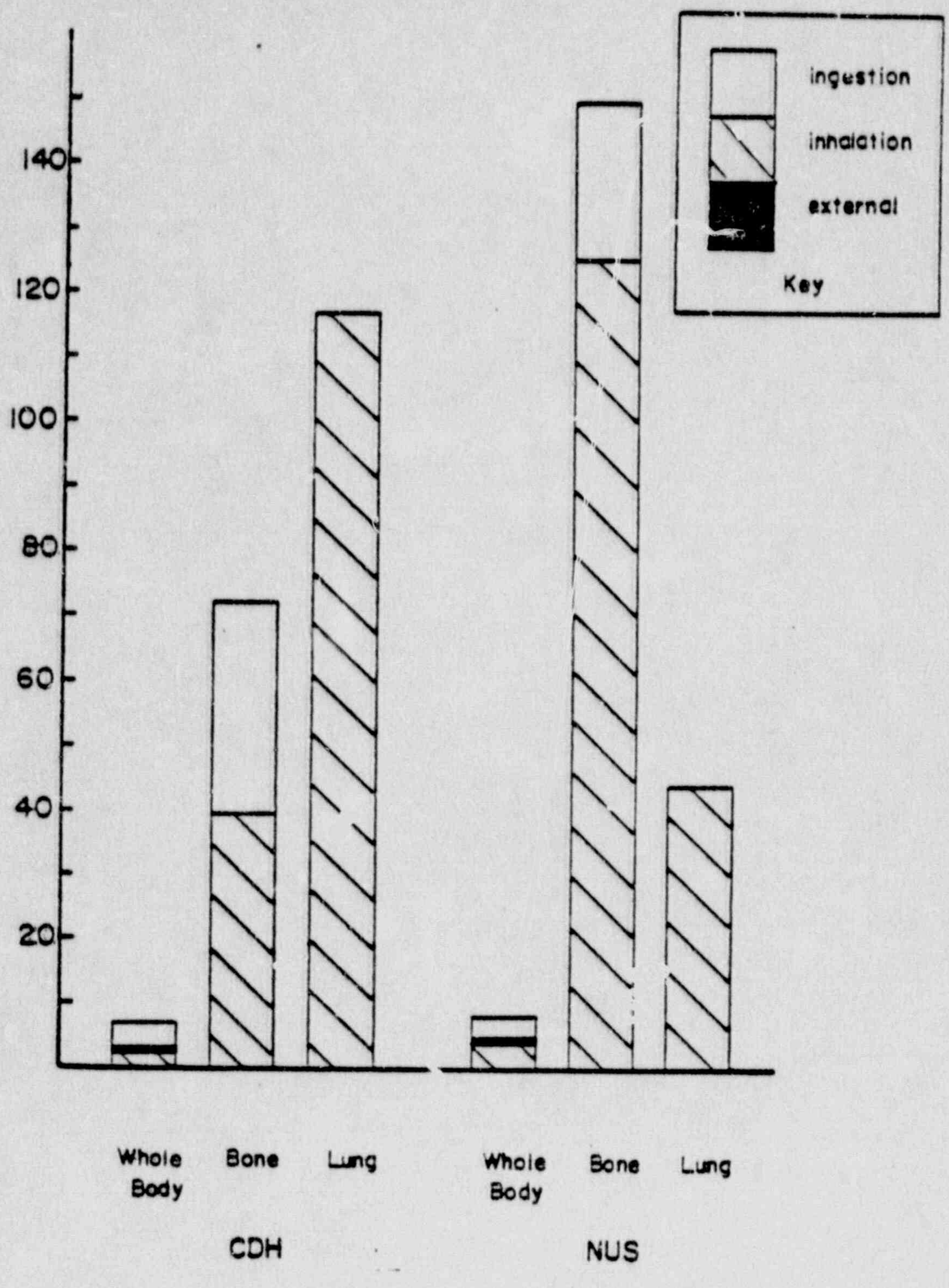


Figure 5.5-6

ANNUAL DOSES ABOVE BACKGROUND AT LOCATION 5
(mrem/y)

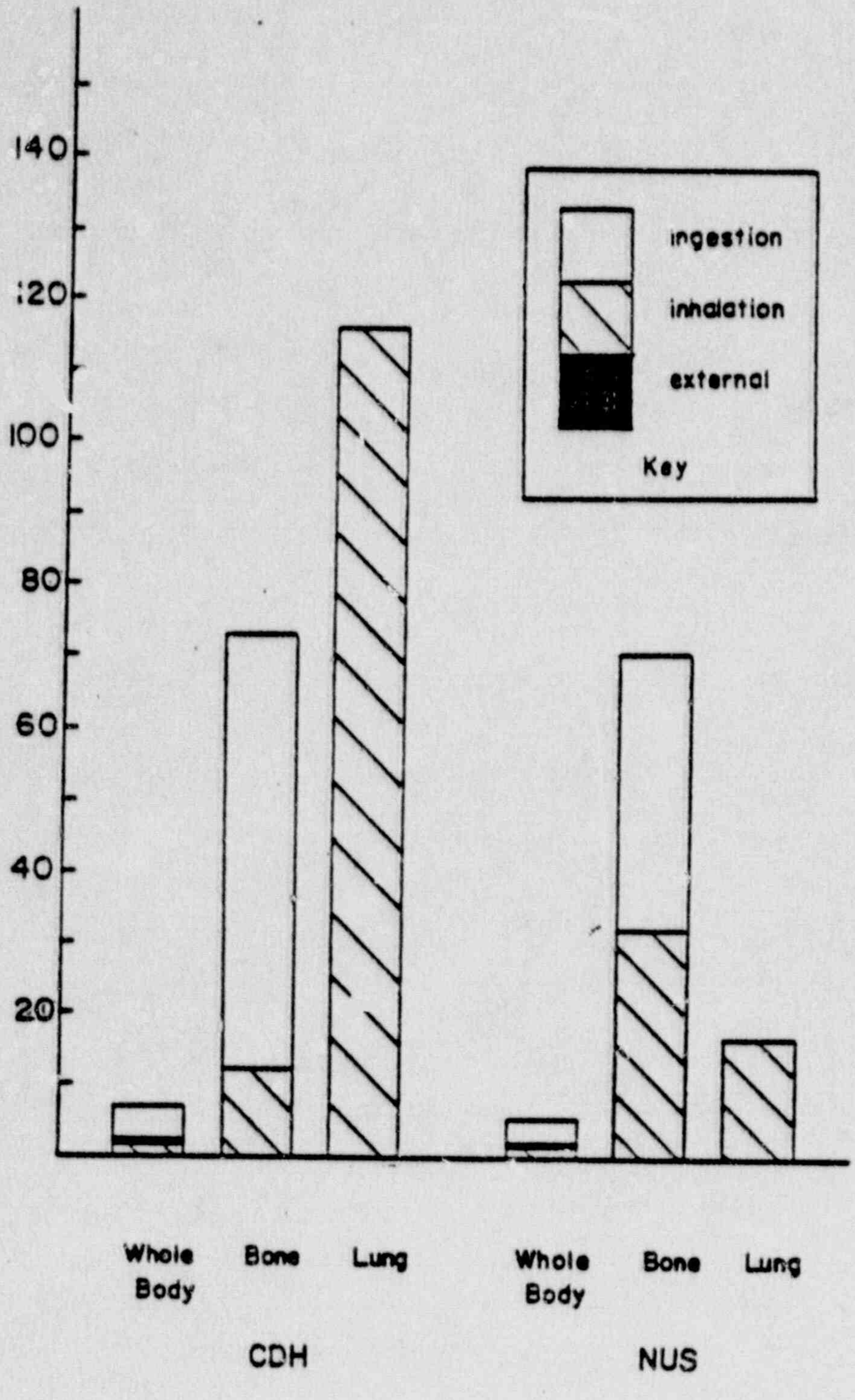


Figure 5.5-9

ANNUAL DOSES ABOVE BACKGROUND AT LOCATION 8
(mrem/y)

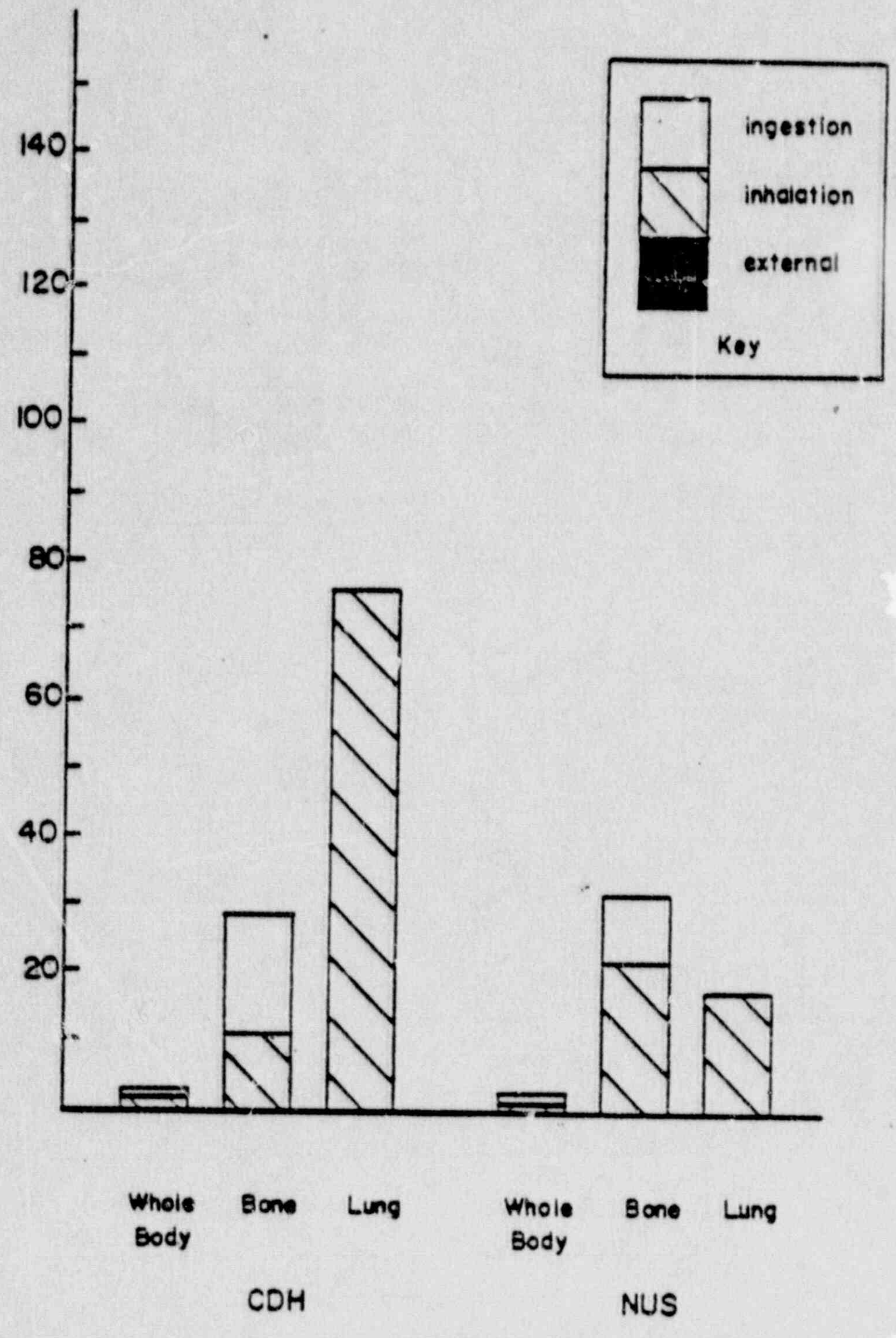
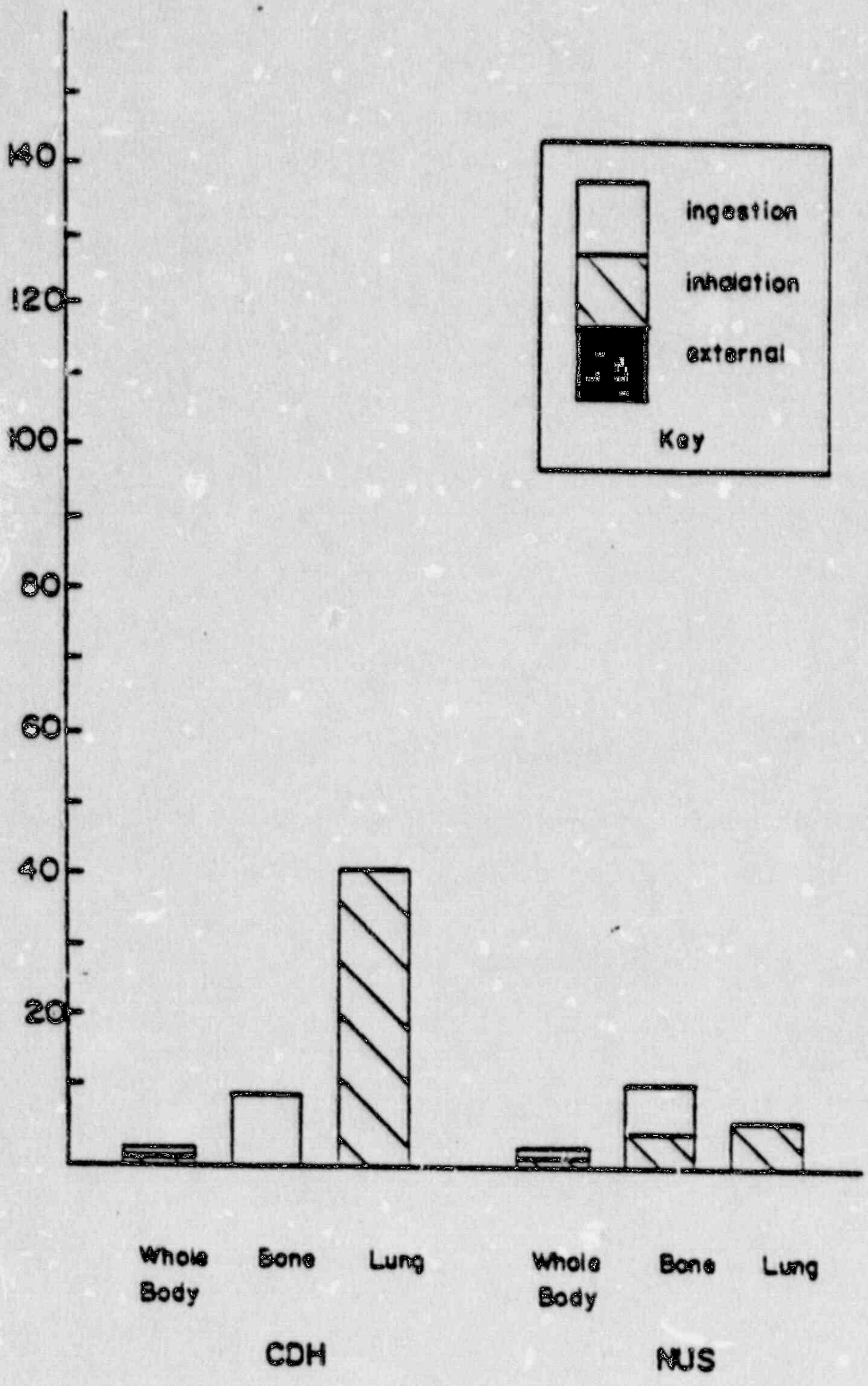


Figure 5.5-10

ANNUAL DOSES ABOVE BACKGROUND AT LOCATION 9
(mrem/y)



Achieving a perspective, from actual studies and data rather than rule-of-thumb or heavily-assumption-laden speculation, on radiation risk and effect issues is difficult. Most risk assessments relating radon exposure and lung cancer are derived from studies on groups of miners. The following chart was a reasonable summary of a number of the original studies as of early 1984 and is sufficient for the purpose of this FLS.

Table 5.5-18

URANIUM MINER STUDIES

Group of miners	Ref.	Excess of lung cancer per 106 persons. lung cancer cases/yr/WLM
Uranium miners (Colorado U.S.A.)	Archer, 1973 (55G-730000:351)	3.2 ± 0.8
Uranium miners (C.S.S.R)	Sevc, 1976 (55G-760000:433)	10 ± 3
Fluorspar Miners (Newfoundland, Can.)	Villiers, 1964 (55G-640000:94)	2.2
Non-Uranium miners (Sweden)	Snihs, 1974 (55G-740000)	3.4
Iron miners (U.K.)	Boyd, 1970 (55G-700000:97)	6.0

(Stranden, 1980) (55G-800000:304-306).

For comparison, U.S. uranium miner lung cancer data and risk estimates are as follows. (55G-800000).

Table 5.5-19

INCIDENCE AND RISK DATA

Cumulative WLM			Lung Cancers		Absolute Risk, cases per 106 PY per WLM	Relative Risk, % increased risk/WLM
Range	Midpoint	Person-Years	Observed	Expected		
0- 119	60	5,183	3	3.96	-	-
120- 239	180	3,308	7	2.24	8.0	1.2
240- 359	300	2,891	9	2.24	7.8	1.0
360- 599	480	4,171	19	3.33	7.8	1.0
600- 839	720	3,294	9	2.62	2.7	0.3
840-1,799	1,320	6,591	40	5.38	4.0	0.5
1,800-3,719	2,760	5,690	49	4.56	2.8	0.4
over 3,719	7,000 (est.)	1,068	23	0.91	3.0	0.3
All	1,180 (mean)	32,196	159	25.24	3.52	0.45

Other lung cancer risk estimates appearing in the literature include:

Table 5.5-20

LUNG CANCER RISK ESTIMATES

6.5×10^{-6}/yr/WLM	(BEIR I) (55G-721100)
6-47 cases/yr/10^6/WLM	(BEIR III) (55G-800000)
50×10^{-6}/yr/WLM (at low exposure less than .01 WL	(Harley et al.) (55G-810000)
10×10^{-6}/yr/WLM	(Harley et al.) (55G-790000)
$200-450 \times 10^{-6}$/WLM lifetime risk	(UN 1977) (55G-770000
520×10^{-6}/yr/WLM lifetime risk	(Cohen, 1982) (55G-820000:695-702)
$860/10^6$ person-WLM	(EPA, 1983) (32G-830900:C-12)

Risk calculations specific to the Uravan situation can be made. The chart below estimates excess lung cancer potential risks based on several levels of exposure pertinent to the situation.

Table 5.5 - 21

POTENTIAL RISK AT URAVAN

	.005 WL (background)	.015 WL (Surg. General's lower limits)	.018 WL (Uravan average)	.055 WL (Surg. General upper limit)
Approx. outdoor Radon	1 pCi/l	3 pCi/l	4 pCi/l	10 pCi/l
WLM/yr	.26 WLM	.77 WLM	.93 WLM	2.83 WLM
WLM/lifetime (70 yrs)	18 WLM	54 WLM	65 WLM	200 WLM
Excess lung cancer risk (lifetime per individual)	.015	.046	.056	.17

Simplifying assumptions made in Table 5.5-21 on the previous page included:

1. A 50% equilibrium relationship between outdoor Rn and indoor WLs.

2. 100% presence in the stated Rn-progeny concentration. This simplifying assumption is made reasonable in light of the outdoor Rn levels to which the town population would be exposed when not indoors. EPA uses 75% occupancy in their assessments where a population can "get away" from an exposure related solely to a structure. Cohen (1980) calculates an exposure of 0.22 WLM/yr for individuals exposed to indoor Rn progeny at 0.005 WL plus negligible outdoor exposure. Based on the above methods of calculation, this equates to 15 WLM per lifetime and a lifetime excess lung cancer risk of 0.013.

3. The EPA excess cancer risk factor of 860 X 10-6/WLM. This assumption is conservative as the factor is higher than those of BEIR III and the 1977 UNSCEAR reports. NRC considers it high by a factor of about 3. Umetco used the exact factor in its Uravan report (00-831130-03).

As the current thinking on the issue of radiation effects accepts a linear dose-response relationship with no threshold level, it is apparent that increases in indoor WL values may cause increases in potential lung cancer risks above that of natural background within the Uravan population.

Harley and Pasternak (1981) (55G-810000) and Stranden (1980) (55G-800000) have proposed the possibility of a threshold dose of 20-30 WLM below which no increased risk exists.

Archer (1979), (55G-790000) on the other hand, postulated higher risk estimated for lower doses (less than 0.1 WL).

In July 1986, an overview by RA Consultants became available, entitled "Qualitative Health Risk Assessment, Uravan Uranium Mill, Uravan, Colorado" (01-860301). The federal Public Health Service has also provided its evaluation (35-860820).

Table 5.5-22

ANNUAL INHALATION DOSES DUE TO RADON-222 AND PROGENY

Location	Dose Rate (mrem/y)	
	Operating	Shutdown
Ballpark	470	220
F Block	430	230
003 Discharge	1900	1200
B Block	1700	780
G Block	690	360
Sewage Plant	1300	620
J Block	690	380
Swimming Pool	750	380

(10-821230:70)

TABLE 5.5-23

WHOLE BODY DOSES DUE TO INHALATION OF RADON-222 AND PROGENY a

Location	Dose Rate (mrem/y)	
	Operating	Shutdown
Ballpark	4.5	2.1
F Block	4.1	2.2
003 Discharge	18	12
B Block	16	7.8
G Block	6.6	3.4
Sewage	12	5.9
J Block	6.6	3.6
Swimming Pool	7.2	3.6

(10-821230:71)

a Assuming inhalation of air containing radon at a mean atmospheric concentration of 0.5 pCi/l results in partial absorption and delivery of a dose to the whole body of 3.0 mrem/y.

Several conclusions can be drawn from the Umetco, Radiation Division NRC, and other evaluations of dose to off-site individuals.

Primary Standards

- Individuals, including minor workers or visitors, spending time in areas on the A-Plant side of the river, in or near the relatively high air concentrations of the controlled area, do not appear to exceed the limits in RH 4.2.1 and RH 4.5.1 of the Rules, although 25-50% of the limits are presently reached for whole body dose (00-831130-03:6).

- Off-site individuals, including minors, residing in the town of Uravan received total doses which approached the 500 millirem per year primary limit, if all or the major part of calculated radiation doses are considered to originate from the licensed milling operations (00-831130-03:6, 10-821230).

- Some off-site population subgroups (residents of a housing block in the town) received doses which exceeded the 170 millirem per year limit.

Secondary Standards

- Depending on interpretation of radon sources and boundaries appropriate, the Maximum Permissable Concentration (MPC) in air has been and continues to be exceeded at the controlled area boundary.

- By all calculations, off-site doses presently exceed the 25 millirem per year limit to whole body, lung, or bone.

For populations, Tables 5.5-11 and 5.5-12 project the 100-year environmental dose commitments from current operations (31-811230:8 & 11) for persons within 80 km (50 miles) of the mill. Umetco calculated only 50-year population-at-risk dose commitments (00-831130-03:75).

As noted previously, several blocks exceed the 170 millirem per year limit which applies to a subgroup of the population such as the residents of one block of the town.

Table 5.5-24

ANNUAL ENVIRONMENTAL DOSE COMMITMENTS (EDCS) TO REGIONAL POPULATION*
RESULTING FROM THE OPERATION OF THE URAVAN MILL
(within 8 km [50 miles] radius)

Exposure Pathway	100-year EDC (person-rem per year of exposure)**			
	Whole body	Bone	Lung	Bronchial epithelium#
Inhalation	2.1	65.0	93.0	36.3
External ground	16.0	16.0	16.0	16.0
External cloud	0.1	0.40	0.40	0.40
Vegetable ingestion	3.3	42.0	3.3	3.3
Meat ingestion	0.11	1.5	0.11	0.11
Milk ingestion	0.25	2.6	0.25	0.25
Inhalation	2.1	65.0	93.0	36.0
Inhalation	2.1	65.0	92.0	36.0
Total	22.0	127.0	113.0	56.0

* Population is estimated to the last year of operation (2000) based on an approximate density of 3 persons per square mile (00-780831) (00-800530-06), except for known population centers.

** Doses to the whole body, lung, and bone are those resulting from the releases of U-238, U-234, Th-230, Ra-226, and Pb-210 particulates.

\# Inhalation doses to the bronchial epithelium are those resulting from the inhalation of radon daughters.

(31-811230)

Table 5.5-25

TOTAL ENVIRONMENTAL DOSE COMMITMENT RESULTING FROM THE URAVAN MILL OPERATIONS*
(person-rem)

Location of population	Whole body	Bone	Lung	Bronchial epithelium
Within 80 km of the mill	7.354 x 10+2**	3.727 x 10+3	[illegible] x 10+3	2.086 x 10+3
Beyond 80 km of the mill	8.737 x 10+2	1.079 x 10+4	8.737 x 10+2	8.737 x 10+2
Total	1.609 x 10+3	1.451 x 10+4	3.578 x 10+3	[illegible] x 10+3
Fraction of Background#	1.932 x 10-6	1.742 x 10-5	4.296 x 10+6	7.106 x 10-7

* Calculated for the operational and postoperational periods totaling 20 years.

** Read as 7.354 X 102 or 735.4.

\# Ratio of total environmental dose commitments resulting from Uravan mill operations to doses from natural background sources, which are estimated on the basis of a North American continental population projected for the year 2000 at 416.4 million persons, each receiving 100 millirem per year to the bronchial epithelium.

(30-811230)

Finally, with respect to windblown particulates, the period of greatest risk is during the post-operational phase of the mill, during which the tailings are drying out but not covered (32-830300:6-9). For this reason, Umetco projected doses for the seventeenth (final) year of operation with a new disposal area (00-831130-03:81-83) (see also 01-860301).

The same concern applies at present, during the period when the top surfaces of existing Ponds 2 and 3 are being prepared for final reclamation.

With respect to ambient radon, which is the acknowledged major factor for local and regional individuals, the Radiation Division regards the abatement to be achieved by removing for disposal all dispersed radon sources and by a thick reclamation cover over the final disposal areas as the most important radiological control objective for this licensing action. While Rn-222 levels have dropped 2-4 fold since 1980, near-term improvements are also being sought by license condition.

5.5.3.4 Radiation Dose Reduction

As stated previously, the primary means to control off-site exposures is on-site control of effluents and emissions at their source. Early Department efforts focused on forcing replacement of the old yellowcake calciner, spraying to control dusting, and ALARA-based suggestions.

Since 1980, Department pressure to improve off-site radiological conditions has intensified. When the 25 millirem per year limit was imposed by Amendment 16, effective December 1, 1980, Umetco immediately appealed. The appeal of the rule itself, based on Umetco's District Court case, was also not resolved. At the same time, Amendment 17 was issued September 22, 1981. Amendment 17 was also appealed. A viable enforcement mechanism for the 25 millirem per year was finally put in place by Amendment 18, January 31, 1983.

Steps taken to reduce U-nat, Th-230, and Ra-226 in air particulate emissions do not necessarily reduce Rn-222 emissions, nor do they deal with total dose inclusive of gamma dose from off-site material due to past operations.

Efforts to reduce emissions from the mill facilities have not been sufficient to meet standards. Thus, recently, Amendment 20 to the license instructed the licensee, based on whole body dose estimates, not to permit vacant residences in blocks "A", "B" "C", "E", and "G" to be reoccupied after May 31, 1984. The Department also considered (10-840522) extending the instruction on reoccupying dwellings to "F', "H", and "J" blocks and the New Trailer Court based on excessive annual average radon progeny doses to the lung. Amendment 20 also instructed the licensee to insure that no garden vegetables are grown for human consumption on licensee-controlled property at Uravan after May 31, 1984.

LC 18.6.3.1 of License 660-02S continues the restriction on garden vegetables.

LC 18.6.3.2 of License 660-02S requires all present residents to vacate by December 31, 1986.

The Department's present determinations, which have evolved since the 1984 PELRS (10-840522: Section 5.5), are that:

1. Once all existing disposal facilities are fully reclaimed and all areas of the mill and town are fully decontaminated, Rn-222 and air particulate emissions will be reduced as low as is reasonably achievable.

2. For full operations to resume, a detailed reevaluation and redesign of ore receiving, sampling, grinding, and stockpiling operations is required.

3. Public activities have been successfully distanced from the A-Plant side of the river.

4. LC 18.6.3.2, which requires all present residents of the Town of Uravan to vacate their residences by December 31, 1986, resolves the issue of total dose commitment to Uravan residents. In 1984 the Department concluded that if a thick, radon-limiting cover were not placed on the face of piles 2 and 3 prior to restart of operations, the radon component of total dose in the town area from the piles might require that some, most or all town residences not be occupied during operations. Of concern was the overall, 24-hour Working Level exposure in the town. A consideration in this regard was whether operating constraints should be imposed for meterological periods when the most elevated radionuclide concentrations are expected or observed to persist.

   Applicable requirements for use of facilities in Uravan by workers, for whom higher exposures are tolerated in the Radiation Rules than are permissable for the general public, will be resolved if and when the issue arises.

5. Continued evaluation of total and 25 millirem per year doses is required until full compliance is achieved with all standards (LC 30.6 of License 660-02S).

The license conditions (LCs) in License 660-02S (Section 7 of this FLS) contain the elements of a program by which the licensed facility will comply with the regulatory requirements detailed in this section. Basically, the License invokes two stern control requirements: Umetco's commitment that residents vacate the town and that new operations cannot occur without a new disposal area.

5.6 WASTE DISPOSAL ALTERNATIVES (SPRING CREEK MESA) FOR FUTURE OPERATIONS

UCC/Umetco investigated several tailings and effluent transportation systems and disposal options at Spring Creek Mesa. Transportation alternatives included: 1) slurry pipleline for tailings and effluent, 2) pipeline for effluent and truck transportation of dewatered tailings, and 3) tramway transportaion of either dewatered tailings or slurried tailings. Disposal options at Spring Creek Mesa included: 1) a no action alternative, 2) cell disposal of dewatered tailings with a separate evaporation pond area, and 3) cell disposal of dewatered tailings with backflooding of the cells for evaporation. Umetco's preferred method of transportation was trucking dewatered tailings to Spring Creek Mesa and effluent transportation by pipeline.

Umetco's preferred disposal method was placement of dewatered tailings into clay-lined cells with subsequent backflooding for evaporation purposes.

The overall goal of the transportation and disposal method was to minimize seepage and potential releases of radioactive and toxic materials. The pipeline transportation system that was proposed by Umetco was designed to minimize possible releases by pipe within a pipe construction and drain-back sumps at the pumping stations. Additionally, the road to Spring Creek Mesa was to be improved so that truck accidents are minimized. The disposal method preferred by Umetco will control a large percentage of potential seepage. However, other methods to further reduce potential seepage may be available and may be reasonably achievable.

5.6.1 Tailings and Effluent Transportation Alternatives

The alternative preferred by Umetco was the transportation of liquid effluent from the mill to Spring Creek Mesa through a pipeline and transportation of dewatered tailings by truck. Transportation of slurried tailings through a pipeline had been previously eliminated because of the abrasive nature of the slurry and the long pipeline route. This abrasiveness could increase the possibility of pipeline failure and release of material to the environment. Aerial tramway was also previously considered as a possible transportation method but high costs and possible environmental impacts preclude the use of such a system.

Under the truck transportation option, solid dewatered tailings would have been transported approximately 3.5 miles (5.6 km) to the tailings facility. The incidence of truck accidents is in the range of 1.6×10^{-6} per mile (10^{-6}/km). However, the county road from the mill to the tailings facility would have been improved and used almost exclusively for the transportation of solid tailings. Vehicle speeds would be limited because of the terrain. These factors would have probably minimized the incidence of truck accidents.

The second type of waste material to be transported to the site was the liquid effluent from the mill at Uravan. This effluent is primarily consists of solvent extraction raffinate solution from within the mill. Process waste effluents would have been pumped via the proposed pipeline to Spring Creek Mesa. Five pump stations were to be located within the pipeline corridor. Power would have been provided by a power line running adjacent to the pipeline. The pipeline would have been protected from severe weather and vandalism. The pipeline option would have been designed and built to allow for emergency and routine surface drainage into a pump station. Any effluent spills will be contained in the sumps within the pump stations. At the disposal site, the pipeline will terminate in an effluent distribution system.

Primary consideration in pipeline system design was given to spill control. To assure a system in which the risk of contamination of the environment was virtually nonexistant, great care was given to the selection of materials for the pipeline, methods of joining the pipeline materials, and physical containment of the pipeline.

The material selected for the pipeline was to be carbon black filled high density high molecular weight polyethylene. The polyethylene material is for all practical purposes chemically inert. This high performance material would have been connected by an equally high performance joining system. This joining method is the heat fusion technique commonly called "butt fusion". Butt fusion joints are stronger than the pipe itself when tested in both tension and hydrostatic loading.

Each time the pipeline is "shut down" regardless of whether it is due to regular plant maintenance, power failure, or other condition, the pipeline would have been automatically emptied. This feature required no power, no maintenance, and no supervision. It was designed into the pipeline system as a permanent feature. The liquid drained from the pipeline would have been held in a series of ground level corrosion protected concrete sumps. Each sump contained pumps capable of returning the liquid to the pipeline when desired.

The first 5800 feet of pipeline was actually a pipeline inside of a pipeline. The inside pipeline, a 8-inch polyethylene pipe, was the actual "live" pipeline. The outside pipeline, a 12-inch polyethylene pipe, is of equal strength and produced to the same rigid standards as the inner pipeline. This outside pipeline would have served only as a backup to the inner pipeline. Should a break, however unlikely, have occured in the inner pipeline, the outer pipeline would have served to contain the raffinate solution and channeled it back into the raffinate pond. This pipeline would have been installed below ground as much as is possible. This installation would have prevented vandalism or other damage to the pipeline. However, due to physical constraints such as crossing the San Miguel River, it was not possible to provide for 100% below ground installation. This dictated the requirement for an elaborate dual pipe system for spill containment.

The remaining pipeline would have been installed below ground. The entire length of the trench would have been lined with an impervious plastic liner. This plastic liner would have contained any possible leaks in the pipeline. Any time the pipeline is shut down, it would have drained automatically into the sump.

All mechanical equipment was to be located inside the containment sumps at the pump stations. This would have allowed maintenance without spillage of the raffinate solution. The only other planned maintenance would have been a regular periodic visual inspection of the pipeline.

5.6.2 Disposal Alternatives

During the 17 year operating life of the new disposal facility, approximately 9 million tons of tailings and 11,000 acre feet of liquid effluent could be disposed of on Spring Creek Mesa.

Three primary alternative methods of tailings disposal were discussed in the Environmental Report: 1) no action, 2) cell disposal with backflooding, and 3) cell disposal with separate evaporation pond. Union Carbide's preferred method is cell disposal with backflooding.

Other alternatives, including spray evaporation and underground injection of liquid wastes were previously investigated by Umetco but were not discussed in detail in the Environmental Report (00-821206:01).

No Action: No action would result in continued shutdown and possible closure of the mill. The mill ceased production indefinitely on November 15, 1984 due to market conditions. This shutdown resulted in the loss of approximately 110 jobs at the mill (00-841024). The loss of these jobs, and the related mining and service jobs they support, reduced local employment. As a result county and school districts property tax revenues were proportionately reduced. The no-action alternative is not Umetco's preferred action because it could continue these social and economic impacts if any when, market condtions improve.

Cell Disposal with Backflooding: This option would provide a combined tailings impoundment and evaporation facility. The impoundment would cover an area of about 350 acres (142 ha) and would be excavated below grade in some areas. The impoundment structure and its impervious clay liner 18 inches thick (00-840106-02:72, Figure 8.2-1) would be subdivided into operational cells which would accept both tailings and effluent at various states in the disposal cycle.

Division into multiple cells allows for operational adjustment to evaporation rates and effluent levels. In one active disposal cell, dewatered tailings would be placed over the liner and/or crystals. Once this cell is filled to capacity with tailings, it would then become an evaporation area for effluent wastes. Shallow surface flooding of the tailings would restore full evaporation area while the next cell in the series is being used for tailings placement.

This option would evaporate and control about 8300 acre feet of liquid effluent from the 11,000 acre feet placed on the mesa. Approximately 2700 acre feet could possibly be available for seepage during the operation, post-operational, and long-term phases of the facility. The preferred alternative may not meet criterion 5 because other designs may be available that could reduce seepage and that are reasonably achievable.

Cell Disposal with Separate Evaporation Pond: A separate evaporation pond could be constructed to segregate effluents from tailings. Based on an estimated annual average net evaporation rate of approximately two gallons/minute/acre (19.2 liter/min/hectare), a pond approximately 160 acres (65 ha) in size would be required for evaporation of the liquid waste. The depth of the effluent pond is estimated at fifteen feet (4.5 m) to provide operational volume and for the accumulation of precipitates during the seventeen year project life. An additional modification of this option could include the use of tailings cells for liquid evaporation prior to the placement of tailings material. However, backflooding of the tailings would not be allowed. Such a modification could possibly reduce the size of the evaporation pond area. Additional reduction may be possible with some spray evaporation.

This modified design, or an alternative such as deep well injection, possibly could reduce seepage by decreasing the head on the liner material and increasing the total evaporation. Such alternatives could be preferable over the alternative proposed by Umetco. Such modified disposal designs and their possible impacts have not been fully presented at the this time.

5.6.3 Regulatory Position

In Part III of the State of Colorado "Rules and Regulations Pertaining to Radiation Control" (6 CCR 1007-1-1 et seq.), rule 3.9 contains the fundamental criteria for approval of a license application (see Section 10). Specifically, for license authorization to be granted, rule 3.9.3 requires the Department to determine whether "the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or property."

Rule 3.10.6.5 further states:

> An application for a license to receive, possess and use byproduct material relating to tailings and waste disposal as defined in RH 1.6 shall contain proposed specifications relating to the emissions control and disposition of the byproduct material to achieve the requirements and objectives set forth in the criteria in Schedule E. Each application for a new license or for license renewal must clearly demonstrate how the requirements and objectives in Schedule E have been addressed. Failure to clearly demonstrate how the requirements and objectives in Schedule E have been addressed shall be grounds for refusing to accept an application. (emphasis added.)

Schedule E (printed in full at Section 10) sets out specific criteria which must be considered and addressed for the Department to determine that the action called for is approval of a license application. Schedule E was modeled after U.S. Nuclear Regulatory Commission regulations that fully considered the reasonableness, including cost-benefit, of these disposal criteria. The Colorado Board of Health used the federal evaluation with slight variations, in adopting these regulations as minimum standards for proper disposal of uranium- and thorium-bearing wastes (by-product materials).

The Department has concluded that, without design improvements, Umetco's design concept as proposed is neither described in sufficient detail nor is it technically sufficient for the Department to accept. After evaluation of supplemental documents and information provided by Umetco since publication of the Department's preliminary regulatory position (see Section 5.6.3, page 7-69 of the PELRS dated May 22, 1984), the Department's determination is that the disposal facility design presently proposed by Umetco does not meet criteria for tailings and other waste disposal systems in Schedule E, Part III, State of Colorado "Rules and Regulations Pertaining to Radiation Control". Additionally, it has been determined that the proposed facility is inconsistent with the Department's policy which became effective February 1, 1984 regarding 40 CFR 192.

Generally, as fully documented in the transcript of the November 19-20, 1984 hearing, the Umetco proposed design is inadequate because it:

(1) fails to contain design features required by the rules, or to provide sufficient and persuasive information regarding exceptions to these design features;

(2) contains insufficient design features for long-term control of toxic and radioactive materials;

(3) fails to provide reasonable assurance that significant concentrations of pollutants will not be reached in identified, currently used and potentially usable waters;

(4) fails to provide reasonable assurance that contaminants will not migrate off the property which Umetco intends to use;

(5) contains insufficient steps to reduce seepage of toxic and radioactive materials into ground water to the maximum extent reasonably achieveable; and

(6) is not consonant with the Department policy dated February 1, 1984 entitled "Policy on Rules for Disposal of Tailings and Other Wastes at Source Materials Mills".

The applicant has the burden through supporting materials and design commitments to demonstrate that all applicable statutory and regulatory requirements are met.

A summary review of the technical requirements follows and states specific major deficiencies in the Umetco proposed design.

Comparison of the Proposed Spring Creek Mesa Disposal Facilities and Technical Criteria.

Uranium mill tailings and waste liquids are to be controlled both during active operations and for long-term time periods. Paramount in this control are minimizing irreversible adverse impacts, minimizing disturbance due to natural phenomena, controlling seepage, and reducing radon flux. Control is to be accomplished without ongoing, active maintenance after closure of the waste repository. The following is a summary analysis of the Schedule E criteria as they relate to uranium tailings and waste disposal on Spring Creek Mesa (see also p 5-5, Section 5.1.2.6).

Criterion 1: Spring Creek Mesa was selected from a number of alternatives based on the best combination of natural features that could possibly accomodate a disposal facility. Original acceptance of the Spring Creek Mesa site was based in part on dewatered tailings and a separate evaporation pond, both clay lined. Major changes in this preliminary design by the applicant have raised serious concerns regarding both the short-and long-term containment of toxic and radiological waste. The State determination was that the broad objective and criteria of isolating tailings and associated contaminants from man and the environment for thousands of years without ongoing, active maintenance will not be achieved at this location by Umetco's preferred design of the waste repository.

Natural geologic conditions present on Spring Creek Mesa are not conducive to short-term or long-term containment of contaminants. Bedrock characteristics in the area are highly variable with regard to rock type and physical properties. Generally, highly-permeable bedrock material, with permeability enhanced by varying joint patterns, underlies the disposal site. Bedrock strata capacity, by itself, is not a sufficient isolation and containment mechanism for controlling contaminant release. Special design features are needed at the repository that will assure both short-term and long-term isolation of the waste materials. Such design features have not been incorporated into the license application.

Criterion 2: Disposal facilities proposed for Spring Creek Mesa will increase the number of waste disposal sites in the Uravan area. The present impoundments are at capacity and, thus, a new disposal area is necessary to continue mill operations.

Criterion 3: Criterion 3 states that the "prime option" for tailings disposal is placement below grade, in specially excavated pits. Sandstone bedrock in the proposed disposal area precludes fully emplacing wastes below grade. The applicant has agreed to remove bedrock materials to the maximum extent reasonably achievable in order to emplace wastes partially below grade.

Criterion 4: Criterion 4 sets forth the site and design features that shall be adhered to whether tailings or wastes are disposed of above or below grade. The license application is deficient in at least two respects related to these design features. First, as required in the criterion, reclamation slopes of the final repository should be as close as possible to grades obtainable if the tailings were disposed of below grade. The applicant has proposed steep embankment slopes (2.5 horizontal to 1 vertical) that do not meet this criterion. The applicant has not shown that less steep slopes are not practical for parts of the containment area. Second, design features must be employed that "reduce wind and water erosion to neglible levels". Final rock cover on top and sides of the repository must be designed "to avoid displacement of rock particles by human and animal traffic or by natural processes, and to preclude undercutting and piping". The applicant has not provided adequate data or calculations regarding the long-term stability of the proposed cover, especially with regard to areas of concentrated flow.

Criterion 5: Criterion 5 sets forth the minimum performance standards for the containment of toxic and radioactive materials and sets minimum site characterization standards. Criterion 5(a) specifically states "In no case shall seepage of toxic and radioactive materials result in significant pollution," which is defined as "deterioration of existing ground water supplies from their current or potential use". The applicant has not clearly demonstrated that this minimum disposal standard is met by the proposed facility design. Numerous design alternatives were discussed with the applicant that could possibly satisfy this criterion. The applicant elected not to incorporate such design alternatives into their license application.

Criterion 5(a) further states that "In all cases steps shall be taken to reduce seepage of toxic and radioactive materials into ground water to the maximum extent reasonably achievable". Umetco has failed to provide detailed, concerted technical evaluation of alternative steps to reduce seepage to the maximum extent reasonably achievable.

Criterion 5(e)(2) states that the information obtained on boreholes shall include geophysical logs. Sufficient geophysical logging to evaluate subsurface conditions was not performed on Spring Creek Mesa. Geophysical logging allows determination and correlation of significant discontinuities, fractures, and channel sand deposits. Additionally, field permeability tests of the saturated zone beneath the impoundment are not sufficient to establish areal variations of permeability.

Criterion 5(e)(3) states "At least one multi-well pump test shall be conducted for each major aquifer unless the applicant demonstrates that such a test will not provide additional information." The applicant did not perform any multi-well tests or adequately demonstrate why they should not or could not be conducted.

Four specific design features are set forth as considerations to accomplish Criterion 5: low permeability liners, recycling of mill process solutions, dewatering, and neutralization. Additionally, effective monitoring and leak detection systems are required for the licensee to demonstrate compliance (Radiation Rule RH 1.10).

The applicant has considered and evaluated low permeability liners in the application. However as a subset of this criterion, Radiation Rule RH 3.10.6.2 must be met. The seepage detection proposed by the applicant does not provide adequate assurance that a major or random failure would be detected. Additionally, the applicant's proposed monitoring will not adequately measure and evaluate compliance with applicable standards and rules, will not adequately evaluate the environmental impacts during active operation, and will not detect all potential long-term impacts. Recycle of mill process solutions and conservation of water to reduce the net input of liquids to the tailings impoundment has not been fully discussed by the applicant in their environmental report. Additionally, the applicant has not provided test data regarding the amenability of reflooded tailings to in-place dewatering nor has the applicant provided technical analysis on the direct neutralization of the tailings or liquid waste to promote the immobilization of toxic substances.

Criterion 6: Criterion 6 requires that at least three meters of earth cover "shall be placed over the tailings or wastes at the end of milling operations". The applicant has indicated that a three meter thick cover is planned for the facility. However, placement of the cover may not be practical for tens of years after operations cease because of resaturation of the dewatered tailings. Additionally, criterion 6 requires that the tailings cover not crack or degrade by differential settlement, weathering or other mechanisms over long-term time intervals. The applicant has not demonstrated that such cover disruption will not occur, potentially causing release of contaminants.

Criterion 7: This criterion addresses airborne effluent releases from milling operations. Air control permits have not been issued by the Department. Full evaluation can only be made after the permits are reviewed. Criterion 7(d) addresses control of tailings dust by covering with water, wetting, chemical stabilization, or phased reclamation. The applicant indicated that tailings dusting would be controlled by backflooding the dewatered tailings in order to meet this criterion; however, backflooding is not desirable from a seepage control standpoint. Additionally, the applicant has not fully considered phased covering and reclamation of the tailings material as required in this criterion.

Criterion 8: Criteria in this section relate to the ownership of tailings disposal sites. Title to the disposal site shall be transferred to the United States or the state in which such land is located. At the present time, the applicant has not demonstrated clear title to the land at Spring Creek Mesa. Additionally, the applicant has not demonstrated either clear possession of subsurface mineral rights or that ultimate ownership of the mineral rights is unnecessary.

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6″

Comparison of Proposed Disposal Design With Department Policy on 40 CFR 192

Departmental policy was issued on February 1, 1984 to provide guidance with regard to recent rule changes by the federal government. Specifically, the EPA standards for active uranium mills became effective December 6, 1983. The NRC informed the state that these standards were to be implemented.

A complete review of Umetco's design regarding 40 CFR 192 has not been conducted at the present time. However, the merits of the proposed disposal design presented by the applicant were evaluated for specific technical issues. Specifically, the amount and rate of seepage from the proposed cells were compared to the type of liner required by 40 CFR 192. It was determined that the amount and rate of seepage from the proposed design would be greater than the required type of design during the operational period. The proposed design would not be equivalent and, thus, not meet the state's policy on 40 CFR 192.

Process Considerations

The following have not been provided to the Department by the applicant or must be complete and acceptable in order for final authorization:

1. air emission control permits;

2. surface ownership of the Spring Creek Mesa disposal site;

3. mineral rights beneath the Spring Creek Mesa disposal site;

4. tailings transportation, socioeconomic, and agricultural impacts and mitigation measures;

5. mined land reclamation permits and access to borrow source areas;

6. complete, detailed financial assurance arrangements for decommissioning, decontamination, and reclamation;

7. complete, detailed estimate of the long-term care fund;

8. stability analysis of interior embankments; and

9. freeboard conditions of disposal cells.

5.7 RECLAMATION AND LONG-TERM CONTAINMENT

Reclamation of the Uravan area and those facilities proposed for Spring Creek Mesa must assure the long-term (thousands of years) control of the radioactive and toxic material. Paramount in this control is minimizing the disruption of the final repository by natural forces, controlling and minimizing seepage, and reducing radon flux to appropriate standards. These factors are to be accomplished without ongoing, active maintenance of the repository.

5.7.1 Cleanup for the Existing Facilities and Town of Uravan

Reclamation activities in the Uravan area focus on the long-term control of the radioactive and toxic materials. At the present time, by-product material is located on Club Mesa and within the San Miguel River valley. Areas of specific concern include the Club Ranch Ponds, River Ponds, Atkinson Creek Disposal Area, Tailings Piles 1, 2, and 3, and the Club Mesa Spray Area. Specific reclamation activities, including conceptual designs, time schedule, monitoring, and quality control, are discussed in LC 11.1, Section 4. In general, the reclamation activities include: the in-place stabilization of Tailings Piles 1, 2, and 3; the removal of the Club Ranch Ponds, Atkinson Creek Disposal Area, and the River Ponds; and the relocation of material from the Club Mesa Spray Area. Insoluble materials from these areas will be disposed of on Tailings Piles 1, 2, and 3, before they are reclaimed and soluble material will be placed in a new disposal area.

The Town of Uravan will be cleaned up according to the plan presented in LC 11.1, Section 4.7. In general, this plan requires the removal of tailings material and decontamination of the townsite.

It is felt that the reclamation plan in LC 11.1 will meet the criteria set forth in Schedule E, Part III of the Radiation Rules and, thus, will meet applicable public health, safety and environmental control standards.

5.7.2 Comparison of Reclamation Activities and Technical Criteria

Reclamation activities proposed for the Uravan area are consistent with the Part III, Schedule E titled "Criteria Related to the Disposition of Radioactive Tailings or Waste" as presented in Colorado's Rules and Regulations Pertaining to Radiation Control" (see chapter 10 for a complete listing of applicable rules). Special design considerations were made because of the existing nature of the disposal facilities.

Key aspects regarding the criteria and the design considerations are as follows:

CRITERION 1: The broad objective of isolating the tailings and associated contaminants from man and the environment for thousands of years without ongoing active maintenance will be achieved in the location and design of the waste repositories. Specifically, all waste material will be located on Club Mesa which is remote from major population centers. Relocation of the 10 million tons of tailings material to a more remote site is impractical. The tailings and insoluble waste will be reclaimed in-place on Tailings Piles 1, 2, and 3 with an appropriate cover material. This cover will reduce radon emission levels to applicable health standards and will minimize future infiltration and seepage. Additionally, the cover is designed to withstand water, wind, and seismic forces.

Active maintenance is not required by this design. Soluble material (raffinate crystals) will be placed in a separate disposal facility meeting these Schedule E Criteria. Final plans and specifications for this facility are to be submitted to the Department as set forth in LC 11.1 (see Section 5.02 of this FLS and Section 1 of LC 11.1).

CRITERION 2: The proposed reclamation plan will significantly reduce the number of waste disposal areas in the Uravan area by relocating materials in the Club Ranch Ponds, Atkinson Creek Disposal Area, and River Ponds to Club Mesa. Numerous, small waste disposal sites will thus be eliminated.

CRITERION 3: Criterion 3 indicates that the "prime option" for the disposal of tailings is placement below grade. The pre-existing nature of the disposal site and the geologic conditions at Club Mesa make below grade tailings disposal impractical. The reclamation design provides reasonably equivalent isolation of the tailings from natural erosion by the placement of a thick, large size riprap on the top of the tailings piles. The raffinate crystals will be disposed below grade.

CRITERION 4: Design criteria discussed in this criterion include a number of specific items to be considered in the reclamation design. The proposed design minimizes the upstream rainfall catchment area, insures that the site is not located near a capable fault, insures that the repository will withstand large earthquake forces, and requires thick rock cover (riprap). This rock cover has been selected based on good long-term weathering characteristics and sized based on runoff from probable maximum precipitation events. Areas of concentrated runoff have been appropriately riprapped and gully erosion minimized by drainage diversions. It is anticipated that the area will naturally revegetate but this is not a critical factor in the reclamation design.

The top of Tailings Piles 1, 2, and 3 have been gently sloped to a diversion channel adjacent to the upper mesa rim. During high flows, fine material could accumulate on the top of the tailings piles, thus promoting minor deposition.

Two factors for which allowance has been made are in the area of wind protection and steepness of slopes. Criterion 4 suggests that topographic features provide good wind protection. The preexisting nature of the disposal area does not allow for selection in relation to such a factor. However, adequate, long-term protection from wind erosion is provided by the riprap in the cover design. The second factor is the steepness of the slopes. The present angle of the embankment slopes (Horizontal=H, Vertical=V) is 3(H):1(V). Significant reduction of this slope to 5(H):1(V) would remove the outer embankment material that provides the basic stability of the tailings repository. Removal would jeopardize the static and dynamic stability of the repository in both the short and long term. As such, steeper 3(H):1(V) slopes will be used in the reclamation plan and is acceptable in meeting the Department and NRC requirements.

CRITERION 5: Criterion 5 addresses seepage control so that existing ground water supplies do not deteriorate from their current or potential use. Seepage should also be reduced to the maximum extent reasonably achievable. In the area of the San Miguel River, past seepage has contaminated ground water. LC 11.1, Section 4, provides for removal of the source of any future contamination by excavation and placement of raffinate crystals and contaminated material on Club Mesa. LC 11.1, Section 5.4, prescribes a corrective action program for ground water contamination.

On Club Mesa, seepage was reduced by the cessation of spray evaporation. However, the tailings piles, because of their saturated nature, will continue to seep at progressively reduced rates. Past seepage has accumulated in the Salt Wash sandstone beneath the tailings piles, but has not impacted regional ground water in the Kayenta or Wingate formations at the present time. Additionally, dewatering of the pile surfaces and the reclamation cover will reduce infiltration from precipitation and, thus, reduce future seepage. Ground water conditions beneath Club Mesa will be monitored.

The preexisting nature of the tailings piles precludes the installation of low permeability liners, tailings neutralization, or dewatering systems. Contaminant release, especially radionuclides, is minimized by geochemical reactions between the seepage and geologic units. Such a reaction is anticipated to continue into the future. Dewatering of the tailings has been previously attempted by a series of special horizontal drains near the base of the tailings piles. The drains were largely ineffective. Liquid from the entire drain system is collected at the base of the ponds. LC 11.1, Section 5.1, requires continued collection of seepage from the toe of the impoundments and along the mesa rim to reduce impact on water resources.

In summary, future seepage in San Miguel River valley will be addressed by the remedial actions prescribed in LC 11.1. Seepage on Club Mesa will decline to minimal rates. Remedial activities are designed to meet Criterion 5 with respect to both Club Mesa and the San Miguel River valley.

CRITERION 6: Earth cover design for tailings pond cover is 3 meters thick measured perpendicular to the slope. The cover designed to withstand wind, and water erosion, earthquake forces, to reduce infiltration, and to reduce radon emissions. Cover design meets or will be finalized to meet conditions set forth in Criterion 6. Other areas where contaminated material has been removed will be reclaimed with local or imported soil material.

CRITERION 7: Dusting of the tailings will be controlled prior to placement of the final cover by a thin layer of soil. This practice fulfills the geotechnical criteria set forth in this criterion that is generally related to operational controls.

CRITERION 8: Criterion 8 deals with ownership of the disposal site; i.e., title to the disposal site shall be transferred to the U.S. Nuclear Regulatory Commission (NRC) or the State of Colorado at the option of the State. The criteria of the Department are modeled after and are equivalent to, to the extent practicable, or more stringent than the NRC criteria. The reclamation plan described in LC 11.1 complies with the NRC regulations. The State may tranfer control of the disposal site to the federal government after reclamation has been completed.

5.7.3 Financial Assurance

5.7.3.1 Description

UCC/Umetco is required by LC 31 and LC 32 to establish with the Department financial assurance arrangments to cover the costs of tailings area reclamation, mill facility decommissioning, and long term care and monitoring. The previous agreement (00-840522-00: 8-12 to 8-29) is superseded by Section XVII of the Consent Decree, which states that "projected costs...shall be projected by Defendants for purposes of the "restricted, single-purpose construction fund or account." (see Section 8 of this FLS) Table 5.7.3-1 is UCC/Umetco's previous estimate of plans and costs.

5.7.3.2 Evaluation

Various cost estimates for reclamation have been derived in the past. Table 5.7.3-1 exhibits a former UCC/Umetco estimate. Independent State estimates are in Department files. In past discussions, a 20% state indirect cost was added to the estimate (10-840821:174-187; 10-841016-00). Indirect costs cover costs the state would incur if for some reason the company could not complete reclamation and the state had to assume control. Thus, supervision and engineering contingencies that are included in contractor (Umetco's) estimates are not included in indirect costs and are therefore separate. "Indirects" are common in public institutions and range in the Colorado Department of Health from 0 to 140 percent (10-840821-02:179 and 181). Hence the 19.6 percent assessment is moderate.

Significant design and schedule innovations have occurred in subsequent negotiations. At the present time, all past Department estimates are in abeyance pursuant to Section XVII of the Consent Decree, which requires UCC/Umetco to provide with UCC/Umetco's proposed final plans and specifications detailed cost estimates, for review and approval by the Department; the approved plans and costs will then serve for financial assurance purposes. Section XVII of the Consent Decree delineates how the State's indirect costs are to be considered.

All financial assurance arrangements are subject to annual review and revision pursuant to proposed LCs 32.5 and 33.3 and Section XVII of the Consent Decree.

Table 5.7.3-2 is an example of a typical detailed spreadsheet of long-term monitoring and maintenance costs. Assumptions and costs are included in the spreadsheet and endnotes. As provided by LC 33.0 and paragraph IV(G) of the Consent Decree, a Long Term Care Fund shall be established at or prior to petitioning for termination of the Consent Decree.

Table 5.7.3-1

Reclamation Costs for Pre-1984 Agreement

Task	Costs
Tailings Pile 1-2-3 Phase I	7,548,000 **
Tailings Pile 1-2-3 Phase II included above	
River Ponds	1,766,000 **
Atkinson Creek	1,590,000 **
Club Ranch Ponds	5,035,000 **
Club Mesa Spray	3,123,000 **
Crystal Disposal Area	4,540,000 **
Mill Cleanup	3,455,000 **
Town Cleanup	not included
Other Cleanup	not included
Upkeep	not included
Total Direct Costs	27,057,000
Indirect State Costs @ 20%	5,411,400
TOTAL COSTS	32,468,400

*All estimates are updated from 1983 dollars to 1984 dollars using the GNP price deflator (CPI was used in the PELRS).

** Did not include the monitor installation costs.

Table 5.7.3-2

UCC/UMETCO
LONG TERM MONITORING AND MAINTENANCE

First Year Draft

ASSUMPTIONS (also see Endnotes below)

Cost/Person-Hour	$50
Office/Inspection time ratio (1a)	2.5
Unit Well Replacement Materials Cost (1b)	$5,000
Unit Fence Replacement Materials Cost (1c)	$500
Unit Road Replacement Materials Cost (includes operator and grader) (2)	$2,000
Unit Monument Survey Cost (includes crew and travel) (3)	$1,000
Unit Aerial Photograph Cost (includes crew and plane) (3)	$5,000

WATER ANALYSIS CLUSTERS AND COSTS (from July 1986 CDH Consumer Price List)

Field analysis: pH, temp., conductivity and water level.	$0
Majors analysis: TDS, Ca, Mg, Na, K, Cl, SO4, CO3, HCO3, NO3 and NH3.	$84
Minors/trace analysis: Fe, Mn, Zn, Se, U, Ra-226 (wet & dry), Ra-228 and Th-2	$273

CLUB MESA AREA

Task	HOURS/ ITEM	NUMBER ITEMS	FREQENCY /YEAR	TOTAL HOURS	HOURS COST	LAB/UNIT COST	TOTAL COST
1. Visual Inspection (2a)	4	1	2	8	400		400
2. Gamma Measurements (2a)	2	1	1	2	100		100
3. Atmospheric Radon (2b)	1	6	2	12	600		600
4. Radon Emanation (flux) (2c)	0.5	6	2	6	300		300
5. Vegetation Analysis (2)	0.25	8	2	4	200		200
6. Water Analysis (2)							
field (3a)	1	18	2	36	1800	0	1800
majors (3a)	1	13	1	13	650	1092	1742
minors/trace (3a)	1	11	1	11	550	3003	3553
7. Well Maintenance (1a,3)	12	18	0.05	10.8	540	4500	5040
8. Fence Maintenance (1b,2)	1	1	1	1	50	500	550
9. Piezometer Measurements (3b)	0.5	20	1	10	500		500
10. Erosion Monuments (3)	0.25	14	1	3.5	175		175
11. Deep-Rooted Veg. Control (2)	0.5	1	1	0.5	25		25
12. Rodent Control (2)	0.5	1	1	0.5	25		25
Contract Help Tasks							
13. Road Maintenance (2)	8	1	0.1	0.8	40	200	240
14. Monument Measurements (3c)	0	23	1	0	0	1000	1000
15. Aerial Photographs (3)	0	1	0.1	0	0	500	500
				118.3	$5,915	$9,095	$16,750

Table 5.7.3-2 continued

SAN MIGUEL AREA

Task	HOURS/ ITEM	NUMBER ITEMS	FREQENCY /YEAR	TOTAL HOURS	HOURS COST	LAB/UNIT COST	TOTAL COST
1. Visual Inspection (2a)	1	1	2	2	100		100
2. Gamma Measurements (2a)	0.5	1	1	0.5	25		25
3. Atmospheric Radon (2b)	1	4	2	8	400		400
4. Radon Emanation (flux) (2c)	0.5	4	2	4	200		200
5. Vegetation Analysis (2)	0.25	8	2	4	200		200
6. Water Analysis (2)							
field (3d)	1	18	2	36	1800	0	1800
majors (3d)	1	8	1	8	400	672	1072
minors/trace (3d)	1	6	1	6	300	1638	1938
7. Well Maintenance (1a,3)	12	18	0.05	10.8	540	4500	5040
8. Fence Maintenance (1b,2)	1	1	1	1	50	500	550
9. Piezometer Measurements (3b)	n/a	0	0	0	0		0
10. Erosion Monuments (3)	n/a	0	0	0	0		0
11. Deep-Rooted Veg. Control (2)	n/a	0	0	0	0		0
12. Rodent Control (2)	n/a	0	0	0	0		0
Contract Help Tasks							
13. Road Maintenance (2d)	n/a	0	0	0	0	0	0
14. Monument Measurements (3c)	n/a	0	0	0	0	0	0
15. Aerial Photographs (3)	above	0	0	0	0	0	0
				80.3	$4,015	$7,310	$11,325

TRAVEL AND FIELD/OFFICE SUPPORT--TIME AND COST	MILES	FREQENCY /YEAR	TOTAL HOURS	TOTAL DAYS	UNIT COST	TOTAL COST
1. Field Work (Trav Hrs + Onst Hrs)/8						
Travel Hours		2	14	1.75		
Onsite Hours (from above)			213	26.58		
Total Field Days @$75 Per Diem (4)				28.33	75	2124
Travel miles @$0.20 (4)	600	2			0.2	240
2. Office Days (1a)				70.81		3541
				99.14		$5,905

Table 5.7.3-2 continued

EQUIPMENT

CAPITAL COSTS (1)		
1. 2 Submersible pumps (operating pump and spare). Capacity of 6.6 gpm @ 480 feet. Sized to permit very deep well sampling. $500/unit	1000	
2. 2 generators (one for spare), 7 hp. units @ 580 each.	1725	
3. 4-wheel drive vehicle with A-frame sampler hoist and power winch.	17950	
4. Hose, 500 ft. of 1" hose @ $2.25/lineal foot.	750	
SUBTOTAL	$21,425	
ANNUAL CAPITAL COSTS AND SUPPLIES (1)		
1. Assume all capital costs (from above) are amortized over a 5-year period.	4285	
2. Maintenance costs and repair supplies @ 10% capital costs assumed.	2143	
3. Supplies and miscellaneous sampling equipment such as sample bottles, reagents, fuel for generator, etc. (laboratory analysis costs are outlined and included in "WATER ANALYSIS..." above)	6000	
SUBTOTAL	$12,428	
AVERAGE ANNUAL CAPITAL COST PER SITE		
1. Total Field Days (from TRAVEL AND FIELD... above)	28.33	
2. Work Days in a Work Year	237.50	
3. Use Factor (portion of work-year at site)	0.119	
TOTAL ANNUAL SITE EQUIPMENT COST (Use factor * annual equipment cost)		$1,482
ANNUAL TOTAL		$35,462
INDIRECT STATE COSTS @ 19.6% (5)		$6,951
		$42,413

Table 5.7.3-2 continued

ENDNOTES

Best technical judgement was used for all variables unless delineated in an endnote. Estimates are based on what a Denver Contractor would bill the licensee for each task and service. All estimates are in 1985 dollars.

(1) NRC Final Generic Environmental Impact Statement (GEIS), Appendix R.

(1a) The GEIS estimated two to three days of office work for every day in the field (which includes travel days). Therefor, the Radiation Control Division (RCD) assumed 2.5 office support days (for report writing as required by license) for every day in the field. For an active mill site, the RCD's ratio is more like 4 or 5 to 1 (K. Weaver, personal communication).

(1b) The GEIS estimates that it costs $10,500 (in 1984 $'s) to replace a well. Because wells at Uravan are often shallow, RCD's per well estimate is based on the following formula: average well depth, (194~)200 feet * cost per foot, $25 = $5000.

(1c) The GEIS estimate for fence maintenance is ~ $1500 /year for heavy duty 6-guage wire fence. Because of Uravan's remote nature a three-string barb wire fence will be used to restrict grazing. Thus, the maintenance cost of such a fence would be less: ~ $500 /year.

(2) RCD Policy on Elements of Long-Term Care Agreements.

(2a) As suggested in UCC/Umetco's long term monitoring costs document, visual inspections will be conducted annually and gamma measurements semiannually (00-840809-15). See (2b) and (2c) for specifics regarding radon measures.

(2b) Because of the multiple piles 6 ambient radon measures will be taken at Club Ranch Mesa. When the valley measures are added to the Mesa measures, 8 compass points will be covered.

(2c) An annual total of 20 Rn flux and ambient Rn measures from the Mesa and the valley will combine to make a statistically valid sample.

(2d) This area has state highway access.

(3) Preliminary Executive License Review Summary (PELRS), Chapter 9.

(3a) None of the wells are predicted to clean up prior to long term care.

(3b) The 20 Peizometers on Club Mesa are to be measured semiannually for the first five years after cessation of operations (1986-1991). Piezometers are then to be read every year thereafter until the tailings piles no longer contain free liquids as determined by two successive readings (estimated to take more than 25 years).

(3c) The 17 monuments currently in place will be read every six months until the final reclamation cover is in place. After final reclamation, the 23 monuments will be surveyed on an annual basis.

(3d) 2 wells are assumed/expected to "shift down" by category every 5 years. All wells must be "field" sampled (see above) until the entire area is at background.

(4) Based on present State rates.

(5) Indirect state costs are included to insure that, when the Federal (or State) Government assumes control, enough funds to supervise the contractor are available.

5.8 LAND, CULTURAL AND SOCIOECONOMIC IMPACTS

The following assessment was drafted by Mr. Matthew K. Jones in 1984 for the Preliminary Executive Licensing Review Summary. Revision has been editorial only, not based upon new or additional information. By and large, the situation as described below persists today. Of note is that Section IV(D) of the Consent Decree contains a significant provision related to this analysis, to wit, the requirement that UCC/Umetco hire locally if possible.

5.8.1 Land

The U.S. Bureau of Land Management (BLM) administers most of the land around the Uravan mill and the present and proposed tailing disposal areas. The land is "...generally unsuitable for cultivated agriculture because of inadequate water supply for irrigation and general lack of accessability" (00-821206-01:2-5), and is used primarily for cattle and sheep grazing. Many native species of plants and grasses have dwindled through the effects of overgrazing (00-821206-01:2-5).

Wildlife present in the area are discussed in Umetco's Updated Environmental Report (00-820331-13).

Agricultural crops, primarily hay and corn, are produced largely in the eastern end of Montrose County, some 30 to 50 miles distant from Uravan (00-821206-01:2).

5.8.2 Cultural - Archeological and Historical

5.8.2.1 Local

The Hanging Flume, located several miles from the Uravan impact area, is the only site within a fifty-mile radius that has been actually nominated for the National Register of Historic Places. Fourteen miles from Uravan, the Dominguez-Escalante Trail has been recommended for nomination. Neither site will be affected by the existing facility nor the proposed Spring Creek Mesa disposal facilities (00-820331-01:2-34).

A survey conducted by professional archeologists of Spring Creek Mesa archeological sites in 1981 "revealed forty-nine sites and forty-five isolated finds". All the archeological sites, with the exception of the landing strip for airplanes, were of aboriginal lithic origen. The majority of the sites (29) were classified as chipping sites while the other sites (19), usually located near the mesa rim, were classified as short-term camps for procurement activities (00-820331-01:2-35).

No natural landmarks in the vicinity are registered with the National Registry of Natural Landmarks. According to Umetco staff and current data, no sites have "been deemed eligible" for such a distinction (00-820331-01:2-36).

5.8.2.2 Impact and Mitigation Measures

The project has stated that archeological sites identified in the 1981 study "requiring more data will be evaluated prior to any disturbance by construction. Site specific mitigation measures will be determined once the evaluations are performed" (00-820331-01:3-14). Present and proposed License Condition 12.6.2 confirms and amplifies this commitment.

The Socioeconomic Impact Statement ("SIS") (00-821206-05) divides impact areas into two categories: (1) the regional impact area of Mesa, Montrose, San Miguel, and Dolores counties of Colorado and San Juan County of Utah, and (2) the local impact area consisting of the west end of Montrose County. (The term "West End" is used by local residents to mean the western area of Dolores, Montrose, and San Miguel Counties. The SIS did not quantify the area in the same manner as is common for the local residents. For this reason, in this document we will refer to the local area analyzed by the SIS as the "west end of Montrose County"). Most review under the headings below concentrates on the local impact area because of the area's isolation; however, the population and economy categories are analyzed for both regional and local impacts.

5.8.3 Socioeconomic

Completeness

Umetco documents addressed the "baseline" case, e.g. current conditions in the area and: (1) the effect of continued operations and construction of the Spring Creek Mesa Impoundment area or (2) cessation of mill operations.

Additional consideration by UCC/Umetco was requested. The impacts of reclamation activity and the possibility of the Town of Uravan's removal or extensive cleanup needed to be addressed and analyzed from a socioeconomic view. The benefit such an assessment provides are especially important in a period of growth or a period of cutback, as has been the case in recent years due to uncertain market conditions.

Resolution of the Department's requests involved:

(1) LC 18.2.5 of Amendment 20 to the existing license required a benefit-cost evaluation by June 30, 1984. Umetco appealed this provision.

(2) The October 30, 1984 PELRB supplement further defined what should be included in the analysis by asking that the following three scenarios that are possible at Uravan be analyzed.

   A. Cessation of mill operations and reclamation of existing tailing and crystal areas.

   B. Continued operation of the mill, reclamation of present tailing and crystal areas and construction and operation of the Spring Creek Mesa Tailings disposal area.

C. Continued operation of the mill, reclamation of present tailing and crystal areas, construction and operation of Spring Creek Mesa tailing disposal area and removal or extensive cleanup of the Town of Uravan.

(3) Efforts in 1986 by the Governor's Job Training Office and Colorado Department of Local Affairs have made this further socioeconomic evaluation unnecessary.

Uravan Residents

The following socioeconomic analysis shows that the surrounding towns' services--water, sewer, schools--are overbuilt for the current number of residents in anticipation of populatin growth that didn't take place. Because fewer people are available to pay for these services the local municipalities are experiencing financial stress. The socioeconomic analysis also showed the availability of housing in the area surrounding Uravan. Thus, current Uravan residents moving to the nearby towns will have been able to find available housing and would, in fact, will be providing needed financial assistance to the neighboring municipalities.

Review Introduction

Because the further information noted above was not available, this FLS review will primarily consider the "baseline" presented by Umetco as well as the Spring Creek Mesa construction and operation impacts. Impacts of reclamation activity and town removal will be discussed where possible, in a general way.

Major Umetco documents reviewed for this section include the Socioeconomic Impact Statement (SIS) (00-821206-05) and the Environmental Report (ER) for Spring Creek Mesa (00-820331-01)

Additional documents considered were: Western Montrose County Comprehensive Development Plan (23-780900), San Miguel County West Development Plan (23-801100), Region 10 Overall Exonomic Development Program - Volume One (23-820100) and Volume Two (23-820700), and Crises in the West End (00-820331-14).

5.8.3.1 Employment

Region

The SIS states that from 1969 to 1980, there was an average employment increase of 4.9% ending with a total population of 54,519 employed. Mining grew from 1,748 in 1969 to 4,360 in 1980 and comprised 8% of the work force in 1980. In 1982, there was a loss of job opportunities in the four Colorado counties resulting in an unemployment rise from 3.9% in 1980 to 8.4% in March, 1982 and an outmigration of workers. However, projections made in 1981 predict that the region will grown substantially over the next 20 years (00-821206-05:7-19).

Local

The SIS emphasized that the economy in the west end of Montrose County was dominated by mining, therefore, making it more closely related to the west end of San Miguel County and Dolores Counties than to Eastern Montrose County. An estimated 710 of the 1,460 jobs in the local impact area were mining related in 1978 (00-821206-05:20). "Agriculture, construction, public utilities, trade and government employment" also are prevalent in the area.

Trends show that "Mining has been declining since 1979" (00-821206-05:20). The SIS estimates that in 1980 there were 600 mining related employees; by 1981 there were only 361. The SIS further estimated that if the Umetco Uravan mill continues to operate and no new mills open in the area, the local economy will "maintain the same level from 1983-2000" (00-821206:22). The 1983 survey put "West End" unemployment at 15.5% (14-830600).

Impacts

Construction of the Spring Creek Mesa disposal facility will require 60 person-years of labor according to the SIS. The peak labor force will be 66 workers during months 2 through 11, with 30 workers in months 1 and 12. Half of the 66 jobs will be filled by local residents and the project should have a payroll of around $1.2 million (1980) dollars (00-821206-05:74).

The SIS further states that the 33 new residents would increase the labor force by 2.8 percent. Unemployment would decrease by approximately 47 jobs (both construction and secondary impact). If unemployment is 12.5 (150 persons) as it was in 1982, it would decrease to 8.4% (104 persons). An increase of 6.5% would occur to per capita income from $6,833 to $7,103 with total earnings up from 20.5 million to 21.8 million (00-821206-05:74-75).

In 1981, there were 316 persons employed by UCC in mining, milling and drilling; 85% of which lived in Montrose County, the remainder were miners in San Miguel and Dolores Counties. Of the workers in Montrose County; 137 lived in Uravan, 84 in Nucla, and 26 in Naturita.

The SIS estimated that "Operation of the facility will require an addition of 8-11 workers to the local workforce, 2-3 company employees at the site and 6-8 truck drivers conveying material from the mill to the disposal site" (00-821206-05:74-79). The 21 new jobs created by the Spring Creek Mesa project will all be taken by local residents (00-821206-05:83) This will increase earnings $331,000 annually and decrease unemployment from 12.5 to 10.8% (00-821206-05:83).

The SIS predicts that cessation of mill and mining activity would put 250 West End employees out of work "in the forecast period, (of) 1984-2004" (00-821206-05:83). These jobs, along with the related support service employment, would mean a loss of 525 of 1,050 jobs in the West End. The net result would be increased unemployment (the SIS predicts 25%), outmigration of workers, abandoned housing and fiscal stress on several government improvement districts (00-821206-05:81-87).

5.8.3.2 Population

Region

The SIS highlighted the unevenness of growth in the region over the past 35 years. In the 1950's, the annual growth was a rapid 3%; in the 1960's, it slowed to 0.37 percent; and in the 1970's the growth boomed with 4.3%. In the future, substantial growth is predicted for the region. It is expected that the region will outdistance state growth with an annual rate of 3%; a 79.2% increase from 1980-2000. These projections are made from assumptions of medium growth and continued oil shale and uranium mining (the greatest growth was projected for Mesa County) (00-821206-05:28-37).

Ethnicity, per capita income, and household population was also included in the SIS. 91% of the population was Anglo in 1981, with the remainder comprised of "American Indian and persons of Spanish origin" (00-821206-05:30). Per capita income was $7,815 dollars in 1980, 78% of the Colorado average. In 1980, average population per household was 2.81 (2.65 average for Colorado), with a total of 42,948 households (00-821206-05:30-33).

Local

The SIS remarked that the Nucla (West End) census division contains 50% of the land area of Montrose County's with only 16.2% of the population. In 1980, Nucla and Naturita claimed 47% of the "West End" population with 1,846 residents; Uravan had 510; Bedrock, Redvale, Paradox Valley and unincorporated households comprised the remaining 1,596. The town of Uravan has 3.27 persons per household, higher than the local average of 2.97 and the Colorado average of 2.65. This is attributed to "almost all households consisting of married couples, many with children" (00-821206-05:37-41).
As of November 1983, the population of Uravan was 321 residents (00-831130-03:76).

Population figures in the SIS illustrate the variable nature of the economy. The yearly average population change during 1950 to 1960 was an increase of 9.6 percent; from 1960 to 1970, a decrease of 2.8%; and from 1970 to 1980 no discernable change. To further illustrate this population flux, in 1950 there were 2,794 residents, by 1960 there were 5,475, in 1979 - 3,960, and in 1980 - 3,952 (00-821206-05:37-41).

From 1980 to 1981, the SIS informally estimated a 25% decline in population due to decreased job opportunities. This estimate is based on increased house vacancies, declining school enrollments, and removal of mobile homes from their pads. While the Montrose County Governing Board in 1981 adopted high growth projections for the County with almost all the growth taking place in Eastern Montrose County, the West End is projected to either remain stable or decline in population over the next twenty years. This low or no growth predictions was based on trends in 1981 (00-821206-05:42-44).

Impacts

The SIS emphasized that "water systems in Nucla and Naturita were at 33% of capacity" in 1980 (00-821206-05:89). Therefore, the expected additional 33 construction workers for Spring Creek Mesa disposal area could easily be accomodated. If the mill ceased operation and an outmigration occurred, the result would be increased financial strain on the taxpayers and the indebted service districts.

5.8.3.5 Sewer

Local

The three sewer district's in the west end of Montrose County are located in Nucla, Naturita and Uravan; all other households utilize individual systems. The SIS addressed impacts to the sewer districts and not the individual systems.

Naturita has recently increased its sewer treatment capacity making the system adequate for present and any near term growth. The town constructed a new areated lagoon sewer treatment system with a capacity of 200,000 gallons per day (gpd) in 1981 (11-820929). Average sewer system use was 80,000 gpd in 1980 (00-821206-05:58-60).

However, the CPD notes that the collection system needs to be upgraded. Problems with the collection system include: infiltration of ground water through antiquated collection lines (thus putting additional demands on the treatment plant), undersized piping for present and possible growth increases, and root migration which requires periodic maintenance (23-780900:54).

The SIS mentioned that currently the collection system "is being upgraded" (00-821206-05:60). However, the Water Quality Control Division has no record of these improvements except for an interceptor line to a subdivision (10-840108, 11-820929). Dan Crane, Naturita Town Board, stated that two measures had been taken since 1981 to reduce stress on the collection system: 1) replacement of a water main, and 2) metering of homes to reduce water waste and runoff (10-840307). Two additional phases are being planned if demand necessitates such action: phase two consists of further extending the interceptor line and phase three consists of expanding treatment capacity to 400,000 gpd (00-821206-05:60).

Nucla's sewer and collection system is in good condition and should be able to accomodate any reasonable future growth according to the SIS. The sewer treatment system utilizes a 200,000 gpd lagoon and has two additional lagoons with 100,000 gpd capacity for future growth. Average daily use is 103,000 gpd. The collection system is also in good condition (00-821206-05:59-62, 23-780900:53).

Finally, the SIS conveyed that Uravan's sewer treatment facility is adequate. As of April 1982, the system was operating at one quarter of its 100,000 gpd capacity.

Impacts

Construction of Spring Creek Mesa new disposal area would have been expected to bring in 33 workers to the west end of Montrose, Dolores, and San Miguel Counties. The SIS states that there were 240 vacant housing units in 1980 and probably more in 1982 to house these workers (00-821206-05:88). However, this housing surplus is less significant because of reasons stated in the previous paragraph. If there were a housing shortfall, the impact could be mitigated through the use of mobile home pads already in place.

Operation of the mill would have increased West End employment by 21 people, but no immigration would occur according to the SIS (00-821206-05:88). Project cessation would result in substantial outmigration, removal of mobile homes and an increase vacant permanent housing, thereby further reducing housing values (00-821206-05:88).

Using the local labor force in a phased reclamation program and/or on Uravan town removal will mitigate some adverse impacts related to housing (in addition to employment and public services).

5.8.3.4 Water

Local

The SIS observed that Naturita has a good water system that is "sufficient to accomodate present usage" (00-821206-05:53). In fact, in 1980, average use was "about 32 % of the system's capacity" (00-821206-05:53). Even using high population growth projections (3,000 residents) the system has enough capacity to accomodate any foreseeable peak loads (00-821206-05:53-55).

According to the SIS, the Nucla Public Water System at present is adequate only for little or moderate growth. Nucla recently completed a portion of the first phase of a three phase improvement plan by installing meters, distribution lines and a new treatment facility. The latter provides adequate treatment capacity for "substantial growth" (00-821206-05:31). The biggest constraint to growth is the final portion of phase one: replacement of an antiquated open drainage ditch that recharges holding reservoirs. The proposed solution to bypassing the open drainage ditch which is prone to: freezing, landslides, leakage, and no guaranteed winter water rights (23-780900:47-48), is construction of an emergency pumping station on the San Miguel River that would pump water directly to the holding reservoirs (00-821206-05:55-57, 23-780900:47-48).

Funding for phase two of Nucla's improvement plan, additional water storage and a major transmission line, was being sought as of 1980. Phase three, to be implemented in a large growth situation, would add an additioal water treatment plant (00-821206-05:57-58).

Uravan's Umetco-owned water system as of 1982 was at or near full capacity. However, increased demand is not expected. The system, which relies on a system of wells, serves both the mill and town (00-821206-05:58).

Impacts

The SIS did not address impacts to highways. It did show the property tax mill levy (in 1981=.60 of a mill: a mill is one hundredth of a penny) for the county road and bridge fund, but did not equate how Umetco sponsored-use corresponded to County and State taxes paid by Umetco.

5.8.3.8 Public Budgets

Local

Governmental bodies serving the west end include the County, Nucla, Naturita, and School District RE-2. In addition, special districts "provide water, sewer, library, recreation, fire protection, and related services" (00-821206-05).

Components of the 1982 Montrose County budget of $16,256,123 included: Public Hospital Fund ($8,182,931), General Fund ($2,729,800), Public Welfare Fund ($2,612,405), Road and Bridge Fund ($2,293,740), Revenue Sharing Trust Fund ($288,127), and Retirement Fund ($149,120). Main revenue sources include: property tax, sales tax, and federal aid state intergovernmental revenue.

As of 1981, the west end contained 22.6 percent, or $19.5 million of Montrose County's assessed value. Mining accounted for 5.0 millions of this assessed value with most of the activity taking place in the west end (00-821206-05:66).

In 1981, the Montrose County property tax rate was 22.77 mills and the RE-2 school district rate was 44.51 mills according to the EIS. Additional property taxes were assessed for the Naturita and Nucla "fire improvement districts for water, sewer, and fire protection".

Impacts

The EIS states that construction will add 7.5% to the work force; meaning 79 newly employed workers of which 33 are the "in-migrant" construction workers. This increase in the labor force will generate increased revenues (benefits) that are expected to offset costs (00-821206-05:90).

Closure of the mill would lead to an out-migration of the labor force, therefore, reducing the revenue base for all local forms of tax. The result would be increased taxes for those who remain and financial stress for the tax districts--particularly those that have recently financed capital improvement projects (00-821206-05:90).

Impacts

As stated in the SIS and the above review, the present sewer systems are adequate for current and near term growth. This includes the expected influx of 33 workers for the construction of the Spring Creek Mesa disposal area. In 1982, the combined systems were operating at 53% of capacity (00-821206-05:89).

However, if substantial growth did occur in the future, Naturita would need to upgrade its collection system to accommodate such growth. If the mill ceased operations, the outmigration after reclamation would decrease the town's tax base, therefore, potentially jeopardizing the financing of the sewer districts.

5.8.3.6 Schools

Local

The SIS observed that the West End School District (RE-2) in 1981 operated at less than half (627 pupils) of their peak enrollment at 1,342 in 1960-61 (00-821206-05:62-63).

While the school buildings have ample space for possible growth, the SIS states that there are two current fiscal problems related to the unstable nature of the economy in a mining community. First, the Naturita junior high school and Uravan elementary school were built as temporary buildings during the uranium boom of the 1950's. Having an expected life of twenty years, the schools now cost the district additional funds for maintenance. Second, student turnover in the schools varies from 26 to 33% (23-780900:99). This flux requires that teachers spend extra time orienting students, therefore, requiring a low pupil/teacher ratio. The flux also makes it difficult to plan for the upcoming school year, compounding the fiscal problem (00-821206-05:62, 23-780900:99).

Impacts

The schools have ample capacity to absorb increased enrollment resulting from construction and operation of the Spring Creek Mesa disposal area facility (00-821206-05:88-89). Mill shutdown would compound the School District's fiscal problems and decrease enrollments after reclamation (00-821206-05:89).

5.8.3.7 Highways

Local

The Comprehensive Development Plan observed that Western Montrose County contains four highways classified as major collectors: Highway 90 and State Highways 97, 141 and 145. All are on the Federal Aid Secondary System except for portions of Highways 90 and 141 inside the corporate limits of Naturita which are on the Federal Aid Primary System (20-780900:76-77).

6.0 INTRODUCTION

The following findings of fact, conclusions of law and order apply to the Matter of the Application of Umetco Minerals Corporation for renewal and amendment of radioactive materials license SUA-673 for the Uravan Uranium Mill and associated facilities pursuant to the Colorado "Rules and Regulations Pertaining to Radiation Control" (the "Radiation Rules", 6 CCR 1007-1-1 et seq.).

6.1 FINDINGS OF FACT

6.1.1 INTRODUCTORY FINDINGS

F 1. The Facility and Site

Umetco Minerals Corporation ("Umetco"), through its parent corporation, Union Carbide Corporation ("UCC") has owned and operated a uranium/vanadium mill at Uravan since 1928.

The Uravan Facility is located approximately 90 miles southwest of Grand Junction, Colorado, along State Road 141 in Montrose County within the canyonlands section of the Colorado Plateau. The mill is situated along the canyon of the San Miguel River and recovered uranium and vanadium from ores mined underground in the Uravan Mineral Belt.

The mill facility is divided into two parts. The B Plant is located on a canyon plateau bench where Hieroglyphic Canyon joins the San Miguel River. Ore arrived by truck and was placed either in a storage bin or selected stockpile. At the B Plant the ore was crushed, ground and leached by acid. The tailings disposal areas and raffinate spray evaporation were located southwest of the B Plant on the plateau.

The A Plant is directly below the B Plant on the canyon floor beside the river and adjacent to the town of Uravan. Uranium-vanadium separation by ion exchange and solvent extraction, product drying and packaging, and maintenance work occured at the A Plant.

The town of Uravan, extending in both directions along the river from the mill, is also UCC/Umetco property.

5.8.3.9 Social Impacts

Local

The "West End" economy is dominated by mining with its boom-bust cyclical nature. In addition, the population is relatively small, contributing to a friendly rural atmosphere. Currently a core of long-time residents exists along with a more transient population that has dwindled with the recent economic times. (00-820331-14, 00-821206-05) It is estimated in Crises in the West End that in April of 1981, 64% or 690 uranium industry employees" were unemployed, with an additional 214 supposed business employees also being layed off. In all, Crises in the West End estimates 37% of the total population of the "West End" is directly affected by this present "bust" period (00-820331-14).

Crises in the West End further states: "In human terms, the results of extensive unemployment are high levels of stress and loss of sense of community". Residents are experiencing a loss of security, anxiety about the future, and increased depression. Physical and mental health problems result, including alcoholism and suicide. Many of these symptoms are documented to be already occurring in the West End. The most telling are the ten suicides in the last ten months (00-820331-14:iv).

Local

Reclamation of the existing facility and construction and operation of Spring Creek Mesa would help mitigate social stress by reducing the umemployment rate. Project ceasation would aggravate an already stressful situation by putting 250 of 500 mining employers out of work (00-821206-05:91) along with a corresponding number of support people (00-821206-05:91, 00-820331-14).

Dr. Robert A. Arnott presided as hearing officer for the Department and was counseled by Edward R. Martinez, Colorado Department of Law. Appearing on behalf of the Radiation Control Division were Richard L. Griffith and Adonis A. Neblett of the Colorado Department of Law. Henry W. Ipsen and Linnea N. Brown of Holme, Roberts & Owen appeared on behalf of UCC/Umetco. Margaret Puls appeared on behalf of FUTURE. Frances M. Green appeared on behalf of the National Wildlife Federation. Roy Young appeared on behalf of Sierra Club. Robert E. Yuhnke and James B. Martin appeared on behalf of the Environmental Defense Fund. John A. Brooks appeared on behalf of Montrose County. John F. Peeso appeared on behalf of the Western Small Miners Association.

On December 9, 1983, the State of Colorado filed a complaint, which was twice amended, against Union Carbide Corporation and its wholly-owned subsidiary, Umetco Minerals Corporation. In the complaint, the State sought recovery for natural resource damages and response costs, among other claims. Final action in the licensing proceeding was held in abeyance pending the outcome of negotiations in the lawsuit. Negotiations resulted in settlement of all claims which is embodied in the Final Consent Decree, Order, Judgement, and Reference to a Special Master Filed in the United States District Court, Civil Action No. 83C2384, State of Colorado, Plaintiff, vs. Union Carbide Corporation, A New York Corporation, and Umetco Minerals Corporation, a Delaware Corporation, Defendants, (hereafter "Consent Decree") and related Appendices I through VII entered by Judge Jim R. Carrigan.

Certain positions taken by the Radiation Control Division in the May 22, 1984, Preliminary Executive Licensing Review Summary (PELRS) and at the licensing hearing have in part changed due to new information and analyses generated in the course of negotiation in the lawsuit. Consequently, the Department reopened the administrative record for the purpose of receiving and considering comments on supplemental information generated since the close of the administrative record. A supplemental record including the Consent Decree was made available for review and comment. The comment period on the supplemental record closed December 4, 1986.

The record in this matter includes the hearing transcript; all written and graphic documents presented by the applicant, parties, agencies and the public which were accepted into the record; the Consent Decree and appendices; all comments received from the public and local, state and federal agencies, including in particular the comments of the parties to the licensing action and the U.S. Nuclear Regulatory Commission and U.S. Environmental Protection Agency.

The Final Licensing Statement ("FLS") summarizes the Radiation Control Division's licensing deliberation based on the record.

F 2. License History

Licensing of the Uravan Facility began in 1948 with the issuance of a Radioactive Materials License by the AEC. The old number was changed in 1963 when the AEC issued the original SUA-673 license to UCC. On February 1, 1968, after seven amendments by the AEC, jurisdiction was transferred to the State of Colorado pursuant to an Agreement with NRC.

Since February 1, 1968, Amendments 8 through 23 have been issued to UCC or Umetco. Radioactive Materials License SUA-673 expired July 31, 1975. In compliance with the Radiation Rules, Union Carbide applied for renewal June 20, 1975, more than 30 days prior to the expiration date, and continues to operate under a valid license pursuant to the "timely renewal" provision of the Radiation Rules. Between 1975 and 1986, License SUA-673 was periodically updated with respect to plant operations, while cleanup and reclamation plans remained under consideration.

By letter dated March 31, 1982, UCC submitted, at the request of the Department, an updated application for renewal of a radioactive materials license to possess and use source materials at their existing mill in Montrose County. On April 2, 1984, Umetco Minerals Corporation was formed by UCC. Amendment 20 was issued effective upon the transfer to Umetco, although financial assurance arrangements remained unchanged pending renewal action.

Amendments 21, 22, and 23 to License SUA-673 were issued during the course of deliberation on this licensing action. Amendment 21 approved modified procedures for non-operating periods. Amendment 22 required an irrevocable letter of credit for financial assurance. Amendment 23 authorized construction of two lined waste cells. Amendment 22 was appealed in total. Amendment 23 was appealed in part.

F 3. Licensing Hearing and Record

In compliance with the requirements of 6 CCR 1007-1-3 and of Sections 24-4-104 and -105, CRS (1982) and 25-11-103 and -104, CRS (1982), a hearing was conducted by the Colorado Department of Health for the purpose of receiving evidence, testimony, and public comment on the application of Umetco.

A public hearing was held on the application of Umetco on August 21, 22, and 23, 1984 in Nucla, Colorado, and on November 19 and 20, 1984 in Montrose, Colorado. Close of the record for those segments of the hearing relating to Reclamation of Existing Tailings and Waste Disposal Sites and Public Health and Environmental Issues was September 14, 1984. The record closed for that segment of the hearing relating to New Tailings Impoundments/Spring Creek Mesa and Other Relevant Issues on December 17, 1984.

F 6. Environmental Impact Assessment

Based upon (1) conformance to Part III of the Radiation Rules, in particular 6 CCR 1007-1-3.8.8 and -3.10.6, (2) conformance to Department policies and regulatory guides for protection of the environment, and (3) the Department's independent, documented Environmental Assessment (Section 5 of the FLS), the Environmental Report and supporting documents are sufficient for the Department to evaluate the short-term and long-range environmental impact of the project and activity so that the Department may weigh environmental, economic, technical, and other benefits against environmental costs, while considering available alternatives (6 CCR 1007-1-3.8.8).

F 7. Mill Decommissioning and Decontamination

To bring under control radioactive and hazardous materials dispersed by past activities and to prevent loss of control by wind or water erosion or other means of disturbance in the future, based upon evaluation of UCC/Umetco's submittals and commitments in LC 11.1, Sections 4 and 5, and relying in particular on Table 4.1.2-1 as used variously throughout Section 4 of LC 11.1, proposed cleanup of contaminated structures, soils and sediments will meet the objectives of the Uranium Mill Tailings Radiation Control Act, as amended (92 Stat. 3021) of the Radiation Rules, and of Department policy with respect to radiological and non-radiological hazards to the public health and safety.

Based upon written assurances by UCC/Umetco in the licensing record, in particular LC 11.1, and based upon the consideration in Section 4 of the FLS, the schedule of mill area decommissioning prescribed in Section 4.6 of LC 11.1 is appropriate and sufficient to ensure effective and efficient decommissioning of the A- and B-plant areas, ore stockpile area, barrel storage area, heap leach site, scrap equipment yard, town and adjacent areas, and ancillary areas. Umetco's 1984 plan for decommissioning the mill includes removal of all equipment and structures, demolition and removal of concrete structures, and decontamination and removal of salvageable items (00-841009:20).

F 8. Reclamation

To achieve isolation of radioactive and hazardous materials for thousands of years without active maintenance and to achieve the other objectives of Criteria 1 through 6 of Schedule E, Part III, of the Radiation Rules, based upon the August 1984 hearing transcript and numerous State and party documents, including but not limited to Section 5 of the FLS, the remedial action program in LC 11.1 to remove radioactive and hazardous materials deposits and residues from the San Miguel River Valley and non-repository areas of Club Mesa is necessary and apppropriate.

Based upon written assurances in the Consent Decree and its appendices, the schedule of solid wastes remedial action prescribed in Section 4 of LC 11.1 is appropriate and sufficient to ensure effective and efficient reclamation of the Atkinson Creek Crystal Disposal Area, Club Ranch Ponds area, River Ponds area, Club Mesa Tailings Piles, Club Mesa Spray area, and other areas to be reclaimed.

6.1.2 RADIOACTIVE MATERIALS LICENSE 660-02S

F 4. Authorizations

Based upon independent technical evaluation, including but not limited to Sections 4 and 5 of the FLS, and having determined (1) that Umetco is qualified by reason of training and experience to use the material in question for the purpose requested (6 CCR 1007-1-3.9.1), (2) that Umetco's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or property (6 CCR 1007-1- 3.9.2), and (3) that issuance of a license will not be inimical to the health and safety of the public (6 CCR 1007-1-3.9.3), the Department finds that the action called for is issuance of Radioactive Materials License No. 660-02S (the "License").

The License authorizes Umetco to use uranium and thorium series radioactive materials described in License Conditions (LCs) 6.0, 7.0, and 8.0 for the purpose stated in LC 9.0 at the location specified in LC 10.0.

As specified in LC 10, the "Uravan Facility" means those sites and areas considered to be disposal and source control areas including the Atkinson Creek Crystal Disposal area, the Club Ranch Ponds area, the River Ponds area, the tailings piles, the Club Mesa area, Mill Areas, the Town and adjacent areas, and ancillary areas, all as described in the Uravan Uranium Millsite Remedial Action Plan ("RAP"), and any other place where work is planned pursuant to the RAP. The RAP is included as LC 11.1 in the License and is attached as Appendix I to the Consent Decree.

Issuance of the License supersedes License No. SUA-673, all amendments to SUA-673, and all hearing requests and/or appeals of any amendments to SUA-673.

F 5. Safety During Activities

Based upon (1) conformance to Parts III and IV of the Radiation Rules, (2) conformance to Department policies and regulatory guides for protection of the public health and safety, and (3) the Department's detailed, independent, documented Safety Evaluation (Section 4 of the FLS), the operational, inspection, and record-keeping procedures prescribed by the License, in particular the licensee proposals and commitments incorporated by reference in the License, are sufficient and necessary to fully protect worker and public health and safety and meet all regulatory requirements.

Criterion 1--The Spring Creek Mesa site is not on an optimal geologic setting. The broad objective of isolating the tailings and associated contaminants from man and the environment for thousands of years is not met by Umetco's impoundment design. (Tr.-2, Vol. II, pp. 324-339)

Criterion 2--The existing tailings disposal facilities are at capacity. If operations were to continue at Uravan, a new disposal facility would be necessary. The proposed Spring Creek Mesa disposal facility does not involve the proliferation of small waste disposal sites. (Tr.-2, Vol. II, p. 339)

Criterion 3--Sandstone bedrock in the proposed disposal facility area precludes fully emplacing wastes below grade. The proposed facility would to the maximum extent reasonably achievable be emplaced below grade. (Tr.-2, Vol. II, p. 340)

Criterion 4--Criterion 4 sets forth site and design features that shall be adhered to whether tailings are disposed of above or below grade. The license application fails to meet this criterion due to deficiencies in at least two design features, reclamation slope steepness and adequate reduction of water erosion to negligible levels. (Tr.-2, Vol. II, pp. 340-341)

Criterion 5--Criterion 5(a) states, "In no case shall seepage of toxic or radioactive materials result in significant pollution. Significant pollution is deterioration of existing groundwater supplies from their current or potential use." Umetco has failed to demonstrate how this minimum standard is met. (Tr.-2, Vol. II, pp. 341-345)

The existing water supply on Spring Creek Mesa has been used for stock watering and with treatment has a potential use as a domestic water supply. (Tr.-2, Vol. I, Brogden Testimony; Tr-2, Vol. II, p. 280) The disposal cell design proposed by Umetco would impair these present and potential uses based upon near- and long-term seepage and infiltration calculations. (Tr.-2, Vol. I and II, Junge and Stephens testimony.)

Criterion 6--Criterion 6 requires that at least a three meter earthen cover be placed over the tailings impoundment at the end of milling operations. The time required for dewatering will not allow for cover emplacement at the close of operations. Umetco has not demonstrated that cover disruption will not occur due to differential settlement, weathering or other mechanisms over long-term intervals. Criterion 6 has not been met. (Tr.-2, Vol. II, p. 345)

Criterion 7--Umetco has not demonstrated that release of airborne effluents would be reduced to as low as reasonably achievable.

Criterion 8--Umetco has not demonstrated clear title to the proposed impoundment area nor to subsurface mineral rights. (FLS, page 5-103)

The application for license amendment authorizing construction of a new tailings disposal facility on Spring Creek Mesa should be denied.

F 9. Surface Water

To minimize impacts to surface waters from the Uravan Facility, based upon extensive analysis by the Radiation Division in conjunction with the Water Quality Control Division and ERI Logan, Inc., zero point discharge to surface waters is appropriate and attainable, as provided in Section 5.0.1 of LC 11.1 and in LC 24.1. Further, the surface water monitoring program prescribed by Addendum A of LC 11.1, including prescribed biological monitoring, is necessary and appropriate to assure that impacts from non-point pollution are mitigated to the fullest extent.

F10. Ground Water

To correct existing contamination of ground waters to the maximum extent practicable, based upon extensive analysis by the Radiation Division in conjunction with the Water Quality Control Division and independent hydrology consultants, the remedial action program in Section 5.4 of LC 11.1 to mitigate and control impacts of radioactive and hazardous constituents in ground water beneath Club Mesa and in the alluvial, Kayenta-Wingate and all other aquifers of the San Miguel River Valley is necessary and appropriate.

6.1.3 FUTURE OPERATIONS

F11. Existing Mill

To ensure that any future operations are in full compliance with all applicable standards, based upon the independent, documented evaluation in Section 4 of the FLS (the Safety Evaluation) and Section 5.5 of the FLS, LC 18.0 is included in the License. LC 18.0 requires that, excluding production of uranium concentrate product from uranium/vanadium liquors currently stored on site, the licensee shall obtain prior authorization by license amendment from the Department before storing or crushing ores or refining or producing uranium or vanadium product or changing any part of the Uravan Facility from stand-by status.

F12. Spring Creek Mesa Amendment Application

Based upon (1) Part III of the Radiation Rules, in particular 6 CCR 1007-1-3.8.8 and -3.10.6, (2) Department policies and regulatory guides for protection of the environment, and (3) the Department's independent, documented Environmental Assessment (Section 5 of the FLS):

The proposed impoundment design is insufficient to guarantee long-term control of toxic and radioactive materials.

The proposed impoundment design fails to demonstrate that the objectives and criteria of Schedule E, 6 CCR 1007-1-3 will be met (Tr.-2, Vol. II, pp. 321-350).

Those obligations mirror the reclamation activities imposed by the license and are subject to enforcement by court order and stipulated penalties as provided for in Section XVIII of the Consent Decree.

The Surety for Performance, Section XVII of the Consent Decree and the Consent Decree is such other evidence of initial and continued financial responsibility as may be required by the Department and is considered adequate to satisfy the Department that the requirements of 6 CCR 1007-1-3.9.4.1 are met.

F14. For Long Term Monitoring and Maintenance

A long-term monitoring and maintenance fund is required by 6 CCR 1007-1-3.9.5 and 3.10.6.3.

UCC/Umetco have obligated themselves by terms of Section IV(G) of the Consent Decree to posting a fund for Long-Term Monitoring and Maintenance of the Uravan Facility. As permitted by 6 CCR 1007-1-3.9.5, such fund is to be based upon an assumed real rate of 2% per annum. UCC/Umetco have the burden of demonstrating to the Department that such assumed rate of return is appropriate.

Until termination of the Consent Decree, enforceability provisions of the Consent Decree provide financial assurance to the State which is equivalent to that which would otherwise be required by the Department. The obligations embraced by UCC/Umetco in the Consent Decree are subject to enforcement by court order. The United States Supreme Court has ruled that a bankruptcy trustee may not abandon a hazardous waste site without imposing conditions to protect health and safety and a trustee may not abandon property in contravention of reasonable health and safety laws. Midlantic National Bank v. New Jersey Department of Environmental Protection, 106 S.Ct. 755, 88 L.Ed. 2d 859, 23 E.R.C. .·.3, 16 E.L.R. 20278 (1/27/86), Rehrg. Den. 106 S.Ct. 1482, 89 L.Ed. 2d 736 (3/24/86). The obligations for remedial actions imposed by the Consent Decree, LC 11.1 and license require performance by UCC/Umetco of actions that are reasonably designed to protect the public health, welfare, environment and safety from identified hazards. Such obligations are not a money judgement.

A long-term monitoring and maintenance fund must be established by UCC/Umetco by the time UCC/Umetco petitions for termination of the Consent Decree.

6.1.5 REGULATORY INTERRELATIONSHIPS

F15. Relationship Between License and Consent Decree

The State of Colorado, Union Carbide Corporation, and Umetco Minerals Corporation entered into and jointly moved for entry of a Final Consent Decree, Order, Judgment and Reference to Special Master in settlement of all claims raised between them in State of Colorado v. Union Carbide Corporation and Umetco Minerals Corporation, Civil Action No. 83-C-2384. The parties to the litigation agreed that the Consent Decree shall apply to and be binding upon each of the parties, their agents, employees, successors in interests and assigns.

6.1.4 FINANCIAL ASSURANCES

F13. For Decommissioning, Decontamination, and Reclamation

Financial assurance for decontamination and decommissioning, reclamation and stabilization, and revegetation is required by 6 CCR 1007-1-3.9.4 and 3.10.6.3.

Reclamation was previously assured by Union Carbide Corporation by Financial Assurance Test in a Reclamation Surety Agreement entered into on September 22, 1981 as provided by Radiation Control Division "Policy on Financial Assurance Tests for Source Material Mill Radioactive Materials License", Revision 1, effective October 31, 1983.

Union Carbide has not demonstrated its ability to continue to meet the Financial Assurance Tests. The Reclamation Survey Agreement dated September 22, 1981 is therefore null and void.

It is required that the reclamation activities prescribed by the license and committed to in the Consent Decree and RAP are subject to the provisions of Section XVII of the Consent Decree, which defines financial assurances. The cash postings, the full breadth of the Consent Decree, and the obligations of UCC and Umetco thereunder provide financial protection during the initial two years which is equivalent to that which would otherwise be required by the Department. Full surety is required during every subsequent year. The Department expressly adopts and incorporates herein by reference the financial assurance mechanisms of Section XVII of the Consent Decree.

For the limited purposes of radioactive materials License 660-02S and the Consent Decree, "Full Surety" is defined as the completed posting by UCC/Umetco of such cash, and/or financial or insurance instruments and/or meeting by UCC/Umetco of such financial tests, as are acceptable to the State pursuant to Section XVII of the Consent Decree in an amount which is at least equal to the net present value of the projected cost of all of the remaining Work calculated as though it would be performed by an independent contractor.

Union Carbide and Umetco have agreed to timely finance the remedial activities identified in the RAP and the Surety for Performance at their own costs. This commitment is made in a binding Consent Decree, Order, Judgment and Reference to Special Master in Case No. 83C2384.

The United States Supreme Court has ruled that a bankruptcy trustee may not abandon a hazardous waste site without imposing conditions to protect health and safety and a trustee may not abandon property in contravention of reasonable health and safety laws. Midlantic National Bank v. New Jersey Department of Environmental Protection, 106 S.Ct. 755, 88 L.Ed. 2d 859, 23 E.R.C. 1913, 16 E.L.R. 20278 (1/27/86), Rehrg. Den. 106 S.Ct. 1482, 89 L.Ed. 2d 736 (3/24/86). The obligations for remedial actions imposed by the Consent Decree, LC 11.1 and license require performance by UCC/Umetco of actions that are reasonably designed to protect the public health, welfare, environment and safety from identified hazards. Such obligations are not a money judgement.

6.2 CONCLUSIONS OF LAW

On the basis of the record, the above findings of fact, and the applicable statutes and regulations, the Department hereby concludes:

C 1. The Department is empowered to issue radioactive materials licenses. Section 25-11-101 et seq. CRS (1982 and 1986 Supp.) and 6 CCR 1007-1 et seq.

C 2. Umetco is qualified by reason of training and experience to continue use of the material in question for the purpose requested in their license renewal application in accordance with the regulations in such a manner as to minimize danger to public health and safety or property. 6 CCR 1007-1-3.9.1.

C 3. Umetco's renewal application and proposed equipment, facilities, and procedures addressed therein are adequate to minimize danger to public health, safety or property. 6 CCR 1007-1-3.9.2.

C 4. The issuance of the renewal license will not be inimical to the health and safety of the public. 6 CCR 1007-1-3.9.3.

C 5. Umetco's license renewal application and supporting documents clearly demonstrate how the criteria of Schedule E, 6 CCR 1007-1-3 are met. 6 CCR 1007-1-3.10.6.5.

C 6. The financial surety requirements of 6 CCR 1007-1-3.9.4 have been met by the provisions of the Consent Decree.

C 7. Acceptance of financial assurance provisions of Section XVII of the Consent Decree surety provision is in the best interest of the citizens of the State of Colorado.

C 8. UCC/Umetco must establish a long-term monitoring and maintenance fund pursuant to Section IV(G) of the Consent Decree.

C 9. The State of Colorado, Union Carbide Corporation and Umetco Minerals Corporation are parties to and bound by the terms of the Final Consent Decree, Order, Judgment, and Reference to Special Master entered by the U.S. District Court for the District of Colorado in State of Colorado v. Union Carbide Corporation and Umetco Minerals Corporation, Case No. 83-C-2384.

C10. The proceedings and the renewal of the license to Umetco meet the requirements of 42 USC 2021(o).

C11. Umetco has not commenced construction of the proposed new disposal facilities at Spring Creek Mesa. 6 CCR 1007-1-3.9.7.

C12. Umetco's Spring Creek Mesa disposal facility amendment application and supporting documents fail to clearly demonstrate how the requirements and objectives of Schedule E, 6 CCR 1007-1-3 have been addressed. Specifically, the objectives and requirements of Criteria 1, 4, 5, 6, 7 and 8 of Schedule E have not been met.

Upon entry of the Consent Decree by the court, radioactive materials license 660-02S shall become final unless appealed by a non-party to the Consent Decree. Umetco and UCC shall be deemed to have waived their rights to administrative and judicial review under state law of all license matters upon entry of the Consent Decree. See Section XV(A) of the Consent Decree.

Any future modification of the license which is not inconsistent with the terms and conditions of the Consent Decree and related Remedial Action Plan (RAP), initiated by the State or the licensee, shall be subject to the administrative and judicial review procedures established by state law. See Section XV(C) of the Consent Decree.

The Consent Decree at Sections XIII and XIV contains dispute resolution provisions that may be invoked to address a proposed license modification by the state which is believed to be inconsistent with the provisions of the RAP. However, should a non-party to the Consent Decree seek to participate in resolution of the dispute, the matter shall be subject to the administrative and judicial review procedures established by state law. See Section XV(C) of the Consent Decree.

The licensee's right to invoke the dispute resolution provisions of the Consent Decree shall not foreclose any rights of non-parties to the Consent Decree under state or federal law to participate in resolution of the dispute in an appropriate forum. See Section XV(E) of the Consent Decree.

Disputes regarding the effect of subsequently enacted or promulgated statutory, or regulatory changes, state or federal, upon obligations embraced by the Consent Decree or RAP which require modification thereof, may be addressed by the dispute resolution mechanisms of the Consent Decree. However, should a non-party to the Consent Decree seek to participate in resolution of a dispute, the matter shall be subject to the administrative and judicial review procedures established by state law. See Section XV and XXIX of the Consent Decree.

The Federal District Court for the District of Colorado expressly retains jurisdiction over UCC, Umetco and the State and the Consent Decree for purposes of ensuring compliance with the terms and provisions, to consider amendments under Section XXVII and to adjudicate disputes as provided in Section XIV of the Consent Decree. See Section XXXIV of the Consent Decree.

The license and Consent Decree are two separate but related documents with considerable overlap in coverage. Requirements imposed by license condition are often mirrored by obligations undertaken and embraced in Consent Decree and RAP. The State retains all enforcement mechanisms under state law and has alternative enforcement mechanisms under the Consent Decree. The license may be modified without regard for the Consent Decree if such modification is not inconsistent with the terms and provisions of the Consent Decree.

RADIOACTIVE MATERIALS LICENSE

TABLE OF CONTENTS

C13. The proposed Spring Creek Mesa disposal facility design is not adequate to minimize danger to public health and safety or property. Issuance of a license amendment for the proposed Spring Creek Mesa disposal facility would be inimical to the health and safety of the public.

C14. UCC/Umetco shall be deemed to have waived their rights to administrative and judicial review of License 660-02S, with the exception of the aspect of the Order issued herewith which denies the application for authorization to construct a new tailings facility at Spring Creek Mesa.

C15. Paragraph XXIV(C) of the Consent Decree does not constitute a designation by the Department of an area of the Uravan Facility as a permanent respository for low-level radioactive waste materials, specifically the Denver Radium wastes. The Department has made no such designation.

C16. The Colorado Department of Health has no authority to declare a water-supply and its current or potential uses de minimus. Tr. 2, Vol. I, pp. 134-141.

C17. The action called for is issuance of License 660-02S and denial of the application for authority to construct a new tailings disposal facility on Spring Creek Mesa.

6.3 ORDER

WHEREFORE, the Department of Health shall issue to Umetco Minerals Corporation Radioactive Materials License 660-02S, for the purpose of uranium product processing and conducting remedial activities at its Uravan Facility. Further, application for authorization to construct a new tailings facility at Spring Creek Mesa is denied.

DONE AND SIGNED this 19th day of December 1986.

Gary G. Broetzman

Gary G. Broetzman
Hearing Officer
Colorado Department of Health

UMETCO MINERALS CORPORATION
1600 UTE AVENUE
GRAND JUNCTION, COLORADO

Pursuant to the Radiation Control Act, Title 25, Article 11, C.R.S. 1973 as amended, and the State of Colorado "Rules and Regulations Pertaining to Radiation Control", Part III, and in reliance on statements and representations heretofore made by the licensee designated below,

COLORADO RADIOACTIVE MATERIALS LICENSE NO. 660-02S IS HEREBY ISSUED,

authorizing such licensee to transfer, receive, possess and use the radioactive material(s) designated below; and to use such radioactive materials for the purpose(s) and at the place(s) designated below. This license is subject to all applicable rules, regulations, and orders now or hereafter in effect of the Colorado Department of Health (the "Department") and to any conditions specified below.

1.0 LICENSEE NAME

UMETCO MINERALS CORPORATION

2.0 LICENSEE ADDRESS

Regional Address
1600 Ute Avenue
P.O. Box 1029
Grand Junction, CO 81502

Local Address
P.O. Box 860
Nucla, CO 81424

3.0 LICENSE NUMBER 660-02S AMENDMENT NUMBER 00

4.0 EXPIRATION DATE December 31, 1991

5.0 REFERENCE NUMBER SUA-673

11.0 LICENSEE PROPOSALS AND COMMITMENTS ("REFERENCED DOCUMENTS")

Except as specifically provided otherwise by this license, the licensee shall possess and use radioactive materials described in Items 6, 7, and 8 and 9 of this license in accordance with statements, representations, and procedures contained in the licensee's:

11.1 Uravan Uranium Millsite Remedial Action Plan (hereafter "RAP") which is attached as Appendix I to the Consent Decree, Order, Judgement, and Reference to a Special Master Filed in the United States District Court, Civil Action No. 83C2384, "State of Colorado, Plaintiff, vs. Union Carbide Corporation, a New York Corporation, and Umetco Minerals Corporation, a Delaware Corporation, Defendants, (hereafter "Consent Decree").

11.2 Procedures Manual for Plant Operations at Uravan, dated March 31, 1982, as revised through December 1984 pursuant to LC 20.

11.3 Final Plans and Specifications submitted in accordance with LC 11.1, when such Final Plans and Specifications become Final Submittals as defined by the Consent Decree.

11.4-1 Procedures Manual for Environmental Monitoring at Uravan, dated March 31, 1982, as revised through December 1984 pursuant to LC 20.

11.4-2 When the Quality Control/Quality Assurance, Monitoring and Performance Evaluation Plan (Quality Plan) submitted in accordance with LC 11.1, becomes a Final Submittal, as defined by the Consent Decree, the Final Submittal shall replace in full the Procedures Manual for Environmental Monitoring at Uravan designated as LC 11.4-1.

11.5 Financial assurance requirements stated in Section XVII of the Consent Decree, which shall, upon becoming fully effective, replace in full the Reclamation Surety Agreement, dated September 22, 1981, as revised pursuant to LC 32.

11.6 Long term monitoring and maintenance requirements as stated in Section IV(G) of the Consent Decree, as may be revised pursuant to LC 33.

A U T H O R I Z A T I O N S

6.0 RADIOACTIVE MATERIALS

Naturally-occurring uranium and thorium series radionuclides, in particular natural uranium, thorium-230, radium-226, and their radioactive decay products.

7.0 CHEMICAL AND/OR PHYSICAL FORM

Product (yellowcake) and uranium product concentrates, milling and cleanup residues, including tailings, evaporation crystals and sludges; milling refuse, including decommissioned equipment and building materials.

8.0 MAXIMUM QUANTITY LICENSEE MAY POSSESS AT ANY ONE TIME

12,500,000 dry tons (11,000,000 metric tonnes) of tailings or other residues; unspecified quantities of milling refuse; up to 4,100,000 gallons of uranium concentrate liquors currently stored on site; and 333,512 pounds of uranium product concentrates currently stored on site.

9.0 AUTHORIZED USES

The licensee is authorized to produce interim product of uranium/vanadium concentrate from the liquors currently stored on site for transport prior to January 1, 1988; store yellowcake product, uranium/vanadium concentrate; and store/dispose ores, milling residues, tailings, and refuse consistent with the Remedial Action Plan to which reference is made in LC 11.1.

10.0 AUTHORIZED PLACE OF USE

The licensee's uranium processing facilities at Uravan in Montrose County, Colorado, located as follows:

Those portions of Township 47 North, Range 17 West, New Mexico Principal Meridian, Section 4, and Township 48 North, Range 17 West, New Mexico Principal Meridian, Sections 28, 29, 33 and 34 delineated in Annex A, and any other portion of the Uravan Facility, as defined in the Consent Decree, to which reference is made in LC 11.1.

12.6 HAZARDOUS RELEASES

By this License, the Department does not permit, authorize, concur in, or otherwise approve of, the release or threatened release of hazardous substances, pollutants, or contaminants into the environment, except as specifically authorized by this license.

12.7 WRITTEN APPROVAL

12.7.1 Required Department "approval", "authorization", or "concurrence" shall be obtained in writing from the Division, unless otherwise provided in the Radiation Rules, Division or Department policy.

12.7.2 When the Department reasonably and routinely consults with another party, including but not limited to the State Archaeologist, State Engineer and Colorado Geological Survey, the licensee shall:

12.7.2.1 Permit such party to inspect designated documents, facilities, or sites;

12.7.2.2 Submit designated documents to the party for review; and

12.7.2.3 Conform applications and supporting documents to the written guidelines to or of such party as determined by the Division to be applicable to the project.

12.8 LICENSE CONDITIONS MODIFY REFERENCED DOCUMENTS

The following license conditions, to the extent such conditions are not inconsistent with LC 11.1, modify and add to commitments in the documents in LC 11.

13.0 OWNERSHIP AND CONTROL

13.1 NOTIFICATION OF INTENT

As required by Section XII of the Consent Decree, the licensee shall provide the Department with ninety (90) days advance notification of any proposed change in property ownership or control.

13.2 DEPARTMENT AUTHORIZATION REQUIRED

Subject to Section XII of the Consent Decree, no transfer of title to any portion of the licensed site may be made at any time without prior written authorization from the Department. Any such transfer shall be in accordance with 6 CCR 1007-1-3.14.2, unless otherwise authorized by the Department.

13.3 TRANSFERABILITY

Ownership or control of the tailings confinement area shall be such that jurisdiction over the property may be readily transferred to the State or federal government under the provisions of 6 CCR 1007-1-1 *et seq*.

12.0 GENERAL CONDITIONS

12.1 DEFINITION OF TERMS

12.1.1 Unless otherwise provided in this license, terms used herein are as defined in the State of Colorado "Rules and Regulations Pertaining to Radiation Control" (6 C.C.R. 1007-1-1 *et seq.*, hereafter the "Radiation Rules").

12.1.2 The terms used herein are to be interpreted in a manner consistent with the Consent Decree and LC 11.1.

12.2 OBTAIN PERMITS OF OTHER AGENCIES

Prior to beginning any new construction or new operations, the licensee shall obtain all applicable permits and other authorizations of local, state and federal agencies having authority over health, safety, and environmental protection aspects of the activities authorized by Items 6, 7, 8, and 9 of this license. The licensee shall maintain in force such applicable permits from beginning to end of the project.

The licensee shall inform the State through the On-Site Coordinator (as that term is defined in paragraph III(h) of the Consent Decree, hereafter "OSC") and provide a copy to the Radiation Control Division of the Department (hereinafter referred to as "the Division") thirty (30) days prior to, or as soon thereafter as it is available but in no event later than the date of filing of, any application to permitting agencies for modification or renewal of such permits or other authorizations.

12.3 COMPLY WITH PERMITS

Within the scope of applicable statutes and lawful regulations thereunder, the licensee shall operate in full compliance with the requirements of each other division of the Department.

Violation of such other requirements shall not by itself constitute violation of this license, unless the Department makes an independent finding of violation of the Radiation Rules or a condition of this license other than this LC 12.3.

12.4 STATUS OF REFERENCED DOCUMENTS

Proposals and commitments in referenced documents are in effect license conditions.

Where the word "will" or "should" is used in the documents referenced in LC 11 above, it shall denote a requirement.

12.5 SEVERABILITY

If any part of the Radiation Rules, Department or Division policy, or this license is held invalid, the remainder shall not be affected.

15.0 EMERGENCY ACTIONS

15.1 REPORT OF ACCIDENTS

The licensee shall, immediately upon discovery, notify the OSC and Director, Radiation Control Division, Colorado Department of Health, 4210 East 11th Avenue, Denver, Colorado by telephone (303-377-6326, or 370-9395 after office hours) and in writing of any failure or imminent threat of failure in any process, diversion, or retention system which results or may result in a release of radioactive material into uncontrolled areas. This requirement is in addition to the requirements of 6 CCR 1007-1-4.29 and -4.31.

15.2 EMERGENCY RESPONSE CAPABILITY

The following shall be approved by the Department:

15.2.1 Warning System

The licensee's system for warning in the event of a tailings impoundment break shall be as specified in LCs 11.2 through 11.4. Liquid emergency catchment basins shall have alarms tested at a frequency specified in LC 11.2, and LC 11.4-1 or 11.4-2.

15.2.2 Response Plans

The licensee shall use plans, approved by the Department in conjunction with such agencies as the Division of Disaster Emergency Services and specified in LC 11.2, and LC 11.4-1 or 11.4-2, to respond to accidents and fires in the mill complex and in transportation of radioactive material. These plans shall include provisions for prompt retrieval of any radioactive material released to uncontrolled areas by rupture of any storage or disposal area or pipeline.

15.2.3 Equipment

The licensee shall have available, every calendar day all year, sufficient personnel, equipment and supplies to respond to accidents, fires, and other emergencies in accord with the plans specified in LC 11.2, and LC 11.4-1 or 11.4-2, as approved by the Department.

15.2.4 Training

The licensee shall maintain a documented emergency response training program to insure that sufficient trained persons are always available.

14.0 USERS

14.1 AUTHORIZATION

The licensee shall submit resumes and documentation of users' training and experience to the Department and obtain written authorization from the Department for each user.

14.2 LIST

The licensee shall maintain throughout use of radioactive materials authorized by this license at least two (2) trained, qualified, and authorized users, to include the Radiation Safety Officer (RSO).

14.3 AVAILABILITY

An authorized user shall be on hand at the facility or immediately available at all times during facility operation.

14.4 NON-SAFETY ASSIGNMENTS

The licensee's radiation safety and environmental control staff shall fulfill requirements of this license prior to being given assignments not related to health, safety and environmental protection, unless otherwise authorized by the Department.

14.5 MINIMUM TECHNICAL QUALIFICATIONS FOR RADIATION PROTECTION OFFICER

The RSO shall have at least a B.S. degree in environmental or radiological sciences, or a related field from an accredited college. The RSO shall have intensive formal training of at least one year duration with a minimum of one week of the course specifically applied to health physics problems at uranium recovery facilities. The RSO shall have at least one year of "hands on" experience in radiation safety and occupational health in an operating mill or related facility, at least six months of this experience at the supervisory level. Refresher training in health physics (a minimum of 40 hours) is required at least every two years.

A Master Degree (or a more advanced degree) may be substituted for the two year intensive training requirement above.

With Department approval, experience may also be substituted for training requirements.

14.6 DESIGNATED ASSISTANTS TO THE RADIATION SAFETY OFFICER

The RSO may delegate to trained assistants functions, including quality assurance/quality control measures, required by this license for which a written procedure is included in LCs 11.1 through 11.4, so long as quality is maintained and documented and minimum qualifications for health physics technicians and other members of the radiation safety staff are specified in LC 11.2.

18.0 GENERAL REQUIREMENTS FOR ACTIVITIES

18.1 FACILITY STATUS

Excluding production of uranium/vanadium concentrate from uranium/vanadium liquors currently stored on site, the licensee shall obtain prior authorization by license amendment from the Department at such time as any part of the Uravan Facility is to change from stand-by status.

18.2 PRODUCTION RATE

The licensee shall not store or crush ores or refine and produce uranium product without prior authorization by license amendment from the Department. Notwithstanding the foregoing, limited production of uranium/vanadium concentrate from uranium/vanadium liquors currently stored on site is authorized pursuant to LC 8.0 and 9.0.

18.3 GENERAL MAINTENANCE

All mill, storage, processing, transport, impoundment, containment, monitoring, and safety systems which shall be operated pursuant to this License shall be maintained in good working order. The licensee shall document a system of routine preventive maintenance so that safety-related equipment is checked for proper working order according to a regular schedule.

18.4 ALARA (AS LOW AS REASONABLY ACHIEVABLE)

The licensee shall keep exposures as low as reasonably achievable (ALARA) as provided in LCs 11.1, 11.2, and 11.4-1 or 11.4-2. Final Submittals, as defined by the Consent Decree, shall conform to U.S. Nuclear Regulatory Commission Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational Exposure as Low as Reasonably Achievable", except as authorized by the Department.

The ALARA program performance shall be reviewed monthly by the Radiation Safety Officer (RSO) in a monthly written report to the manager.

18.5 MANAGEMENT

The licensee shall provide, by March 31st of each calendar year, updated details of the authority and responsibility of each level of management, noting any changes.

18.6 OFF-SITE DOSE LIMITS

18.6.1 Limits

The licensee shall conduct activities in such a manner as to provide reasonable assurance that the annual radiation dose equivalent of 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public is not exceeded as the result of exposures of radioactive materials resulting from planned discharges of radioactive materials, radon and its progeny excepted, to the general environment.

18.6.2 Performance

Determination of performance in relation to LC 18.6.1 shall be based upon the annual reports required by LC 30.

18.6.3 Specific Requirements

18.6.3.1 The licensee shall insure, and specify in LC 11.4-1 or 11.4-2, a method to document that no garden produce is grown for human consumption on licensee-controlled property at Uravan.

18.6.3.2 The licensee shall cause all present residents of the Town of Uravan to vacate their residences by December 31, 1986. Defendants shall not permit any building or improvement at the Uravan Facility to be constructed for or occupied as a residence.

18.7 BASELINE INFORMATION

For the purpose of reviewing site cleanup and reclamation, the following shall be included as baseline references:

18.7.1 Environmental Report, dated August 31, 1978 for all baseline data and analyses, in particular: Section 2, pages 29-30, 43-50, 74-102, 109-113; Section 3, pages 32-34, 47-49, 60-63; Section 5, pages 9-10; Section 6, pages 20-21; Section 7, page 35; Appendices C & D;

18.7.2 Updated Environmental Report, dated March 31, 1982;

18.7.3 ERI Logan, Inc. Reports, Vols. I and II, August 11, 1986.

19.0 SITE CONTROL AND PERSONNEL SAFETY

19.1 RESPONSIBILITY

19.1.1 The Plant Superintendent shall be accountable for safety, security, fencing, posting, and area control.

19.1.2 The RSO or RSO's designee shall have authority to remove employees from a work environment or suspend the operation in a particular mill area if he has determined that a condition exists that would likely result in any individual being exposed to radiation that may present an imminent health hazard.

19.1.3 The Plant Superintendent shall act promptly on the recommendations of the RSO or RSO's designee pertaining to radiation safety and security.

19.2 TRAINING

19.2.1 New employees shall not commence work assignments in controlled areas until they have been adequately trained in their assignment and in radiation safety, in accordance with a program approved by the Department and specified in LC 11.2. Such training shall be documented by dates, nature of training, tests and scores, and written acknowledgment of receipt by employee.

19.2.2 The RSO shall document employee review of (1) procedures applicable to each employee's assignment and (2) provisions of 6 CCR 1007-1-10.

19.2.3 The licensee shall accumulate at least ninety (90) minutes of training meeting time per year, or alternative amount approved by the Department and specified in LC 11.2, for each radiation worker to review radiation protection topics, documenting employee attendance, and retrain radiation workers annually on current developments in radiation safety.

19.3 PROTECTIVE CLOTHING

Respirators, gloves, boots, coveralls, helmets, goggles and other protective items shall be used at all times in areas or activities where designated by the RSO.

19.4 RADIATION WORK PERMITS

The licensee's RSO or RSO's designee shall prepare a special work permit, describing specific radiological controls, prior to start of any work or maintenance, at any location of the licensed facility or site, having radiation safety implications and for which no written procedure exists. The licensee's Radiation Work Permit program shall be included in LC 11.2, as approved by the Department. A copy of all permits shall be retained for no less than five (5) years for inspection by the Department.

19.5 SHOWERS

All workers shall shower or monitor head, face, and hands, and document absence of contamination exceeding 1000 dpm/100 cm^2, in areas or activities where designated by the RSO.

19.6 CONTROLLED AREA RESTRICTIONS

The licensee shall not allow eating and smoking in controlled areas, except in control rooms, offices, and lunchrooms, or other areas designated by the RSO.

19.7 SECURITY

The licensee shall fence and post the controlled area boundary as specified in LC 11.2 and in accordance with 6 CCR 1007-1-4.14.

19.8 POSTING EXEMPTION

The licensee is hereby exempted from the requirements of 6 CCR 1007-1-4.11 for areas within the exclusion area boundary, provided all entrances to the property are conspicuously posted with the sign:

"Any Area or Container on this Property
May Contain Radioactive Materials."

20.0 HEALTH, SAFETY AND ENVIRONMENTAL PROCEDURES MANUAL

20.1 PROVISIONS

The licensee shall operate according to and maintain comprehensive written health, safety and environmental procedures manuals, approved by the Department, governing licensed activities, to wit: LC 11.2, and LC 11.4-1 or 11.4-2. The procedures manual shall contain safety, monitoring, decontamination, and emergency procedures, including:

20.1.1 Administrative and operating procedures relating to radiological health and safety;

20.1.2 Instructions and precautions to keep exposures ALARA;

20.1.3 Specific information on analytical equipment, laboratories, and procedures for each aspect of the monitoring program.

20.2 REVISIONS

20.2.1 No reduction in monitoring provisions shall be made without Department approval.

20.2.2 All procedures manual revisions shall be submitted to the Department for prior approval.

20.2.3 The licensee shall consider proposed procedures manual revisions whenever new or revised regulatory guidance requiring such revisions is provided to the licensee by the Department.

21.0 POINT SOURCE AIR EMISSIONS CONTROLS

Emissions from all activities shall be controlled in accordance with LC 11.2, and LC 11.4-1 or 11.4-2, and applicable permits.

22.0 AREA SOURCE AIR EMISSIONS CONTROLS

22.1 RESIDUE STORAGE AREAS

The licensee shall implement dust control as approved by the Department and specified in LC 11.2, and 11.4-1 or 11.4-2.

22.2 ROADS

The licensee shall control dusting from controlled area roads by sprinkling, or chemical crusting agents, and shall limit vehicle speeds to twenty (20) miles per hour.

22.3 TAILINGS DUSTING

The licensee shall obtain Department approval for a program, specified in LC 11.4-1 or 11.4-2 by written operating procedures for all conditions, to minimize, to the maximum extent reasonably achievable, dispersion of airborne particulates from the tailings disposal area.

23.0 SOLID WASTE MANAGEMENT

23.1 SUPERVISION

The tailings confinement system shall be monitored by persons trained and under the supervision of a professional engineer, or other engineer, scientist, or person qualified by virtue of training and experience approved by the State as provided in LC 11.1.

23.2 QUALITY CONTROL PLAN FOR TAILINGS

The licensee shall strictly adhere to LC 11.4-1 and Annex E, as modified and superseded by LC 11.4-2, at all times, particularly with respect to minimum reserve capacity, freeboard, and beach width, until such time as Final Submittals incorporating all required provisions are approved by the State.

23.3 MAINTENANCE

Culverts and roads shall be maintained at all times. All required maintenance, repair and erosion control shall be undertaken as expeditiously as possible.

23.4 DRAIN SYSTEMS

The drain and collection systems shall be monitored and maintained functional at all times. Required maintenance, repair and erosion control shall be as expeditious as possible.

23.5 MILL REFUSE AND EVAPORATION RESIDUE DISPOSAL

Radioactive materials, including insoluble sludges and residues, and waste from construction, operation and decommissioning, may be disposed in tailing piles 1, 2 and 3, or in a disposal area approved by the Department. All waste materials shall be disposed in accordance with LCs 11.1 through 11.4.

23.5.1 Disposal shall not occur within any current or future external dike of the tailings ponds; and

23.5.2 The materials shall be disposed in a manner which minimizes void spaces and future settling abnormalities.

23.6 TOWN RESIDUES AND CONTAMINATED MATERIAL

All contaminated materials on licensee-controlled property at Uravan shall be disposed in accordance with the detailed requirements and the schedule in LCs 11.1 through 11.4.

24.0 LIQUID WASTE MANAGEMENT

The licensee shall meet the following requirements not inconsistent with LC 11.1.

24.1 Consistent with LC 11.1, the licensee shall not discharge radioactive materials or toxic pollutants to SURFACE WATERS.

24.2 The licensee shall not allow significant pollution to migrate to GROUND WATERS beyond the limited area specified in LCs 11.1 through 11.4.

24.3 The licensee shall control, by diversion or catchment, all SURFACE RUNOFF due to a 10-year, 24-hour precipitation event to or from all facilities or areas, as provided by LCs 11.1 through 11.4.

24.4 The licensee shall prepare CONTINGENCY PLANS, including in these corrective action plans remedial measures approved by the Department and specified in LCs 11.1 through 11.3, for any situation in which ongoing seepage threatens degradation of surface and ground waters.

24.5 The licensee shall provide by March 31st of each calendar year an updated water balance analysis of all inflows and outflows which are occurring and/or may be expected to occur.

25.0 TRANSFER OF CONTAMINATED MATERIALS

25.1 MILL TAILINGS

Mill tailings, other than samples for laboratory analysis or research, shall not be transferred to or from the site without specific prior approval of the Department obtained through application for amendment of this license. The licensee shall maintain a permanent record of all transfers made under the provisions of this condition.

25.2 CONTAMINATED ITEMS

The licensee shall release contaminated equipment, packages (including product) or materials from controlled areas for sale, repair, reuse, resale or disposal only after documented radioactive decontamination meeting the requirements of the Department, as detailed in Annex C to this license or required pursuant to 6 CCR 1007-1-3.24. Procedures for monitoring filled barrels of U_3O_8 approved by the Department are to be included in LC 11.2 and/or LC 11.4-1 or 11.4-2.

26.0 GENERAL SPECIFICATIONS FOR INSPECTION AND MONITORING

26.1 RECORDS

26.1.1 Consistent with LC 11.1, the results of sampling, analyses, surveys, instrument calibrations, inspections and audits, employee training, as well as any related reviews, investigations, and corrective actions shall be documented.

26.1.2 All such documentation shall be retained and archived until other disposition is authorized by the Department. Personnel exposure records shall be preserved indefinitely.

26.2 LOWER LIMITS OF DETECTION

26.2.1 The licensee shall follow, at the least, the lower limits of detection (LLDs) contained in Annex D for the analysis of samples collected pursuant to LCs 27 and 28. If the licensee is using other LLDs, such LLDs shall be submitted to the Department for review and approval and specified in LC 11.4-1 or 11.4-2.

26.2.2 If actual concentrations being measured are sufficiently higher than the lower limits of detection specified in LC 26.2.1, the sampling and analysis procedures need only be adequate to measure the actual concentrations. In such cases, the standard deviation estimated for variability due to random error of the analysis shall be no greater than ten percent (10%) of the measured value.

26.3 QUALITY ASSURANCE/QUALITY CONTROL

26.3.1 The licensee shall maintain a quality assurance/quality control program approved by the Department and specified in LC 11.4-1 or 11.4-2.

26.3.2 NRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment", as revised, may be followed by the licensee; or the licensee's specifications may provide for an equivalent quality assurance program.

26.4 EQUIPMENT AVAILABLE

The inventory of monitoring equipment shall be such that operable and calibrated units are always on hand.

26.5 CALIBRATION OF EQUIPMENT

The licensee shall calibrate all radiation monitoring and sampling equipment after repair and, unless otherwise authorized by the Department, at least as frequently as the manufacturer's suggested interval, or semiannually if no interval is specified. Also, a check source shall be used to assure that radiation detection instruments are operating properly before each use.

27.0 PERSONNEL AND FACILITY MONITORING

27.1 Consistent with LC 11.1, the licensee's personnel and facility monitoring program shall be sufficient to enable the Department to estimate maximum potential occupational dose commitment and to demonstrate compliance with 6 CCR 1007-1-4, and shall be:

27.1.1 As in the procedures manual (LC 11.2) required by LC 20, as modified by this LC 27;

27.1.2 Revised as necessary in accordance with LC 20.2.

27.2 The RESULTS of personnel and facility monitoring required by LC 27 shall be included in the report required in LC 30.

27.3 PERSONNEL MONITORING control badges shall be kept in a background location.

27.4 **BIOASSAY**

27.4.1 The licensee shall comply with the program as in the procedures manual approved by the Department and NRC Regulatory Guide 8.22 "Bioassay at Uranium Mills" (Revision 0 or as subsequently revised), unless other conditions of this license or LC 11 are more restrictive, and the following:

Urinalysis for uranium shall be performed for employees assigned to Radiation Work Permit activities exceeding one work day. Specimens shall be collected as close as is reasonably possible to the period beginning 48 hours and ending 96 hours after the last exposure. The measurement sensitivity shall be 5 ug/l or less. A special urinalysis shall also be performed if there is any reason to suspect an inhalation exposure to yellowcake exceeding 40×10^{-10} uCi-hr/ml in a period of one work week or to ore dust exceeding 520×10^{-10} uCi-hr/ml in a period of one calendar quarter. The licensee shall make a formal documented evaluation if bioassay measurements exceed any of the following criteria:

27.4.1.1 The urinary uranium concentration exceeds 30 ug/l for any two consecutive sampling periods.

27.4.1.2 The urinary uranium concentration for any measurement exceeds 80 ug/l.

27.4.1.3 Action levels based on bioassay measurements shall be in accordance with Tables 1 and 2 of NRC Regulatory Guide 8.22. In addition, all bioassay results shall be evaluated and acted upon by the RSO and appropriate licensee officials.

27.4.2 Urinalysis results exceeding 15 ug/l shall be reported to the RSO within 20 days of specimen collection.

27.4.3 Urinalysis results exceeding 30 ug/l shall be reported immediately to the RSO by telephone.

27.4.4 Prevention of specimen contamination shall be in accordance with Section C.6 of NRC Regulatory Guide 8.22.

27.4.5 The licensee shall implement a documented quality control program for urine specimens that includes background samples, blanks, and spikes and also criteria for requiring repeat collection and analysis.

27.4.6 A baseline urine sample shall be obtained from any new worker who will be subject to urinalysis, prior to start of work.

27.5 **MILL AIR SAMPLING**

The licensee shall conduct an air sampling program to assess airborne radioactivity concentrations to which employees may be exposed, as follows:

27.5.1 A representative air sample for no less than thirty (30) minutes duration shall be collected at least quarterly at work stations

Based upon at least two initial samples at each work area and a sample at the start of each major work activity, the initial monitoring frequency for each work area shall be determined according to the following:

Work Area Status	Initial Monitoring Frequency**
Conc.<10% MPC*	Quarterly
Conc.<25% MPC*	Monthly
Conc.>25% MPC*	Weekly

* u-natural, or the average of uranium decay series radionuclides, in accordance with pertinent footnotes to 6 CCR 1007-1-4, Appendix A.

* unless a different minimum duration is approved by the Department and included in LC 11.2, or LC 11.4-1 or 11.4-2.

27.5.2 Worker breathing zone sampling shall be conducted at least quarterly to determine the representativeness of the station air samples.

27.5.3 Pursuant to LC 27.5.1, monthly air samples for no less than thirty (30) minutes duration (unless a different minimum duration is approved by the Department and included in LC 11.2, or LC 11.4-1 or 11.4-2), representative of potential employee exposure, shall be collected at activity and storage locations, as appropriate, to determine airborne uranium concentrations.

27.5.4 Sampling at selected work areas shall be performed at least monthly to determine radon progeny concentrations. If these values exceed 25 percent of the applicable standards, the frequency of sampling at these locations shall be increased to weekly.

27.5.5 If the air sampling program reveals work activity locations where concentrations exceed 25 percent of the applicable standards, the licensee shall establish a program to determine time-weighted exposures of employees working at these locations and establish additional procedures required to maintain employee exposures as low as reasonably achievable. Time-weighted studies shall be done at least quarterly.

27.5.6 Uranium particulate air sampling, supplementing the routine air sampling program, shall be conducted for cleanup and maintenance activities as appropriate.

27.5.7 In-plant air monitoring committed to in LC 11.2, or LC 11.4-1 or 11.4-2 shall be performed under conditions typical of employee exposures.

27.5.8 Along with results of airborne activity, the license shall keep a record of the activity underway during sampling.

27.5.9 The licensee shall maintain records of any respirator maintenance, fit and training program.

27.6 MILL ALPHA CONTAMINATION SAMPLING

27.6.1 The licensee shall perform documented spot surveys for alpha contamination at least quarterly on ten (10) per cent of the workers leaving the site. Alpha contamination on skin or clothes exceeding 1000 dpm/100 cm^2 shall require decontamination and an investigation by the RSO as to the cause.

27.6.2 The licensee shall conduct alpha contamination surveys of the lunch rooms, control rooms, change rooms, and offices at least monthly. If the surveys reveal contamination levels that exceed Department guidelines, (1) the area shall be decontaminated immediately, (2) an investigation shall be made by the RSO to determine the cause and corrective measures required to prevent recurrence, and (3) the location shall be surveyed weekly until four (4) consecutive weekly surveys are below guidelines, at which time the survey frequency shall revert to monthly.

27.7 ACTION LEVELS

The licensee shall specify in LC 11.2, or LC 11.4-1 or 11.4-2, action levels for all work area monitoring and effluent discharge monitoring which requires administrative action if MPC-based or ALARA-based concentration values are exceeded.

28.0 ENVIRONMENTAL MONITORING AND ANALYSIS PROGRAM

28.1 Consistent with LC 11.1, the licensee's environmental monitoring and analysis program shall be sufficient to enable the Department to estimate, with reasonable assurance, maximum potential radiation dose commitment to individuals and populations off-site and to demonstrate compliance with LC 18.6.1, and shall be as in the procedures manual (LC 11.4-1 or 11.4-2) required by LC 20, as modified by this LC 28, and revised as necessary in accordance with LC 20.2.

28.2 The RESULTS of monitoring required by LC 28 shall be included in the report required by LC 30.

28.3 TAILINGS PILES 1, 2, and 3 monitoring shall include the monitoring program set forth in LC 11.4-1 or 11.4-2, Annex E and the long-term monitoring and maintenance program pursuant to LC 33.

28.4 AIR PARTICULATES shall be:

28.4.1 Monitored at the locations specified in LC 11.4-1 or 11.4-2, at least one nearest feasible residence, and at a control location;

28.4.2 Collected with weekly filter changes, or more frequently as required by dust loading;

28.4.3 Composited monthly by location;

28.4.4 Analyzed for natural uranium, thorium-230, radium-226, and lead-210.

28.5 AMBIENT RADON shall be monitored at the locations specified in LC 11.4-1 or 11.4-2 continuously, or at least once per month, representing approximately the same period each month.

28.6 GROUND WATER shall be monitored as specified in LC 11.4-1 or 11.4-2.

28.7 SURFACE WATER shall be monitored as specified in LC 11.4-1 or 11.4-2.

28.8 RIVER SEDIMENTS shall be sampled as specified in LC 11.4-1 or 11.4-2.

28.9 SURFACE SOILS shall be collected at locations approved by the Department as specified in LC 11.4-1 or 11.4-2.

28.10 A BETA/GAMMA CONTAMINATION SURVEY shall be conducted for areas approved by the Department and specified in LC 11.4-1 or 11.4-2.

28.11 VEGETATION, FORAGE AND FOOD CROPS shall be sampled as specified in LC 11.4-1 or 11.4-2 during each growing season at three or more locations which have the highest expected contaminant levels. Three samples of any form of livestock grazing within three (3) km of the mill site shall be taken annually at time of slaughter and analyzed for Ra-226 and Pb-210.

28.12 FAUNA AND FISH shall be sampled only in accordance with a permit issued by the Colorado Division of Wildlife as appropriate and as approved by the Department.

29.0 SAFETY INSPECTIONS AND AUDITS

The licensee shall perform the following safety inspections and audits:

29.1 DAILY TAILING INSPECTIONS

The integrity of the tailing confinement system, associated structures and plumbing, and the effectiveness of the control methods used to control tailings dusting (LC 22.3), shall be verified at least daily by trained personnel during documented inspections in accord with written procedures specified LC 11.4-1 or 11.4-2.

29.2 WEEKLY INSPECTIONS

Weekly documented inspections of all active work areas and storage areas shall be conducted by the RSO to ensure that the radiation safety program is as required. Any deviation from operating procedures, license requirements, or safety practices, including housekeeping practices, affecting radiological safety shall be reviewed with management or the employees and corrected.

29.3 RSO'S AUDIT

The RSO shall audit the inspection logs and reports and audit all monitoring data as provided in LC 11.4-1 or 11.4-2. The RSO shall summarize this information and submit a written report to the Plant Superintendent recommending any necessary corrective actions and including an evaluation of the adequacy of the implementation of license requirements.

29.4 ANNUAL ALARA INDEPENDENT AUDIT

The licensee shall obtain and submit to the Department a performance audit of the health, safety, and environmental radiation protection programs required by this license.

30.0 REPORTS TO THE DEPARTMENT

The licensee shall, for the previous calendar year ending December 31st, provide to the Department by March 31st of each year:

30.1 An ALARA REPORT on the program (in LC 18.4) for maintaining uranium and decay product exposures and releases ALARA, (including as attachments the RSO's monthly reports to the Plant Superintendent, the auditor's report required by LC 29.4, and any revisions to the procedures manual required by LC 20).

The report shall include conclusions and recommendations of inspections required by LC 29 and shall evaluate employee exposures (including bioassay data), and environmental data to determine (1) if there are any upward trends developing in personnel exposures for identifiable categories of workers or types of operations, (2) if exposures might be lowered under the concept of maintaining exposures as low as reasonably achievable (in particular from the yellowcake dryer emission control system) and (3) if equipment for exposure control is being properly used and maintained.

30.2 An OFF-SITE RADIATION DOSE REPORT which evaluates, using site specific input parameters and methods approved by the Department, doses to off-site individuals and populations and, as necessary, indicates if standards in LC 18.6 are exceeded.

30.2.1 The licensee's assessment shall refer to details of regional natural radiation background and of past and present uranium fuel cycle or other operations which have contributed or could contribute to radiation doses above those from natural radiation background.

30.2.2 The licensee's assessment shall include an up-to-date inventory of sources other than authorized by this license and which could reasonably be expected to affect compliance with LC 18.6, such as mine waste dumps and subore storage piles, and shall include a detailed topographic map locating all sources (with their area, height above ground surface, and average grade) within 5 miles (8 km) of the controlled area boundary, to the extent the information is available.

30.3 The results of an annual LAND USE SURVEY, conducted as in LC 11.1 and LC 11.4-2, of land and water use in an area within 5 miles (8 km) of any portion of the restricted area boundary, including:

30.3.1 A detailed topographic map(s) showing all environmental sample collection locations and all of the following within 5 miles (8 km) of any portion of the restricted area boundary: private residences, grazing areas, private and public potable water and agricultural wells, milk cattle, nonresidential structures and uses, mining areas, and ore storage pads.

30.3.2 Indication of any differences in land use from that described in the licensee's previous report.

30.4 As provided in LC 11.2, and LC 11.4-1 or 11.4-2, monitoring data, in particular all data obtained pursuant to LC 27 and LC 28, shall be presented in tables and graphs which identify trends, including:

30.4.1 Tables containing date, type, and location for each analytical result, including the magnitude of the random error.

30.4.2 Graphs or charts which are summaries.

30.4.3 Data, analyses, and results of surface and groundwater monitoring required by LC 28.6 and 28.7. In general, consistent with the Consent Decree and LC 11.4-1 or 11.4-2, reporting shall include an assessment of surface and groundwater conditions and the analysis of tailings ponds and crystal disposal repository, stability, settlement (consolidation), drainage, erosion conditions, and describe the status of reclamation activities and the quality control program related thereto.

30.4.4 All data, analysis and results of measurements set forth in LC 28.3 and Annex E.

31.0 FINANCIAL ASSURANCES

31.1 FINANCIAL ASSURANCE AGREEMENTS REQUIRED

Failure to have properly and in timely manner executed and delivered to the State agreements to cover mill and site decontamination and decommissioning, reclamation and stabilization of disposal areas, and long term monitoring and maintenance may be reason for suspension or revocation of this license.

31.2 MAINTENANCE OF FINANCIAL ASSURANCE AGREEMENTS

As provided in the Consent Decree, the licensee shall maintain in force a financial assurance agreement and instruments pursuant to 6 CCR 1007-1-3.9.4 for the decommissioning and decontamination of the mill, ore storage and tailings transport areas, and for the reclamation of the mill tailings and crystal disposal confinement areas until final action on release is taken by the Department as provided by the financial assurance agreements between the licensee and the Department.

32.0 DECOMMISSIONING, DECONTAMINATION AND RECLAMATION

32.1 RECLAMATION ASSURANCES

As provided in the Consent Decree, the financial assurance arrangements shall remain in force until final reclamation is completed pursuant to LC 11.1, final reclamation meets applicable State and federal regulations, and the property is transferred to the State or federal government under the provisions of 6 CCR 1007-1-3, Schedule E, Criterion 8.

32.2 NON REPOSITORY AREAS

32.2.1 As provided in the Consent Decree and LC 11.1, any portion of these decommissioned areas which are to be returned to unrestricted use shall be decontaminated toward the goal of background radiation ranges and toxic contaminant ranges acceptable to the Department based on statistically defensible tests of soil contamination with depth.

32.2.2 As provided in the Consent Decree and LC 11.1, the licensee shall minimize wind and water erosion of contaminated materials during reclamation using written procedures approved by the Department.

32.2.3 The licensee shall reclaim the existing solid and liquid waste disposal areas in accordance with the framework, schedule and details presented in the Consent Decree and LC 11.1.

32.3 AMOUNT OF FINANCIAL ASSURANCE

The decommissioning and reclamation financial assurance instruments shall be maintained in an amount sufficient to comply with LC 11.5.

32.4 ANNUAL REVIEW OF FINANCIAL ASSURANCE ARRANGEMENTS

The financial assurance agreement and instruments required by this license shall be subject to annual review for adequacy by the Department, and such other agencies as the Department designates, in accord with 6 CCR 1007-1-3.9.4.5. Cost estimates may be adjusted upward or downward as current circumstances, including, but not limited to, inflation, regulations, and technology, require. The licensee shall submit proposed changes by June 30th each year.

32.5 REPORTING

The licensee shall provide all reports required by LC 11.5 and Department policy as soon as the reports are generally available but not later than June 30th of each year. No reports are required until April 10, 1987 and annually thereafter.

32.6 RELEASE OF FINANCIAL ASSURANCES

32.6.1 Upon determination by the Department that performance required by this license has been complete and adequate, the licensee shall be released from the financial assurance requirement of the Radiation Rules. In the event of partial or complete default on the part of the licensee in the performance of the work, the State may draw upon the financial assurance instruments as necessary to complete the reclamation, in accordance with LC 11.5.

32.6.2 The licensee shall notify the Department of the intent to request release of other applicable financial assurance arrangements with other agencies having jurisdiction over any aspect of the Uravan facility.

32.7 OWNERSHIP OPTION RESPONSIBILITIES

32.7.1 Until the property is transferred to the State or federal government, the restrictions of 6 CCR-1007-1-3, Schedule E, Criterion 8, and the following shall be in force:

32.7.1.1 The licensee shall carry out the long-term monitoring and maintenance program.

32.7.1.2 The licensee shall not permit tailings material to remain exposed or be released to the surrounding area after reclamation.

32.7.1.3 The licensee shall prohibit the erection of any structures for occupancy by humans or animals.

32.7.1.4 The licensee shall prohibit establishment of private roads, trails, or rights-of-way across the covered surface.

32.7.1.5 The licensee shall maintain any necessary fencing to preclude entry of people or grazing or browsing animals shall be maintained.

32.7.1.6 The licensee shall maintain warning signs in accordance with 6 CCR 1007-1-4.11.

33.0 LONG TERM MONITORING AND CARE

33.1 Prior to license termination, the licensee shall provide a cash fund whose projected growth and income will fully provide for long-term monitoring and care as approved by the Department.

33.2 The long-term care agreement and fund required by this license shall be in accord with 6 CCR 1007-1-3.9.5.4.2.

December 19 1986

Dated

For the Colorado Department of Health

Annex A

Boundary Lines of Areas for

Tailings Reclamation, Mill Decommissioning

and Pond Reclamation at the

Uravan Mill - for Surety Purposes

ATKINSON CREEK AREA

A parcel of land in Sections 28 and 29 of Township 48 North, Range 17 West, New Mexico, Principal Meridian. Described as follows

Commencing at the Northwest corner of said Section 28 whence the Southwest corner of Section 28 bears S 0° 53' 24" E; Thence S 17° 19' 03" E 1408.09 feet to the TRUE POINT OF BEGINNING; Thence S 43° 10' 04" E 111.30 feet; Thence S 36° 30' 41" W 395.53 feet; Thence S 56° 50' 34" E 106.77 feet; Thence S 13° 48' 14" E 135.24 feet; Thence S 65° 02' 51" W 94.38 feet; Thence S 89° 38' 16" W 147.86 feet; Thence N 74° 26' 50" W 148.30 feet; Thence N 66° 12' 28" W 481.65 feet; Thence N 54° 56' 32" E 323.11 feet; Thence N 88° 36' 38" E 280.40 feet; Thence N 46° 03' 43" E 205.02 feet; Thence N 69° 25' 59" E 173.16 feet to the TRUE POINT OF BEGINNING, containing 6.55 acres.

CLUB RANCH POND AREA

A parcel of land in Section 28, Township 48 North, Range 17 West, New Mexico, Principal Meridian. Described as follows:

Commencing at the Northwest corner of said Section 28 whence the Southwest corner of Section 28 bears S 0° 53' 24" E; Thence S 18° 01' 47" E 2005.34 feet to the TRUE POINT OF BEGINNING; Thence N 62° 39' 54" E 296.05 feet; Thence N 66° 17' 38" E 189.77 feet; Thence N 83° 57' 12" E 146.53 feet; Thence S 73° 03' 30" E 125.78 feet; Thence S 69° 53' 17" E 236.49 feet; Thence S 53° 20' 01" E 176.95 feet; Thence S 45° 03' 12" E 205.56 feet; Thence S 49° 41' 57" E 1136.56 feet; Thence S 50° 43' 56" E 336.57 feet; Thence S 39° 13' 21" E 149.07 feet; Thence S 38° 55' 14" E 579.12 feet; Thence S 45° 35' 09" E 380.38 feet; Thence N 82° 52' 29" E 91.41 feet; Thence S 34° 05' 10" E 129.85 feet; Thence S 81° 57' 06" W 237.60 feet; Thence S 52° 14' 18" W 312.40 feet; Thence S 42° 37' 26" E 44.54 feet; Thence S 49° 38' 15" W 420.93 feet; Thence N 35° 51' 20" W 613.70 feet; Thence N 37° 04' 46" W 382.11 feet; Thence N 41° 38' 08" W 1145.59 feet; Thence N 66° 50' 11" W 450.95 feet; Thence N 70° 07' 50" W 814.49 feet; Thence N 20° 39' 16" E 293.77 feet; Thence N 11° 21' 38" W 263.41 feet to the TRUE POINT OF BEGINNING. Containing 62.72 acres.

RIVER POND NORTH OF RIVER

A parcel of land in Section 34 Township,48 North, Range 17 West, New Mexico, Principal Meridian. Described as follows:

Commencing at the Northwest corner of said Section 34 whence the Southwest corner of Section 34 bears S 0° 10' 16" W; Thence S 29° 39' 53" E 2382.52 feet to the TRUE POINT OF BEGINNING; Thence S 85° 28' 26" E 173.80 feet; Thence S 69° 29' 22" E 311.77 feet; Thence S 60° 48' 24" E 262.61 feet; Thence S 23° 26' 09" E 136.68 feet; Thence S 25° 34' 39" W 153.30 feet; Thence N 85° 01' 19" W 129.28 feet; Thence N 75° 55' 01" W 184.15 feet; Thence N 48° 13' 17" W 141.06 feet; Thence N 39° 59' 48" W 222.49 feet; Thence N 33° 39' 00" W 229.74 feet to the TRUE POINT OF BEGINNING, containing 4.49 acres.

RIVER POND SOUTH OF RIVER

A parcel of land in Section 34, Township 48 North, Range 17 West, New Mexico, Principal Meridian. Described as follows:

Commencing at the Northwest corner of said Section 34 whence the Southwest corner of Section 34 bears S 0° 10' 16" W; Thence S 20° 41' 00" E 1992.09 feet to the TRUE POINT OF BEGINNING; Thence S 69° 22' 46" E 218.78 feet; Thence S 48° 23' 26" E 273.21 feet; Thence S 34° 53' 00" E 219.68 feet; Thence S 41° 41' 30" W 80.31 feet; Thence N 52° 40' 36" W 225.01 feet Thence N 59° 55' 13" W 240.92 feet; Thence N 53° 53' 11" W 215.88 feet; Thence N 35° 11' 13" E 139.78 feet to the TRUE POINT OF BEGINNING, containing 2.42 acres.

CLUB MESA RAFFINATE AREA

A parcel of land in Section 33 Township 48 North, Range 17 West New Mexico, Principal Meridian described as follows:

Commencing at the Southwest corner of said Section 33 whence the Southeast corner of Section 33 bears S 85° 49' 22" E; Thence N 77° 20' 45" E 1241.57 feet to the TRUE POINT OF BEGINNING; Thence N 31° 15' 13" E 421.54 feet; Thence N 18° 49' 49" E 168.84 feet; Thence N 13° 38' 11" W 230.57 feet; Thence N 6° 19' 20" W 432.28 feet; Thence N 21° 01' 46" W 425.68 feet; Thence N 10° 49' 48" W 176.81 feet; Thence N 20° 44' 55" E 162.21 feet; Thence S 73° 51' 35" E 276.29 feet; Thence S 50° 53' 03" E 374.13 feet; Thence N 49° 18' 09" E 466.36 feet; Thence N 72° 28' 22" E 166.12 feet; Thence S 89° 37' 37" E 304.30 feet; Thence S 72° 45' 42" E 243.72 feet; Thence N 51° 33' 03" E 237.00 feet; Thence S 7° 12' 44" E 753.58 feet; Thence S 17° 12' 35" E 464.57 feet; Thence S 39° 39' 11" W 245.01 feet; Thence S 53° 20' 43" W 333.33 feet; Thence S 34° 28' 08" W 424.74 feet; Thence S 82° 45' 36" W 354.65 feet; Thence S 21° 24' 08" W 158.77 feet; Thence S 10° 46' 47" W 146.57 feet Thence S 50° 20' 3[illegible]" W 416.18 feet; Thence N 27°23' 41" W 268.93 feet; Thence N 59° 47' 05" W 575.37 feet to the TRUE POINT OF BEGINNING. Containing 76.09 acres.

TAILINGS PONDS 1 & 2

A parcel of land in Section 33 Township 48 North, Range 17 West, New Mexico, Principal Meridian, described as follows:

Commencing at the Southeast corner of said Section 33 whence the Southwest corner of Section 33 bears N 85° 49' 22" W; Thence N 31° 08' 52" W 1889.45 feet to the TRUE POINT OF BEGINNING; Thence S 64° 46' 40" W 222.49 feet; Thence S 83° 32' 43" W 269.18 feet; Thence N 86° 08' 43" W 165.12 feet; Thence S 74° 27' 06" W 248.26 feet; Thence N 80° 10' 02" W 200.16 feet; Thence N 17° 12' 35" W 464.57 feet; Thence N 7° 12' 44" W 753.58 feet; Thence N 32° 42' 50" E 353.67 feet; Thence N 35° 51' 59" E 219.15 feet; Thence N 34° 31' 46" E 275.32 feet; Thence N 56° 37' 42" E 324.56 feet; Thence N 58° 57' 19" E 98.67 feet; Thence S 61° 25' 37" E 96.10 feet; Thence S 77° 10' 35" E 165.15 feet; Thence S 43° 19' 16" E 685.29 feet; Thence S 48° 00' 03" E 93.36 feet; Thence S 32° 28' 44" E 204.87 feet; Thence S 9° 22' 21" E 224.45 feet; Thence S 8° 43' 04" W 183.34 feet; Thence S 29° 20' 27" W 125.08 feet; Thence S 36° 18' 01" W 326.31 feet; Thence S 4° 29' 26" W 151.55 feet; Thence S 35° 26' 04" W 287.41 feet to the TRUE POINT OF BEGINNING. Containing 62.17 acres.

TAILINGS POND 3

A parcel of land in Section 33 Township 48 North, Range 17 West New Mexico, Principal Meridian. Described as follows:

Commencing at the Southwest corner of said Section 33 whence the Southeast corner of Section 33 bears S 85° 49' 22" E; Thence S 87° 01' 34" E 2710.40 feet to the TRUE POINT OF BEGINNING; Thence N 13° 30' 14" W 500.19 feet; Thence N 34° 28' 08" E 424.74 feet; Thence N 53° 20' 43" E 333.33 feet; Thence N 39° 39' 11" E 245.01 feet; Thence S 80° 10' 02" E 200.16 feet; Thence N 74° 27' 06" E 248.26 feet; Thence S 86° 08' 43" E 165.12 feet; Thence S 58° 14' 31" E 226.87 feet; Thence S 62° 59' 26" E 347.70 feet; Thence S 32° 19' 18" E 110.99 feet; Thence S 8° 28' 24" E 148.65 feet; Thence S 30° 18' 23" W 102.40 feet; Thence S 61° 55' 49" W 1360.60 feet; Thence N 89° 50' 24" W 480.19 feet to the TRUE POINT OF BEGINNING. Containing 34.48 acres.

A PLANT

A parcel of land in Section 33 and 34 of Township 48 North, Range 17 West, New Mexico Principal Meridian. Described as follows:

Commencing at the Northwest corner of said Section 34 whence the Southwest corner of Section 34 bears S 0° 10' 16" W; Thence S 1° 54' 50" E 1769.46 feet to the TRUE POINT OF BEGINNING: Thence N 51° 44' 34" E 140.94 feet; Thence S 54° 08' 00" E 398.55 feet; Thence S 64° 12' 10" E 144.95 feet; Thence S 53° 53' 12" E 215.88 feet; Thence S 59° 55' 13" E 240.92 feet; Thence S 52° 40' 35" E 225.01 feet; Thence S 54° 19' 37" E 579.18 feet; Thence S 1° 45' 50" W 97.78 feet; Thence S 26° 55' 12" W 142.83 feet; Thence S 36° 16' 51" W 766.68 feet; Thence S 3° 33' 41" E 291.44 feet; Thence S 39° 25' 23" W 204.96 feet; Thence N 39° 30' 14" W 242.55 feet; Thence N 47° 54' 25" E 120.45 feet; Thence N 28° 52' 36" E 491.00 feet; Thence N 22° 27' 58" W 139.58 feet; Thence N 52° 07' 08" W 424.05 feet; Thence N 46° 07' 40" W 289.13 feet; Thence N 85° 34' 23" W 261.91 feet; Thence N 26° 12' 23" W 120.96 feet; Thence N 32° 53' 24" W 528.66 feet; Thence N 11° 42' 27" E 171.62 feet; Thence N 43° 10' 56" W 136.88 feet; Thence N 48° 12' 20" E 164.14 feet; to the TRUE POINT OF BEGINNING. Containing 29.58 acres.

B PLANT

A parcel of land in Section 4 Township 47 North, Range 17 West and Section 33 and 34 of Towhship 48 North, Range 17 West, New Mexico Princip Meridian, described as follows:

Commencing at the Northeast corner of said Section 33 whence the Southeast corner of Section 33 bears S 0° 10' 16" W; Thence S 49° 20' 16" W 1573.54 feet to the TRUE POINT OF BEGINNING; Thence S 31° 46' 21" E 1181.56 feet; Thence S 29° 36' 06" E 339.84 feet; Thence S 24° 38' 56" 181.02 feet; Thence S 70° 20' 47" E 403.77 feet; Thence S 54° 38' 27" E 278.09 feet; Thence S 43° 44' 07" E 426.43 feet; Thence S 33° 02' 32" E 490.65 feet; Thence S 37° 31' 07" W 354.83 feet; Thence S 51° 08' 27" W 507.58 feet; Thence S 61° 42' 50" W 328.85 feet; Thence S 72° 54' 21" W 653.75 feet; Thence S 52° 49' 45" W 724.87 feet; Thence S 62° 37' 34" W 670.70 feet; Thence S 55° 30' 00° W 261.14 feet; Thence S 24° 45' 15" W 486.91 feet; Thence S 36° 42' 51" W 249.82 feet; Thence S 53° 41' 49" W 343.73 feet; Thence N 71° 27' 00" W 273.05 feet; Thence N 9° 45' 33" W 107.70 feet; Thence N 52° 43' 12" E 231.29 feet; Thence N 26° 48' 28" E 502.60 feet; Thence N 38° 27' 35" E 281.50 feet; Thence S 89° 50' 24" E 480.19 feet; Thence N 61° 55' 49" E 1360.60 feet; Thence N 30° 18' 24" E 102.40 feet; Thence N 8° 28' 25" W 148.65 feet; Thence N 22° 19' 18" W 110.99 feet; Thence N 61° 06' 57" W 574.10 feet; Thence N 83° 32' 43" E 269.19 feet; Thence N 64° 46' 40" E 222.49 feet; Thence N 35° 25' 04" E 287.41 feet; Thence N 4° 29' 27" E 151.55 feet; Thence N 36° 18' 01" E 326.31 feet; Thence N 29° 20' 26" E 125.08 feet; Thence N 8° 43' 05" E 183.34 feet; Thence N 9° 22' 21" W 224.45 feet; Thence N 32° 28' 44" W 204.87 feet; Thence N 48° 00' 02" W 93.37 feet; Thence N 42° 19' 16" W 685.29 feet; Thence N 77° 10' 36" W 165.15 feet; Thence N 61° 25' 30" W 96.10 feet; Thence S 58° 57' 19" W 98.67 feet; Thence S 56° 37' 41" W 324.56 feet; Thence N 89° 30' 50" W 102.62 feet; Thence N 87° 38' 49" W 370.41 feet; Thence N 33° 54' 23" W 375.66 feet; Thence S 84° 31' 05" W 295.61 feet; Thence N 40° 38' 28" E 387.01 feet; Thence N 35° 57' 34" E 293.06 feet; Thence N 55° 25' 03" E 199.29 feet; Thence N 78° 23' 36" E 405.37 feet; Thence N 76° 43' 45" E 373.27 feet; Thence S 48° 05' 52" E 340.65 feet; to the TRUE POINT OF BEGINNING. Containing 104.66 acres.

PIPE RACK

A pipe rack in Sections 33 and 34 of Township 48 North, Range 17 West, New Mexico Principal Meridian.

Commencing at the Northwest corner of said Section 33 whence the Southwest corner of Section 33 bears S 0° 10' 16" W; Thence S 2° 25' 00" E 2304.91 feet to the TRUE POINT OF BEGINNING; Thence S 38° 16' 27" W 390.33 feet.

PIPELINE 1

A pipeline crossing the San Miguel River in Section 33 Township 48 North, Range 17 West, New Mexico, Principal Meridian.

Commencing at the Northeast corner of said Section 33 whence the Southeast corner of Section 33 bears S 0° 10' 16" W; Thence S 65° 56' 08" W 934.49 feet to the TRUE POINT OF BEGINNING; Thence S 1° 10' 10" E 111.18 feet.

PIPELINE 2

A pipeline crossing the San Miguel River in Section 34, Township 48 North, Range 17 West, New Mexico Principal Meridian.

Commencing at the Northwest corner of said Section 34 whence the Southwest corner of Section 34 bears S 0° 10' 16" W; Thence S 20° 18' 12" E 1843.08 feet to the TRUE POINT OF BEGINNING; Thence S 23° 55' 27" W 231.60 feet.

PIPELINE 3

A pipeline crossing the San Miguel River in Section 34, Township 48 North, Range 17 West, New Mexico Principal Meridian.

Commencing at the Northwest corner of said Section 34 whence the Southwest corner of Section 34 bears S 0° 10' 16" W; Thence S 30° 01' 55" E 2614.84 feet to the TRUE POINT OF BEGINNING; Thence S 58° 29' 26" W 77.30 feet.

Annex B

FORMAT FOR REPORTING MONITORING DATA

0. Headnotes

   a. This table is not a complete list of data to be reported.

   b. Error estimate should be calculated at 95% confidence level, based on counting error and other sources of random error. Significant systematic error should be reported separately.

   c. All calculations of lower limits of detection (LLD) and percentages of maximum permissible concentration (MPC) should be included as supplemental information.

1. STACK SAMPLES

   For each sample analyzed, report the following information:

   a. Date sample was collected
   b. Location of sample collection
   c. Stack flow rate (m^3/sec)

Radionuclide	Concentration (uCi/ml)	Error Estimate (uCi/ml)	LLD (uCi/ml)
U-nat			
Th-230			
Ra-226			
Pb-210			

Radionuclide	Release Rate (Ci/qtr)	Error Estimate (Ci/qtr)
U-nat		
Th-230		
Ra-226		
Pb-210		

FORMAT FOR REPORTING MONITORING DATA

2. AIR SAMPLES

For each sample analyzed, report the following information:

a. Date sample was collected
b. Location of sample collection

Radionuclide	Concentration (uCi/ml)	Error Estimate (uCi/ml)	LLD (uCi/ml)	% MPC
U-nat				
Th-230				
Ra-226				
Pb-210				
Rn-222				

3. LIQUID SAMPLES

For each sample analyzed, report the following information:

a. Date sample was collected
b. Location of sample collection
c. Type of sample (for example: surface, ground, drinking, stock, or irrigation)

Radionuclide	Concentration (uCi/ml)	Error Estimate (uCi/ml)	LLD (uCi/ml)
U-nat			
(dissolved)			
(suspended)*			
Th-230			
(dissolved)			
(suspended)*			
Ra-226			
(dissolved)			
(suspended)*			
Pb-210			
(dissolved)			
(suspended)*			
Po-210			
(dissolved)			
(suspended)*			

* Not all samples must be analyzed for suspended radionuclides.

FORMAT FOR REPORTING MONITORING DATA

4. VEGETATION, FOOD, AND FISH SAMPLES

For each sample analyzed, report the following information:

a. Date sample was collected
b. Location of sample collection
c. Type of sample and portion analyzed

Radionuclide	Concentration (uCi/kg wet)	Error Estimate (uCi/kg)	LLD (uCi/kg)
U-nat			
Th-230			
Ra-226			
Pb-210			
Po-210			

5. SOIL AND SEDIMENT SAMPLES

For each sample analyzed, report the following information:

a. Date sample was collected
b. Location of sample collection
c. Type of sample and portion analyzed

Radionuclide	Concentration (uCi/g)	Error Estimate (uCi/g)	LLD (uCi/g)
U-nat			
Th-230			
Ra-226			
Pb-210			
Po-210			

6. DIRECT RADIATION MEASUREMENTS

For each measurement, report the dates covered by the measurement and the following information:

Location	Exposure Rate (mR/qr)	Error Estimate (mR/qr)

FORMAT FOR REPORTING MONITORING DATA

7. RADON MEASUREMENTS

Without in any way modifying or altering the monitoring requirements under the license, the following format is provided for use in reporting any information required by the license. For each measurement, report the dates covered by the measurement and the following information:

	Flux Rate		Progeny		Gas	
Location	(pCi/m^2-sec)	Error	WL	Error	pCi/L	Error

8. Non-Radiological Measurement

All routine and/or required non-radiological measurements (e.g., for liquid samples: pH, electrical conductivity, total dissolved solids, total suspended solids, Cl^-, $SO_4^=$, etc.) are also to be reported in an appropriate format.

Annex C

DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR RADIOACTIVE MATERIAL

These instructions in conjunction with Table I specify the radioactivity and radiation exposure rate limits which are to be used in accomplishing the decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table I do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control will be considered on a case-by-case basis.

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, constuction, 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 Department 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 Radiation Control Division, Colorado Department of Health. 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 finding of the survey in units specified in the instruction.

Following review of the report, the Department will visit the facilities to confirm the survey.

TABLE I: ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES a	AVERAGE b c f	MAXIMUM b d f	REMOVABLE b e f
Alpha emissions from U-nat, U-235, U-238, and associated decay products	5,000 dpm per 100 cm^2	15,000 dpm per 100 cm^2	1,000 dpm per 100 cm^2
Alpha emissions from Ra-226, Ra-228 Th-230, Th-228, Ac-227	100 dpm per 100 cm^2	300 dpm per 100 cm^2	20 dpm per 100 cm^2
Alpha emissions from Th-nat, Th-232, Ra-223, Ra-224, U-232	1,000 dpm per 100 cm^2	3,000 dpm per 100 cm^2	200 dpm per 100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except others noted above.	5,000 dpm per 100 cm^2	15,000 dpm per 100 cm^2	1,000 dpm per 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 surface area, the average should be derived for each such object.

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

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

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 milligrams per square centimeter of total absorber.

Annex D

Lower Limits of Detection (LLD) for Sample Analysis

U-natural, Th-230, Ra-226 in air	1×10^{-16} uCi/ml
Pb-210 in air	2×10^{-15} uCi/ml
Rn-222	2×10^{-10} uCi/ml
U-natural, Th-230, Ra-226 in water	2×10^{-10} uCi/ml
Po-210 in water	1×10^{-9} uCi/ml
Pb-210 in water	1×10^{-9} uCi/ml
U-natural, Th-230, Ra-226, Pb-210 in soil and sediment (dry)	2×10^{-7} uCi/g
U-natural, Th-230 in vegetation, food, and fish (wet)	2×10^{-7} uCi/kg
Ra-226 in vegetation, food, and fish (wet)	5×10^{-8} uCi/kg
Po-210, Pb-210 in vegetation, food, and fish (wet)	1×10^{-6} uCi/kg

Annex E

Monitoring Requirements for Club Mesa Repositories

Consistent with the Consent Decree and LC 11.1 and as stated in LC 11.6, the monitoring program for Club Mesa involves the surveillance of Tailings Piles 1, 2, and 3, the crystal disposal area, and conditions beneath the mesa. Reports on the Club Mesa monitoring program will address the key factors and components described in the following sections.

Tailings Ponds 1, 2, and 3

The monitoring program for the Club Mesa Tailings Piles is designed to provide information on the phreatic levels in the pile, to ascertain settlement rates and amounts, provide data on stability and erosion of the protective cover, and to determine the rate and impact of cliff retreat. To determine these factors the tailings pile monitoring system is divided into four parts: 1) piezometers, 2) surface movement monuments, 3) erosion monuments, and 4) visual inspection/aerial photography. Ground water monitoring for Club Mesa is described in LC 11.1 and includes seepage monitoring for Tailings Piles 1, 2, and 3.

Piezometers: Piezometers are or are to be installed within the tailings piles at the locations shown in Drawing C-102 (00-831216-03) or alternative locations authorized in LC 11.3. These piezometers are to be designed in accordance with information provided in drawing C-107 (00-831216-03). Generally, the piezometers will monitor the change in fluid levels in the piles at the crest of the rock fill buttress, on the embankment face, and on the retirement crest.

Subject to final approval in LC 11.3, eleven (11) piezometers will be used on Tailings Pile 1-2 and nine (9) piezometers will monitor Tailings Pile 3. Readings from the piezometers will be at least every year until the tailings piles no longer contain free liquids as determined by two successive readings.

Data collected from the piezometers should be used to aid in estimating tailings pile settlement (consolidation) and determining when the toe drain system can be abandoned. Additionally, the monitoring of the piezometers should be used to determine if the reclamation plan is operating as proposed. When all necessary information has been obtained, the piezometers should be properly plugged with a bentonite slurry.

Surface Movement Monuments: Subject to final approval in LC 11.3, surface movement monuments are to be installed on the top and sides of the tailings ponds according to Drawing C-102 and designed according to Drawing C-107 (00-831216-03). An additional monument will be used to more fully establish the post-reclamation settlement, erosion, and to determine the amount of movement of the embankments.

Thirteen (13) monuments are set for Tailings Pile 1-2 and ten (10) monuments for Tailings Pile 3. These locations are at each piezometer installation as well as at additional locations on the reclaimed surface. Monuments currently in place will continue to be read at least every six months until the final reclamation cover is placed.

After final reclamation, the monuments will be surveyed for horizontal and vertical movements on an annual basis until the accumulated settlement is within 10% of total settlement estimated by the monitoring program. Data collected from the surface monuments should be used to determine the integrity and effectiveness of the reclamation cover by ascertaining the amount of settlement, erosion, and embankment movement.

Erosion Monuments: Erosion monitoring monuments will be installed along the mesa rim and in gully areas according to Drawings C-102 and C-107 (00-831216-03). These erosion monuments will be used to determine the amount and rate of gully erosion and cliff retreat in the subject area.

Fourteen (14) erosion monuments will be constructed, most of which will be near the mesa rim. These monuments will be surveyed and their location described. Additionally, the proximity to the cliff edge and other pertinent observations will be described and recorded. The monuments will be observed visually and surveyed, if necessary, during the long-term monitoring program. From these observations, the rate of cliff retreat should be determined and potential impact on the integrity of the disposal area assessed.

Visual Inspection and Aerial Photography: The surface monuments and reclamation cover will be visually inspected on an annual basis after reclamation has been completed. Detailed (large scale) stereoscopic aerial photographs of the tailings piles will also be taken after completion of the reclamation cover and drainage channels. Additional aerial photographs will be required only if the visual inspection indicates such a necessity.

In conjunction with observation of the surface monuments and reclamation cover, the runoff collection and diversion channels will be observed for evidence of erosion or debris and sediment accumulation. These observations will be made at the same time as the monitoring of the erosion monuments.

Crystal Disposal Area

Final plans and specifications in LC 11.2 and LC 11.3 for the new disposal area for crystals located on Club Mesa will include a method to determine settlement, dissolution, and erosion of the reclaimed area, including the number and location of surface monuments, erosion monuments, aerial photographs and visual inspection schedule.

8.0 FINANCIAL ASSURANCE ARRANGEMENTS

Excerpted below is Section XVII of the Consent Decree, Order, Judgement, and Reference to a Special Master Filed in the United States District Court, Civil Action No. 83C2384, State of Colorado, Plaintiff, vs. Union Carbide Corporation, A New York Corporation, and Umetco Minerals Corporation, a Delaware Corporation, Defendants.

8.1 DECOMMISSIONING, DECONTAMINATION, AND RECLAMATION

XVII. Surety for Performance

A. Within 90 days of the effective date of this Consent Decree, Defendants shall establish a restricted, single-purpose construction fund or account to be managed by the Defendants for the sole purpose of providing to the State financial surety for the Work. The sums to be maintained in the fund may be invested by Defendants in Eligible Investments as defined in Appendix IV, or in other investments previously approved by the State. The fund shall be subject to audit by the State for compliance with the restrictions and conditions established pursuant to this Section XVII. Defendants' payments into the construction account shall be on an incremental basis, described below. For purposes of the following subparagraphs, the projected costs referred to therein shall be projected by Defendants and shall be subject to review and approval by the State.

1. On or before April 10, 1987, following entry of this Consent Decree, initial funding shall occur in an amount equal to the projected cost of the required Work for the remainder of 1987, and the first quarter of 1988;

2. On or before April 10, 1988, a sum shall be added to the fund equal to the projected cost of the required Work for the last three quarters of 1988, calendar year 1989, and the first quarter of 1990;

3. On or before April 10, 1989, a sum shall be added to the fund equal to the projected cost of the required Work for the last three quarters of 1990 and the first quarter of 1991;

4. On or before April 10th of each succeeding year, a sum shall be added to the fund equal to the projected cost of the required Work in the next succeeding twelve calendar months for which the cost of Work has not yet been funded. This funding procedure shall be followed until the aggregate amount of the construction fund equals the net present value of the projected cost of remaining Work. At that point, Defendants may cease their annual contribution to the fund, and may make withdrawals from the fund as provided below, so long as the amount retained therein provides Full Surety to the State.

B. On and after April 10, 1989, Defendants must post and maintain Full Surety by: (i) compliance with Paragraphs A and C of this Section; or (ii) compliance with Paragraph D of this Section; or (iii) compliance with Paragraph E of this Section.

C. In addition to the requirements of Paragraph A, the Defendants, or either of them, shall, on or before April 10, 1989, furnish to the State a Securities and Exchange Commission Form 10-K if filed by the Defendants, or either of them, or, if not, a certified financial statement for either company's most recent fiscal year prepared by a licensed auditor and the unqualified opinion of an independent certified public accountant that the Defendants or either of them meet either the financial test described in subparagraph 1 below or the financial test described in subparagraph 2 below:

1. Either of the Defendants must have:

   (a) Two of the following three ratios: a ratio of total liabililties to net worth less than 2.0; a ratio of the sum of net income plus depreciation, depletion and amortization to total liabilities greater than 0.1; and a ratio of current assets to current liabilities greater than 1.5; and

   (b) Net working capital and tangible net worth each at least 6 times the current net present value of the remaining projected cost of Work; and

   (c) Tangible net worth of at least Ten Million Dollars ($10,000,000.00); and

   (d) Assets in the United States amounting to at least 90% of its total assets or at least 6 times the current net present value of the remaining projected cost of Work.

2. Either of the Defendants must have:

   (a) A current rating for its most recent bond issuance of AAA, AA, or A as issued by Standard and Poor's or Aaa, Aa, or A as issued by Moody's; and

   (b) Tangible net worth at least 6 times the current net present value of the remaining projected cost of Work; and

   (c) Tangible net worth of at least Ten Million Dollars ($10,000,000.00); and

   (d) Assets located in the United States amounting to at least 90% of its total assets or at least 6 times the sum of the current net present value of the remaining projected cost of the Work.

3. The accounting terms used in this Paragraph XVII(C) are defined in Appendix IV, which is attached herewith and incorporated by reference herein.

4. To maintain the agreement in effect, the Defendants, or either of them, shall, within 100 days after the end of each fiscal year, provide the most recent form 10-K or certified financial statement, and, in either case, an independent certified public accountant's opinion of continued compliance with the requirements of Paragraph XVII(C)(1) or XVII(C)(2).

5. If a Defendant files a Securities and Exchange Commission Form 8-K (change in financial condition) with the Securities and Exchange Commission, a copy shall be provided forthwith to the State. If neither Defendant is required to file Form 8-K, either Defendant shall report immediately to the State any change in financial condition which would be required to be reported by a company filing a form 8-K. If the State has reason to believe that neither Defendant no longer meets the requirements of Paragraphs XVII(C)(1) or XVII(C)(2), it shall require the Defendants to submit an updated independent certified public accountant's opinion at the end of the most recent fiscal quarter.

6. If, based upon the information described in Paragraph XVII(C)(5), the State determines that neither of the Defendants complies with the requirements of Paragraph XVII(C)(1) or XVII(C)(2), the State shall notify the Defendants by certified mail, which notice shall contain reasonably detailed written findings, and the noncomplying Defendants, or either of them, shall have thirty (30) days from receipt of notice in which to substitute an acceptable alternative surety arrangement, unless granted more time by the State for good cause or unless the Defendants have invoked the dispute resolution provisions of Sections XIII and XIV and obtained a stay of their obligations under this Paragraph C(6).

7. The provisions of this Paragraph C shall not apply when under Paragraph A(4) of this Section XVII, the amount of the construction fund contains the amount required to maintain Full Surety.

D. In the alternative to Paragraphs A and C, on or before April 10, 1989, the Defendants, or either of them, shall submit to the State a surety arrangement in the form of an irrevocable letter of credit, surety bond, certificate of insurance, other financial surety arrangement acceptable to the State, or combination thereof for the amount required to maintain Full Surety.

E. The Defendants, or either of them, may propose to the State, on April 10, 1989, or at any time thereafter, but not more frequently than once per twelve calendar month period, as an alternative to Paragraphs XVII(A) and (C), or as an alternative to Paragraph XVII(D), to attain and maintain Full Surety, a surety arrangement which may consist of any combination of the provisions of Paragraphs XVII(A), (C) and/or (D). The State shall respond to any such proposal with reasonably detailed findings not later than ninety (90) days from receipt of Defendants' proposal.

F. If the Defendants, or either of them, elect to furnish the surety arrangements described in Paragraph XVII(D) or (E) which are acceptable to the State, the provisions of Paragraphs XVII(A) and XVII(C) shall be rendered null and void and of no effect. The State, within thirty (30) days of notice from Defendants, shall confirm liquidation to the bank or other financial institution(s) holding the construction fund, with a copy to Defendants, to enable Defendants to liquidate the construction fund described in Paragraph XVII(A).

G. The amount necessary to attain Full Surety, and the adequacy of the financial assurance instruments under this Section XVII, shall be determined by CDH within one hundred twenty (120) days of the State's approval of plans and specifications submitted by Defendants pursuant to Section VI, Subpart One of this Consent Decree and annually thereafter following review by the State of proposed changes to cost estimates which shall be submitted to the State by the Defendants by June 30 of each year (commencing in 1989). The State shall complete its review and shall respond to such cost estimates within sixty (60) days of its receipt of such estimates. Cost estimates may be annually adjusted upward or downward as current circumstances, including, but not limited to, inflation and technology, require. Each such determination by CDH of the amount necessary to attain Full Surety and of the adequacy of the financial assurance instruments shall, together with the underlying calculations and rationale, be served upon Defendants. Each such determination shall be final and binding upon the Parties and Defendants shall have sixty (60) days in which to adjust the appropriate financial instruments, unless Defendants invoke the dispute resolution provisions of this Consent Decree within ten (10) working days after service by certified mail of such determination upon them.

H. The State shall be entitled to obtain monies from the construction fund and/or instruments established by this Section XVII upon tendering to Defendants and/or their surety(ies) a written demand for a sum certain signed by the Attorney General and the Executive Director of CDH, which demand asserts that (i) a condition at or from the Uravan Facility may present an imminent and substantial endangerment to the public health, welfare, or the environment and that Defendants have failed or refused to timely implement corrective actions deemed appropriate by the State; (ii) the Defendants have failed or refused to timely provide the demanded sum certain; and,

(iii) the demanded sum is necessary to the State's performance of the Work and/or appropriate corrective or mitigative actions. The existence of a condition which may present an imminent and substantial endangerment may be the subject of dispute resolution between the Parties as provided in Paragraph XVI(A); however, the actual existence of such a condition shall not be deemed or construed as a condition precedent to the surety's obligation to honor the State's demand for the sum certain. Monies obtained by the State prior to expenditure shall be retained in an escrow account as provided in Paragraphs J and K of this Section XVII.

I. Following the conclusion, favorable to the State, of any dispute resolution proceeding in which the State alleges that Defendants have failed to comply with any of their obligations imposed by this Consent Decree, the State shall be entitled to an order authorizing the State to obtain the sums determined necessary to the State's performance of all or part of the Work and/or appropriate corrective or mitigative actions from the construction fund and other instruments established by this Section. Monies obtained by the State prior to expenditure shall be retained in an escrow account as provided in Paragraphs J and K of this Section XVII.

J. If any portion of Full Surety being provided to the State is through a cash construction fund managed by Defendants and (i) neither Defendant makes deposits to such fund as and when required by this Section, or (ii) neither Defendant tenders to the State the amount demanded within fifteen (15) days following receipt of a demand by certified mail which complies with Paragraph H of this Section, then the Defendants shall transfer, unless a stay of such obligation has been granted through the dispute resolution provisions of Sections XIII or XIV, all monies in such construction fund into an escrow account with an independent third party agent selected by the Defendants and approved by the State, and shall add to the account the amount required to achieve Full Surety. Defendants shall give preference to a third party agent in Colorado, provided such agent is rated in one of the two highest categories by a nationally-recognized rating service. Administration of such escrow account shall be subject to the terms and conditions of this Consent Decree. In the event the Defendants fail or refuse to transfer the construction fund as and when required by this paragraph, the State shall be entitled, upon filing of a sworn certificate of such failure with this Court, to a Writ of Execution for the entire amount required to achieve Full Surety pursuant to Paragraph C(7) of this Section, which amount shall be deposited into an independent escrow account selected by the State.

K. In the event that an escrow fund is created pursuant to this Section XVII, the independent escrow agent shall invest and reinvest the principal and income of the fund and keep invested as a single fund, without distinction between principal and income in Eligible Investments as described in Appendix IV, or in other investments approved in advance by the Parties. In investing, reinvesting, exchanging, selling and managing the fund, the agent shall discharge his duties with respect to the fund solely in the interest of the Parties and with the care, skill, prudence and diligence under the circumstances then prevailing which persons of prudence, acting in a like capacity and familiar with such matters, would use in the conduct of an enterprise of a like character and with like aims. The agent shall provide quarterly statements to the parties regarding the status of the escrow fund.

L. All letters of credit, surety bonds, certificates of insurance and other financial instruments posted pursuant to this section shall contain a provision requiring direct payment to the State of the amount demanded up to the face amount of each such financial instrument within 15 days following (i) receipt of a demand by certified mail on the financial institution and on the Defendants which complies with Paragraph H of this Section or (ii) presentation by certified mail to Defendants and the financial institution of an order obtained pursuant to Paragraph I of this Section authorizing the State to obtain a sum certain and the State's certification that the Defendants have failed to pay to the State such sum certain as ordered. In the event that some or all of the Full Surety being provided to the State is in the form of financial tests pursuant to Paragraphs C or E of this Section, and the amount demanded by the State exceeds the surety available in other (i.e., non-financial test) forms pursuant to Paragraphs A, D, or E of this Section, then Defendants shall pay to the State within 15 days following the receipt of a written demand as provided by Paragraph H or I of this Section the full amount demanded less any amounts paid by other surety instruments. In the event the Defendants fail or refuse to pay such amount as and when required by this paragraph, the State shall be entitled, upon filing of a sworn certificate of such failure with this Court, to a Writ of Execution for the unpaid amount.

M. So long as Full Surety as annually determined pursuant to Paragraph G of this Section meeting the provisions of Paragraphs A and C, D, or E is maintained, Defendants shall be entitled to the withdrawal of funds or the reduction of the amount of any financial instrument in excess of Full Surety. If an escrow account has been established pursuant to this Section XVII, whenever the funds in such amount exceed Full Surety, Defendants, upon written notice to the State and the independent third party agent, may obtain the release of any funds in excess of Full Surety. Whenever under this Paragraph M the Defendants seek the withdrawal or release of funds, or a reduction in any financial instrument, the State shall, within thirty (30) days of notice from the Defendants, take any and all actions necessary to effect such withdrawal, release, or reduction in excess of Full Surety.

N. In the event the State obtains monies from the construction fund or other instruments established in accordance with Paragraph J to perform all or part of the Work and/or appropriate corrective or mitigative actions, the State three (3) months after initiation of the Work, and for every three (3) months period thereafter until completion, shall provide the Defendants with an accounting of expenditures and shall, upon completion, provide the Defendants with all unexpended monies, if any.

O. In projecting costs of the Work for purposes of this Section, Defendants shall include costs of mill decommissioning.

P. Upon determination by the State that the Work has been satisfactorily completed in accordance with Subpart Three of Section VI and Section XXXIII of this Consent Decree, and the License, and upon transfer of the site to the State or to the United States pursuant to the Uranium Mill Tailings Radiation Control Act of 1978, PL 95-604, 92 Stat. 3021, the Defendants shall be immediately released from their obligations to provide Surety for Performance as described in this Section, and the State shall taken any and all actions necessary to effect the withdrawal, release, transfer, or liquidation of any outstanding surety arrangement.

8.2 LONG TERM MONITORING AND MAINTENANCE

From Consent Decree, Section IV, COMMITMENTS OF PLAINTIFF AND DEFENDANTS:

G. Prior to petitioning the Court for termination of this Consent Decree pursuant to Section XXXIII, Defendants shall post a fund for Long Term Monitoring and Maintenance of the Uravan Facility as required by applicable law, such fund to be based upon an assumed real rate of return of 2% per annum provided that Defendants can demonstrate such assumed rate of return is appropriate.

9.0 SPRING CREEK MESA GEOTECHNICAL AND GEOHYDROLOGICAL REPORT

9.1 GEOLOGY

Stratigraphy: The stratigraphic section beneath Spring Creek Mesa is composed of approximately 18,400 feet of relatively flat-lying sedimentary rocks of Paleozoic and Mesozoic age. About 1,700 feet of Mesozoic sandstones, mudstones, and shales overlie about 16,700 feet of Paleozoic sandstones, carbonates, evaporites, and shales (Figure 5.2-2). The sedimentary section overlies Precambrian crystalline basement rock and is overlain by a thin veneer of soil and colluvium.

Based on ground water observation wells on the mesa and outcrops around the mesa flanks, the following stratigraphic sequence was determine to underlie the Spring Creek Mesa site. The Dakota Sandstone forms the top of the Spring Creek Mesa site. The Dakota in this area ranges from about 70 to 150 feet thick and some of the formation has been removed by erosion along the mesa rim. The Dakota is primarily sandstone with interstratified lenses of siltsone and claystone. Carbonaceous mudstone with some thin coal seams is present in the Dakota. These carbonaceous zones occur as local discontinuous lenses but an apparently continuous carbonaceous zone from 20 to 50 feet thick is present near the base of the Dakota on Spring Creek Mesa. The Dakota is a coastal plain deposit and disconformably overlies the Burro Canyon Formation. Cater (1970) (55G-700000) reports that sandstone samples from the Dakota are mostly quartz with lesser amounts of chert, feldspars and accessory minerals. The sandstone is cemented primarily with silica and lesser amounts of calcite.

The Burro Canyon Formation disconformably underlies the Dakota and crops out along the mesa rim. The Burro Canyon ranges from about 70 to 140 feet thick and is sandstone with interstratified lenses of siltstone, claystone, and some pebble conglomerate lenses. Burro Canyon sandstones represent flood plain deposits and conformably overlye the Brushy Basin member of the Morrison Formation. In places, the Burro Canyon intertongues with the Brushy Basin. Cater (1970) (55G-700000) reports that sandstone samples from the Burro Canyon Formation are mostly quartz with lesser amounts of chert, feldspars and accessory minerals. The sandstone is cemented primarily with silica and lesser amounts of calcite.

Total thickness of the Dakota Sandstone and Burro Canyon Formation on Spring Creek Mesa ranges from about 150 to 290 feet. Below the proposed tailings and effluent impoundment site, the average thickness of these formations is about 220 feet.

The underlying Morrison Formation, which is about 730 feet thick, is divided into two members. The upper Brushy Basin member is about 430 feet thick and is made up largely of variegated bentonitic mudstone but includes some sandstone and conglomerate lenses. The underlying Salt Wash Member is about 300 feet thick. Sandstone lenses become more numerous and thicker in the Salt Wash and are interstratified with variegated mudstone. The Morrison Formation is underlain by the Summerville Formation, which consists of about 80 feet of red, gray, green and brown, thinly bedded, sandy shale and mudstone. The underlying Entrada Sandstone, which is about 185 feet thick, is an orange, buff and white, fine grained, massive sandstone.

The mesa top is generally covered by one to twenty feet of soil deposits of alluvial, eolian, and residual origins. The alluvium is made up of reddish-brown, stratified, silty sandy clays to clayey sands with scattered sandstone and shale gravel. In places, the alluvium is overlain by thin, reddish-brown, sandy silt and clay eolian deposits. Residual sandy clays have developed in areas where claystone bedrock is near the ground surface, and silty sand residual soils have developed on the near-surface sandstones. Colluvium occurs between bedrock outcrops around the mesa rim and is generally made up of a surface layer of angular sandstone blocks. At depth, the colluvium generally has a sandy clay matrix.

Geomorphology: Spring Creek Mesa is the result of downcutting of the San Miguel River, Atkinson Creek, Spring Creek, and Tabeguache Creek. The mesa top is formed of erosionally resistant beds of Dakota Sandstone and the Burro Canyon Formation. The steep sides of the mesa are formed of the less resistant beds in the Morrison and Summerville Formations. About two hundred feet above the valley bottom of the San Miguel River, the resistant sandstone of the Entrada Formation forms cliffs. Along the river, downcutting has reached the Kayenta Formation. Dissection along the principal tributaries bordering the mesa have not cut below the Brushy Basin Member of the Morrison Formation except in areas near their confluence with the San Miguel. There is about 900 feet of relief between the mesa top and the valley bottom of the San Miguel River.

Based on past long-term down-cutting rates observed in the Colorado River system, it is estimated that incision of the San Miguel River through the Spring Creek Mesa caprock and the onset of mesa rim retreat probably took place about two to five million years ago. Judging from the amount of mesa rim retreat which has occured in the Spring Creek Mesa area since this time, the following long-term maximum rim retreat rates can be estimated. A maximum rate for mesa rims adjacent to San Miguel River tributaries is about three feet (1 m) per thousand years. A maximum rate for mesa rims adjacent to the San Miguel River is about four feet (1.2 m) per thousand years. A maximum rate for mesa rims in areas where drainages, which head on the mesas, cross the rims is about five feet (1.5 m) per thousand years.

At its closest points, the Spring Creek Mesa rim is about 200 feet from the proposed tailings and effluent impoundment. Considering the maximum estimated rim retreat rates, it would take over 50,000 years for general rim retreat to impact the facility. Actual erosion rates could be less but caution must be used in the gully areas regarding possible erosion.

Structure: Spring Creek Mesa is located near the boundary of the Paradox Basin and the Uncompangre Uplift. The northwest-trending axis of the Nucla Syncline crosses through the mesa. The syncline is a broad, open fold of low amplitude. At the site, the syncline axis strikes N50oW. Bedding generally dips toward the axis. To the southwest of the mesa, bedding rises gently from the syncline at about two to seven degrees and merges with the northeastern limb of the Paradox Valley Anticline. To the northwest of the mesa, bedding rises at two to seven degrees and merges with the southwestern limb of the Uncompahgre Uplift.

Three sets of joints in the Dakota Sandstone appear to be directly related to the stresses that produces the folding of the Nucla Syncline. The primary and best developed set strikes northwest, parallel to the strike of the syncline. Dips in this set are nearly vertical. The second set, also nearly vertical, runs northeast at nearly right angles to the first set. The third set is parallel to the bedding of the sedimentary rocks. Spacing of individual joints varies from a few inches to up to twenty feet. On the mesa top, separation of the joints ranges from closed to 0.5 cm. Around the mesa rim, separation is up to several feet.

Although faulting is rare in the Nucla Syncline, two small northwest striking normal faults cross the mesa parallel to the syncline axis along the southwest limb. The northern most fault crosses the western part of Spring Creek Mesa. It extends about 2.3 miles to the north, across Atkinson Creek and terminates at the south end of Atkinson Mesa. On Spring Creek Mesa, the fault displaces the Dakota by about three feet. Displacement on Atkinson Mesa is about ten feet. The fault strikes N15oW and dips 45oSW. Based on stratigraphic evidence, the fault is not considered to be potentially active.

The closest fault to Spring Creek Mesa that is considered to be potentially active is seven miles to the east. This fault is the longest of the Uncompangre faults. It is expected that a maximum credible earthquake of 5.7-6.9 on this fault would produce site intensities at Spring Creek mesa of VII to IX.

9.2 HYDROGEOLOGY

Groundwater in the Spring Creek Mesa area occurs in three water-bearing zones: the Dakota Sandstone, the Burro Canyon Formation, and the Salt Wash Member of the Morrison Formation. Additionally, portions of the Brushy Basin member of the Morrison Formation are saturated and will yield small amounts of water. This discussion, however, excludes any regional aquifers below the Morrison Formation such as the Entrada and Kayante-Wingate formations. The Burro Canyon and Salt Wash Formations are separated by an aquitard, the Brushy Basin member of the Morrison Formation. Groundwater which occurs in the Dakota and Burro Canyon is of limited extent and quality, whereas the Salt Wash is a regional aquifer and is used locally as a water supply.

Dakota Sandstone: Dakota Sandstone on Spring Creek Mesa contains water only locally. The dominant portion of the Dakota Sandstone on Spring Creek Mesa does not appear to be saturated. A perennial spring, located about 100-200 feet northwest of H-26, discharges from the Dakota Sandstone at an elevation of 5745 feet. Although little information is available, the extent and thickness of any saturated zone in the Dakota is probably very sensitive to local precipitation. Recharge probably occurs in the upper reaches of the various gullies and on the Mesa top adjacent to these gullies. Therefore, any fluid movement, except vertical recharge to the underlying Burro Canyon Formation, is most likely limited to small flow systems near various gullies.

Dakota groundwater is a magnesium-sodium sulfate water with a Total Dissolved Solids (TDS) of 3510 mg/l. The high sulfate, 2300 mg/l, could be due to contact with carbonaceous material in the Dakota Sandstone. Only one sample, collected from the pond adjacent to H-26, is available from the Dakota Sandstone (00-840124:7). However, conductivities of 3800-4500 micromos/cm @25°C were recently measured in the spring area. The stock pond upstream of the spring was eliminated as a possible source of the spring water since it has a measured conductivity of 310 mirohos/cm@ 25°C.

Burro Canyon Formation: Burro Canyon groundwater is perched above the regional groundwater system by shales of the Brushy Basin member. The uppermost Brushy Basin appears to be saturated (00-840124) and is included in the hydrostratigraphic unit called the Burro Canyon perched aquifer. However, because there is some question as to the Burro Canyon-Brushy Basin contact, as evidenced by differences in the contact "picks" by Chen and Associates and Envirologic, what appears to be saturated Brushy Basin could actually be Burro Canyon. In some cases, it is not known whether the monitoring holes penetrate the full saturated thickness of thewater-bearing zone. Field inspections of this contact in road custs demonstrates the interongoing relationship between the two units. Maroon and green shales, typical of the Brushy Basin, were observed between massive sandstones, typical of the Burro Canyon.

The approximate saturated thickness of the perched Burro Canyon aquifer varies from a few feet northeast and southwest of the proposed impoundment area to 68 feet (81 feet, if Chen data is used) at SCM-1. The axis of the U-shaped trough created by the saturated thickness contours trends to the northwest (00-840124: Plate 8). Although not redrawn for this report, Plate 8 depicts a reasonable representation of the saturated thickness. However, the zero line should be removed since this report considers the hydrostratigraphic unit rather than the formational rock units as the basis for defining the water-bearing zone. This approach will also cause the contours to spread laterally since, as an example, H-28 has a saturated thickness of between 4 and 16 feet, depending on whose data is used, whereas Plate 8 assumes zero saturated thickness.

The potentiometric surface map of the perched aquifer is shown in (00-840124: Plate 7). This map was drawn on the basis of average water level values rather than water levels measured at a specific point in time. This technique is valid in this area, since there does not appear to be any major water level fluctuations. However, a more acceptable method is to contour data measured as close to a single point in time as possible. Contouring data collected in October, 1983, resulted in a similar pattern as presented in Plate 7. Regardless of what data is used, a simpler interpretation of the data resulted in a contour pattern which eliminates the "saddle" in the center of the area, within the 5630 foot contour. Comparing the structure contour map (00-840124: Plate 1) of the Brushy Basin-Burro Canyon rock unit with the potentiometric surface map, indicates the "Saddle" may correspond to a slight rise or upward buldge in the contact in this area. The "simpler" pattern depicts groundwater flow from the mesa margins towards the center and then towards Blue Point Spring, with a minor reversal to the southeast around the gulch where a (unnumbered) major spring discharges from the Burro Canyon. Gradients vary from about .01 over much of the area to .003 along the west-central portion of the mesa, north of H-28.

Umetco reports that 5000 ac-ft are stored under saturated conditions in the Burro Canyon on Spring Creek Mesa (00-840124:4-5). Using nearly the same procedures and assuming saturated thicknesses as discussed previously in this report, a value of 6900 ac-ft was calculated. It is probably valid to assume that these values represent upper and lower limits for any "real"storage value. However, if the Burron Canyon-Brushy Basin contact is in significant error, 6900 ac ft would represent a miminum value.

Aquifer tests were performed in various wells on Spring Creek Mesa. Earlier tests in H-27 yielded poor results because of low yield. Low yield tests and/or slug tests were not attempted on these wells, but rather they were tested by standard pumping procedures which generally are not satisfactory for low yielding aquifers. An aquifer test performed in well SCM-1 resulted in reasonably good estimates of permeability. An independent analysis of Umetco data yielded transmissivity values which were 30 to 50 percent higher than those reported (00-830809:5), but are of the same order of magnitude and therefore, are comparable. This test yielded a permeability value of 16 gallons per day per square foot (gpd/ft2) or approximately 8 X 10^{-4} cm/sec. This compares reasonably well with packer test data and limited data from H-27.

Wells which were tested yielded one gallon per minute (gpm) or less, except SCM-1, which yielded approximately 3 gpm. A second test of SCM-1 at nearly 11 gpm appeared to dewater the well. A maximum flow rate has not been established in the vicinity of this well.

Water quality of Burro Canyon groundwater is highly variable on Spring Creek Mesa. However, the spatial distribution of the water quality is not unexpected within the flow regime for this aquifer. Burro Canyon water quality varies from a low of 640 mg/l (SCM-4) to a high of 2540 mg/l (SCM-2), total dissolved solids (TDS). The majority of the wells, primarily those located near the rim, have a TDS of 1000 mg/l or less. This water is considered to be of moderate quality. Two wells located very close to each other in the central portion of the mesa (SCM-2 and H-27) exhibit water qualities approaching the poor category (2000 mg/l TDS). SCM-1 has water quality intermediate to the first two groups (1400 mg/l TDS). Since well H-26 is completed in both the Burro Canyon and Dakota it is not possible to establish the Burro Canyon water quality at this location. The water quality observed in H-26 is probably of the shallow Dakota water (as exhibited by the spring near H-26) mixed with Burro Canyon water.

Either because of structural or stratigraphic controls or changes in permeability, the Burro Canyon potentiometric surface appears to flatten in the central part of the mesa. Whether this represents groundwater which is relatively stagnant is not known. However, it corresponds reasonably well with poorer quality water, suggesting possible stagnation. The only major anomaly on Spring Creek Mesa is the water quality of H-29 which is directly down gradient of all other wells and has a TDS of about 1000 mg/l. This water may represent dilution by lower TDS water from the southwest, but there is no direct evidence that significant water is available in this direction. Also, since only one analysis is available from this well, there is a possibility the TDS of 1000 mg/l is not representative. Even though the water level contours indicate the general gradient is in the direction of H-29, the relatively thin saturated thickness and possible lower TDS suggest that little water is actually moving into this area.

Present water quality data is not sufficient to determine seasonal variations to any degree of certainty.

Historic use of the Burro Canyon groundwater is limited to one wind-driven stock well in the central portion of the mesa and wildlife watering at the spring on the southeast side of the mesa. This well has been reported to supply stock water duirng the summer months, but occasionally runs dry. It is not known how much of the saturated zone is penetrated by this well.

Salt Wash Member: Salt Wash ground water is under confined conditions in the Spring Creek Mesa area. Monitoring wells on and adjacent to the mesa indicate the gradient is 0.25 to the southwest, towards the San Miguel River (00-821206:29). Salt Wash ground water is generally a sodium bicarbonate water type, sodium not always being the dominant cation. TDS ranges from 253 mg/l in the Tabequache water supply well to 1020 mg/l in H-30s, the Salt Wash monitor well near Blue Spring (00-821206:37).

Recharge/Discharge Relationships on Spring Creek Mesa: Development of a representative water budget for the mesa must consider the following observations.

1) Shape of the potentiometric surface.
2) Hydraulic gradient.
3) Topography vegetation, and precipitation patterns.
4) Permeability of the various units.
5) Areas of known discharge and recharge.

In addition to these observations, several processes must be considered.

1) Geologic control of probable flow paths.
2) Vertical flow from the Burro Canyon.
3) Infiltration.

The Burro Canyon potentiometric surface suggests ground water flow is toward the northwest, parallel to the synclinal axis. As discussed previously, the gradient is fairly uniform except in the central portion of the mesa where the gradient is relatively flat. Areas of discharge include the various springs and seeps which have been observed along the mesa rim, primarily to the northwest and southeast. The gulch north of SCM-1 is another probable area of discharge since the water surface elevation in SCM-1 is higher than the surrounding topography. Field inspection of this area identified general areas of seepage and salt encrustation, but the dominant discharge may be beneath colluvium which covers the north facing slopes beneath SCM-1. It is not possible to estimate probable discharge to the northwest because of its diffuse nature. Discharge to the southeast can be estimated, and appears to be in the few gallons per minute range, however much of the flow appears to occur as underflow, supporting lush vegetation.

Another source of discharge from the Burro Canyon is vertical flow into the Brushy Basin. Even though the Brushy Basin is of relatively low permeability, vertical flow is highly probable, albeit at a low rate per unit area. Reported permeabilities for the Brushy Basin range from 6 x 10^{-6} to 10^{-8} cm/sec. Using the assumptions provided in McWhorter (1984), calculated travel time for water to move vertically through 400 feet of Brushy Basin ranges from 1400 to 2500 years. However, this estimate does not consider the effects of vertical fractures. A field inspection identified well developed vertical fractures or joints in the Brushy Basin shales.

An estimate of total vertical flow over the area of saturated Burro Canyon can be calculated, using the same assumptions. Using a total area of 4457 acres where the Burro Canyon is saturated (Rouse, 1983), a total flow of about 150 gallons per minute is calculated. This should be considered as a minimum since these calculations do not account for possible errors in delineating the actual area of saturation.

Except for a narrow neck of land to the northeast, the mesa is completely dissected down through the Burro Canyon Formation, and therefore, essentially isolated hydrologically from surrounding areas. Using the measured permeability of the Burro Canyon, the average gradient from the potentiometric surface map, and the cross sectional area of the "neck", a maximum flow of 0.6 gpm can be calculated. This number agrees with calculations by Umetco (00-840124-14). However, field inspection of this neck suggests that it is highly unlikely that any water is moving laterally to the mesa from higher areas to the northeast. Gullies which cut completely through the Burro Canyon formation adjacent to this neck show no indication of ground water discharge.

Infiltration of precipitation is the only other source of recharge that can account for the observed and implied discharge from the mesa. Most of the recharge is probably a result of infiltration of snow melt when evapotranspiration rates are relatively low. The sandy surficial soils and level terrain enhance the potential for recharge which occurs mostly through fractures and joints in the Burro Canyon, based on visual inspection of outcrops. The occurrence of recharge undoubtedly is spatially and temporally variable, owing to fracture heterogeneity, topographic controls of infiltration, vegetation, and meteorological factors.

Based on visual inspection of the mesa and comparable studies reported in the literature, a net infiltration rate of 0.5 inches per year or about 5 percent of the available precipitation is assumed for the entire mesa. Even though actual infiltration is not uniform, it is not possible to quantify its variability, and therefore a uniform number is assumed. Also, since infiltration has not actually been measured on the mesa, there is some question as to what value is representative. Average annual infiltration is undoubtedly variable, but is certainly greater than zero and probably does not exceed 5 to 10 percent. An infiltration rate of 2-3 percent is probably realistic, however, an infiltration of 5 percent yields results which are close to those calculated for vertical flow through the Brushy Basin. A net contribution to the Burro Canyon of 125 GPM from percolation of 5 percent of net infiltration is calculated.

The major components of a mesa water budget are infiltration and vertical flow. Horizontal movement of water, both recharge and discharge, appear to be minimal, although actual dishcarge is difficult to estimate because of the low expected flows. Without infiltration, there is no source of recharge which can maintain the system as observed, with or without vertical flow.

9.3 SEEPAGE ANALYSIS

Two seepage models have been presented for the proposed facility on Spring Creek Mesa. The "Specific Retention Model" was presented in the Integrated Report (January 1984). A second model which has been called an "Alternative Hydrogeologic Model" was prepared by McWhorter (1984) for Umetco. A preliminary review of the specific retention model was incorporated in the PELRS document prepared by the Colorado Department of Health. Reviews of both models are presented as follows:

Specific Retention Model: The Specific Retention Model is an interpretation of a simplified seepage model presented by McWhorter and Nelson (1980). The one-dimensional model assumes that the foundation material beneath the impoundment acts as a homogeneous medium and seepage movement is vertical. The model also assumes that when the seepage front contact either an "impervious stratum or the phreatic surface of an aquifer," a groundwater mound will develop and rise towards the impoundment (Stage II flow).

Using the McWhorter-Nelson model as a framework, Umetco presents a seepage analysis of various liner configurations. McWhorter's Table 6-1 presents a summary of the expected seepage from the configurations. There are several assumptions used by Umetco in developing their analysis which are of concern to the Department. The correctness of these assumptions will have a significant impact on the results of this analysis and therefore the characterization of impacts due to seepage from the proposed facility. The Umetco assumptions are:

1) Infiltration does not occur to any significant degree on Spring Creek Mesa.

2) The foundation material beneath the impoundment behaves as a homogeneous medium and will result in only vertical movement.

3) The contaminated "plume" or slug will stop its vertical movement at the end of disposal (17 years) and will forever remain held in specific retention.

4) Time calculations for seepage at the canyon walls, should saturated flow occur, assumes that the saturated conditions will occur at the Brushy Basin-Burro Canyon contact and will therefore exit to the northwest at the contact exposure.

As discussed in the previous sections, the probability that infiltration does occur on the Mesa can be demonstrated; however, the precise amount remains unknown.

Considerable error is introduced into the seepage analysis by assuming vertical movement of the wetting front. A numerical simulation by Siegel and Stephens (1980) of seepage beneath lined ponds substantiates McWhorter and Nelson's work for one-dimensional flow beneath an impoundment when the foundation material behaves isotropically (the same in all directions). However, the simulation also indicates errors of as much as 50 percent in locating the wetting front when the foundation material is anisotropic and using McWhorter and Nelson's one-dimensional analysis. Field observations and inspection of borehole logs and core indicates the bedrock beneath the proposed impoundment to be anisotropic.

Siegal and Stephens (1980) have determined that the horizontal component of unsaturated flow becomes increasingly important with greater degrees of anisotropy. With a ratio of horizontal to vertical permeability of 20, nearly 50 percent of the unsaturated flow occurs horizontally beneath a lined impoundment. Under these conditions, evapotranspiration becomes an important component to the analysis and may actually reduce vertical movement of the wetting front.

In order to calculate maximum vertical movement, Umetco's consultants apparently used McWhorter and Nelson's time-distance equation for determining duration of Stage I flow. Aside from the isotropic-anisotropic conditions, it appears that it was assumed that at 17 years (the operational life of the facility) the plume would stop and used the McWhorter-Nelson equation to calculate the distance. This does not consider continued seepage from the still saturated tails nor does it consider infiltration. The contaminated plume may continue to vertically migrate until it reaches the saturated zone and begin to mix with Burro Canyon water. The arrival time can be estimated by using McWhorter's 1-dimensional analysis, but again, it does not consider horizontal movement.

Umetco's consultants calculated a hypothetical travel time of a contaminated plume to the canyon walls. This calculation assumed that saturated flow would only occur at the Brushy Basin-Burro Canyon contact and that any contaminated flow would travel the maximum down-gradient distance to the mesa rim. However, considering the potential for horizontal movement because of anisotropic conditions, breakthrough to the atmosphere of contaminated fluids could occur in very short distances from the impoundment perimeter in several gullies. The direction of flow in the Burro Canyon aquifer is immaterial to potential flow directions of the unsaturated or saturated contaminated liquid.

Alternative Hydrogeologic Model: Dr. McWhorter's alternative approach to contaminant modelling involves the application of a lumped parameter model to the perched aquifer. In this approach the seepage is assumed to mix instantly and completely with water already in the aquifer. The volume within which mixing occurs was assumed to be limited to areas underlain by stream tubes which passed beneath the impoundments. McWhorter assumed a saturated thickness between 18-30 feet and a 20 percent porosity. Should contamination of the perched aquifer occur, there would most likely be a plume of limited areal extent that would mix only slowly with native water in the aquifer. Therefore, actual concentrations could be significantly greater locally, in comparison to the lumped parameter results for average concentrations in the aquifer. The calculations indicate peak concentrations occur after the seepage held in "specific retention" is displaced from the vadose zone, i.e. using equation 2. It was found that the effect of a five-fold reduction in recharge rate (infiltration), from 0.05 to 0.01 feet per year, causes approximately a two-fold reduction in the peak concentration and a delay in the peak on the order of a few hundred years, using his approach. The significance of the predicted concentrations should have addressed in the report.

The effect of seepage on the lateral spreading of the perched aquifer and influence of capillarity were addressed in another study by Dr. McWhorter. In general, independent calculations support his report when the same hydrologic parameters are assumed. His analysis of mounding, however, is sensitive to the permeability of the shales within the Burro Canyon; if the Burro Canyon shales have a permeability equal to the Brushy Basin shales, the lateral seepage could extend 4000 feet from the center part of the impoundment complex, assuming that complex is a circle. If the impoundment complex is better approximated as a rectangle, then it can be estimated that perched conditions could extend about 3800 feet form the long axis of the impoundment, using his assumed values for leakage.

10.0 RADIATION RULES WHICH APPLY DIRECTLY TO URANIUM MILLS

10.1 GENERAL REQUIREMENTS FOR ANY SPECIFIC RADIOACTIVE MATERIALS LICENSE

Part III of Colorado's "Rules and Regulations Pertaining to Radiation Control" contains key provisions pertaining to issuance of a license. RH 3.9.1, 3.9.2 and 3.9.3 apply to any license. RH 3.9.4, 3.9.5, and 3.9.6 apply in particular for a source material mill license.

A license application will be approved if the Department determines that:

3.9.1 The applicant is qualified by reason of training and experience to use the material in question for the purpose requested...;

3.9.2 The applicant's proposed equipment, facilities, and procedures are adequate...;

3.9.3 The issuance of the license will not be inimical to the health and safety of the public;

3.9.4 Financial surety is furnished to ensure protection of public health and safety in the event of abandonment, default, or inability to meet requirements;

3.9.5 A long term monitoring and maintenance fund is provided;

3.9.6 For any activity which the Department determines will significantly affect the quality of the human environment... the Department has concluded that the action called for is the issuance of the proposed license with any appropriate conditions to protect environmental values.

The basis of determination is information filed and evaluation of the short-term and long-range environmental impact, weighing environmental, economic, technical and other benefits against environmental costs, while considering available alternatives.

10.2 SPECIAL REQUIREMENTS FOR ISSUANCE OF SPECIFIC LICENSES FOR SOURCE MATERIAL MILLING

Part III of the Radiation Rules contains the following specific provisions regarding licenses for source material milling.

3.10.6 Special Requirements for Issuance of Specific Licenses For Source Material Milling

In addition to the requirements set forth in RH 3.8 and 3.9, a specific license for source material milling will be issued if the applicant submits to the Department a satisfactory application as described herein and meets the other conditions specified below:

3.10.6.1 An application for a license to receive, possess, and use source material for milling or byproduct material as defined in RH 1.6 shall address the following:

3.10.6.1.1 Description of the proposed project or action.

3.10.6.1.2 Area/site characteristics including geology, topography, hydrology and meteorology.

3.10.6.1.3 Radiological and nonradiological impacts of the proposed project or action, including waterway and groundwater impacts.

3.10.6.1.4 Environmental effects of accidents.

3.10.6.1.5 Tailings disposal and decommissioning.

3.10.6.1.6 Site and project alternatives.

3.10.6.2 During any one full year prior to any major site construction, a preoperational monitoring program shall be conducted to provide complete baseline data on a milling site and its environs. Throughout the construction and operating phases of the mill, an operational monitoring program shall be conducted to measure or evaluate compliance with applicable standards and regulations, to evaluate environmental impacts of operation, and to detect potential long-term effects.

3.10.6.3 Prior to issuance of the license, the mill operator shall (1) establish financial surety arrangements, as provided by 3.9.4.1, to ensure decontamination and decommissioning of the facility and (2) provide a fund adequate to cover the payment of the cost for long term care and monitoring as provided by 3.9.5.2. Such fund shall be sufficient to meet the requirements of 3.9.5.4.2. The Department will consider proposals to combine the two types of financial assurance.

3.10.6.4 The applicant shall provide procedures describing the means employed to meet the following requirements during the operational phase of any project.

3.10.6.4.1 Milling operations shall be conducted so that all effluent releases are reduced to as low as is reasonably achieveable below the limits of Part IV.

3.10.6.4.2 The mill operator shall conduct at least daily inspection of any tailings or waste retention systems. The inspection shall be performed by a person who is qualified and approved by the Department. Records of such inspections shall be maintained for review by the Department.

3.10.6.4.3 The mill operator shall immediately notify the Department of the following:

3.10.6.4.3.1 Any failure in a tailings or waste retention system which results in a release of tailings or waste into uncontrolled areas; and

3.10.6.4.3.2 Any unusual conditions, which are not contemplated in the design of the retention system which if not corrected could lead to failure of the system and result in a release of tailings or waste into uncontrolled areas.

3.10.6.5 An application for a license to receive, possess and use byproduct material relating to tailings or waste disposal as defined in RH 1.6 shall contain proposed specifications relating to the emissions control and disposition of the byproduct material to achieve the requirements and objectives set forth in the criteria listed in Schedule E. Each application for a new license or for license renewal must clearly demonstrate how the requirements and objectives set forth in Schedule E have been addressed. Failure to clearly demonstrate how the requirements and objectives in Schedule E have been addressed shall be grounds for refusing to accept an application.

10.3 CRITERIA RELATED TO THE DISPOSITION OF RADIOACTIVE TAILINGS OR WASTES

Part III, Schedule E, of the Radiation Rules specifically provides detailed technical criteria which apply to source material mill tailings or wastes.

INTRODUCTION - Each applicant for a license to possess and use radioactive material in conjunction with milling, or sites formerly associated with such milling, is required to include in a license application proposed specifications relating to the milling operation and the disposition of tailings or waste resulting from such milling activities. This schedule establishes criteria relating to the siting, operation, decontamination, decommissioning, and reclamation of mills and tailings or waste systems and sites at which such mills and systems are located and site and radioactive material ownership. Applications must clearly demonstrate how these criteria have been addressed. The specifications shall be developed considering the expected full capacity of tailings or waste systems and the lifetime of mill operations. Where later expansions of systems or operations may be likely, the amendability of the disposal system to accommodate increased capacities without degradation in long-term stability and other performance factors shall be evaluated.

As used in this Appendix, the term "as low as reasonably achievable" has the same meaning as in 4.1.2.

CRITERION 1

(a) In selecting alternative tailings disposal sites or judging the adequacy of existing tailings sites, the following site features which would assure meeting the broad objective of isolating the tailings and associated contaminants from man and the environment in the short term and for thousands of years without ongoing active maintenance shall be considered:

(1) Remoteness from populated areas;

(2) Hydrogeologic and other environmental conditions conducive to continued immobilization and isolation of contaminants from usable groundwater sources; and

(3) Potential for minimizing erosion, disturbance, and dispersion by natural forces over the long term.

(b) The site selection process shall be an optimization to the maximum extent reasonably achievable in terms of these features.

(c) In the selection of disposal sites, primary emphasis shall be given to isolation of tailings or wastes, a matter having long-term impacts, as opposed to consideration only of short-term convenience or benefits, such as minimization of transportation or land acquisition costs. While isolation of tailings will be a function of both site characteristics and engineering design, overriding consideration shall be given to siting features given the long-term nature of the tailings hazards.

(d) Tailings shall be disposed of in a manner that will require no active maintenance to preserve the condition of the site.

CRITERION 2 - To avoid proliferation of small waste disposal sites, radioactive material from in-situ extraction operations, such as residues from solution evaporation or contaminated control processes, and wastes from small remote above ground extraction operations shall preferably be disposed of at existing large mill tailings disposal sites; unless, considering the nature of the wastes, such as their volume and specific activity and the costs and environmental impacts of transporting the wastes to a large disposal site, such offsite disposal is demonstrated to be impracticable or the advantage of onsite burial clearly outweigh the benefits of reducing the perpetual surveillance obligations.

CRITERION 3 - The "prime option" for disposal of tailings is placement below grade, in specially excavated pits. The evaluation of alternative sites and disposal methods performed by mill operators in support of their proposed tailings disposal program shall reflect serious consideration of the disposal mode. In some instances below-grade disposal may not be the most environmentally sound approach, such as might be the case if a high quality groundwater formation is relatively close to the surface or not very well isolated by overlying soils and rock. Also, geologic and topographic conditions might make full, below-grade burial impracticable. Where full below-grade burial is not practicable, the size of retention structures, and size and steepness of slopes of associated exposed embankments, shall be minimized by excavation to the maximum extent reasonably achievable or appropriate given the geologic and hydrogeologic conditions at a site. In these cases, it must be demonstrated that an above-grade disposal program will provide reasonably equivalent isolation of the tailings from natural erosional forces.

CRITERION 4 - The following site and design criteria shall be adhered to whether tailings or wastes are disposed of above or below grade:

(a) Upstream rainfall catchment areas must be minimized to decrease erosion potential and the size of the maximum possible flood.

(b) Topographic features shall provide good wind protection.

(c) Embankment and cover slopes shall be relatively flat after final stabilization to minimize erosion potential and provide conservative factors of safety assuring long-term stability. The broad objective should be to contour final slopes to grades which are as close as possible to these which would be provided if tailings were disposed of below grade; this could, for example, lead to slopes of about 10 horizontal to 1 vertical (10h:1v) or less steep. In general, slopes should not be steeper than about 5h:1v. Where steeper slopes are proposed, reasons why a slope less steep would be impracticable should be provided, and compensating factors and conditions which make such slopes acceptable should be identified.

(d) A full self-sustaining vegetative cover shall be established or rock cover employed to reduce wind and water erosion to negligible levels.

(1) Where a full vegetative cover is not likely to be self-sustaining due to climatic conditions, such as in semi-arid and arid regions, rock cover shall be employed on slopes of the impoundment system.

(2) The following factors shall be considered in establishing the final rock cover design to avoid displacement of rock particles by human and animal traffic or by natural processes, and to preclude undercutting and piping:

((a)) Shape, size, composition, gradation of rock particles, excepting bedding material, average particle size shall be at least cobble size or greater;

((b)) Rock cover thickness and zoning of particles by size; and

((c)) Steepness of underlying slopes.

(3) Individual rock fragments shall be dense, sound, and resistant to abration, and shall be free from cracks, seams, and other defects that would tend to unduly increase their destruction by water and frost actions. Weak, friable, or laminated aggregate shall not be used. Shale, rock laminated with shale, and cherts shall not be used.

(4) Rock covering of slopes may not be required where top covers are very thick, on the order of 10 meters or greater; impoundment slopes are very gentle on the order of 10H:1V or less; bulk cover materials have inherently favorable erosion resistance characteristics; and there is negligible drainage catchment area upstream of the pile, and there is good wind protection as described in points (a) and (b) of this criterion.

(5) Furthermore, all impoundment surfaces shall be contoured to avoid areas of concentrated surface runoff or abrupt or sharp changes in slope gradient. In addition to rock cover on slopes, areas toward which surface runoff might be directed shall be well protected with substantial rock cover or rip rap. In addition to providing for stability of the impoundment systems itself, overall stability, erosion potential, and geomorphology of surrounding terrain shall be evaluated to assure that there are no ongoing or potential processes, such as gully erosion, which would lead to impoundment instability.

(e) The impoundment shall not be located near a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand. As used in this criterion, the term "capable fault" has the same meaning as defined in Section III (g) of Appendix A of 10 CFR Part 100. The term "maximum credible earthquake" means that earthquake which would cause the maximum vibratory ground motion based upon an evaluation of earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material.

(f) The impoundment, where feasible, should be designed to incorporate features which will promote deposition. For example, design features which promote deposition of sediment suspended in any runoff which flows into the impoundment area might be utilized; the object of such a design feature would be to enhance the thickness of cover over time.

CRITERION 5

(a) In no case shall seepage of toxic and radioactive materials result in significant pollution. The terms "significant pollution" means deterioration of existing ground water supplies from their current or potential use. In all cases, steps shall be taken to reduce seepage of toxic and radioactive materials into ground water to the maximum extent reasonably achievable. The following shall be considered to accomplish this:

(1) Installation of low permeability bottom liners. Where synthetic liners are used, a leakage detection system shall be installed immediately below the liner to ensure major failures are detected if they occur. This is in addition to the groundwater monitoring program conducted as provided in 3.10.6.2. Where clay liners are proposed or relatively thin in-situ clay soils are to be relied upon for seepage control, tests shall be conducted with representative tailings solutions and clay materials to confirm that no significant deterioration of permeability or stability properties will occur with continuous exposure of clay to tailings solutions. Tests shall be run for a sufficient period of time to reveal any effects if they are going to occur.

(2) Mill process design which provides the maximum practicable recycle of solutions and conservation of water to reduce the net input of liquid to the tailings impoundment.

(3) Dewatering of tailings by process devices and/or in-situ drainage system. At new sites, tailings shall be dewatered by a drainage system installed at the bottom of the impoundment to lower the phreatic surface and reduce the driving head for seepage, unless tests show tailings are not amendable to such a system. Where in-situ dewatering is to be conducted, the impoundment bottom shall be graded to assure that the drains are at a low point. The drains shall be protected by suitable filter materials to assure that drains remain free running. The drainage system shall also be adequately sized to assure good drainage.

(4) Chemically promote immobilization of toxic substances.

(b) When pollution is occurring at an existing site, (1) such pollution shall be eliminated, (2) the licensee must demonstrate that such pollution is not significant, or (3) the licensee must demonstrate that the pollution is and will be limited to waters in a specified limited area from which there is no significant migration. In any case, ground water quality shall be restored to its potential use before milling operations began to the maximum extent practicable. The specific seepage control and groundwater protection method, or combination of methods, to be used must be worked out on a site-specific basis. Technical specifications shall be prepared to control installation of seepage control systems. A quality assurance, testing, and inspection program, which includes supervision by a qualified engineer or geologist, shall be established to assure that specification is met.

(c) While the primary method of protecting ground water shall be isolation of tailings and tailings solutions, disposal involving contact with ground water will be considered, provided supporting tests and analyses are presented demonstrating that the proposed disposal and treatment methods will not degrade ground water from current or potential uses.

(d) Furthermore, steps shall be taken during stockpiling of ore to minimize penetration of radionuclides into underlying soils; suitable methods include lining and/or compaction of ore storage areas.

(e) In support of a tailings disposal system proposal, the applicant/operator shall supply information concerning the following:

(1) The chemical, physical and radioactive characteristics of the waste solutions.

(2) The characteristics of the underlying soil and geologic formations, particularly the extent to which they will control transport of contaminants and solutions. This shall include detailed information concerning extent, thickness, uniformity, shape, and orientation of underlying thickness strata. Hydraulic gradients and conductivities of the various formations shall be determined. This information shall be gathered by borings and field survey methods taken within the proposed impoundment area and in surrounding areas where contaminants might migrate to usable ground water. The

information gathered on boreholes shall include both geologic and geophysical logs in sufficient number and degree of sophistication to allow determination of significant discontinuities, fractures, and channeled deposits which are of high hydraulic conductivity. If field survey methods are used, they should be in addition to and calibrated with borehole logging. Hydrologic parameters such as permeability shall not be determined on the basis of laboratory analysis of samples alone; a sufficient amount of field testing shall be conducted to assure actual field properties are adequately understood. Testing shall be conducted to allow estimating chemi-sorption attenuation properties of underlying soil and rock.

(3) Location, extent, quality and capacity of any ground water at and near the site.

At least one multi-well pump test shall be conducted for each major aquifer unless the applicant demonstrates that such a test will not provide additional information.

<u>CRITERION 6</u> - Sufficient earth cover, but not less than three meters, shall be placed over tailings or wastes at the end of milling operations to result in a calculated reduction in surface exhalation of radon emanating from the tailings or wastes to less than two picocuries per square meter per second. In computing required tailings cover thicknesses, moisture in soils in excess of amounts found normally in similar soils in similar circumstances shall not be considered. Direct gamma exposure from the tailings or wastes shall be reduced to background levels. The effects of any thin synthetic layer shall not be taken into account in determining the calculated radon exhalation level. If non-soil materials are proposed to reduce tailings covers to less than three meters, it must be demonstrated that such materials will not crack or degrade by differential settlement weathering, or other mechanism over long-term time intervals. Near surface materials, that is within the top three meters, shall not include mine waste or rock that contains elevated levels of radium; soils used for near surface cover must be essentially the same, as far as radioactivity is concerned, as that of surrounding soils.

CRITERION 7

(a) Milling operations shall be conducted so that all airborne effluent releases are reduced to as low as is reasonably achievable. The primary means of accomplishing this shall be by means of emission controls. Institutional controls, such as extending the site boundary and exclusion area, may be employed to ensure that offsite exposure limits are met but only after all practicable measures have been taken to control emissions at the source. Notwithstanding the existence of individual dose standards, strict control of emissions is necessary to assure that population exposures are reduced to the maximum extent reasonably achievable and to avoid site contamination. The greatest potential sources of offsite radiation exposure, aside from radon exposure, are dusting from dry surfaces of the tailings disposal area not covered by tailings solution and emissions from yellowcake drying and packaging operations. Checks shall be made and logged hourly of all parameters, specifically differential pressure and scrubber water flow rate and other appropriate items, which determine the efficiency of yellowcake stack emission control equipment operations. It shall be determined whether or not conditions are within a range prescribed to ensure that the equipment is oeprating consistently near peak efficiency; corrective action shall be taken when performance is outside prescribed ranges. In lieu of hourly checks, the use of monitoring devices with alarms will be considered if the devices monitor all appropriate parameters and are calibrated and checked on a schedule approved by the Department. Effluent control devices shall be operative at all times during drying and packaging operations and whenever air is exhausting from the yellowcake stack.

(b) Drying and packaging operations shall terminate when controls are inoperative. When checks indicate the equipment is not operating within the range prescribed for peak efficienty, actions shall be taken to restore parameters to the prescribed range. When this cannot be done without shutdown and repairs, drying and packaging operations shall cease as soon as practicable.

(c) Operations may not be re-started after cessation due to off-normal performance until needed corrective actions have been identified and implemented. All such cessations, corrective actions, and re-starts shall be reported to the Department in writing, within 10 days of the subsequent re-start.

(d) To control dusting from tailings, that portion not covered by standing liquids shall be wetted or chemically stabilized to prevent or minimize blowing and dusting to the maximum extent reasonably achievable. This requirement may be relaxed if tailings are effectively sheltered from wind, such as may be the case where they are disposed of below grade and the tailings surface is not exposed to wind. Consideration shall be given in planning tailings disposal programs to methods which would allow phased covering and reclamation of tailings impoundments since this will help in controlling particulate and radon emissions during operation. To control dusting from diffuse sources, such as tailings and ore pads where automatic controls do not apply, operators shall develop written operating procedures specifying the methods of control which will be utilized.

CRITERION 8 - These criteria relating to ownership of tailingsand their disposal sites become effective on November 8, 1981, and apply to all licenses terminated, issued, or renewed after that date.

(a) Any uranium or thorium milling license or tailings license shall contain such terms and conditions as the U.S. Nuclear Regulatory Commission and Department determine are necessary to assure that prior to termination of the license, the licensee will comply with ownership requirements of this criterion for sites used for tailings disposal.

(b) Title to the byproduct material licensed pursuant to 3.10.6 and land, including any interest therein, other than land owned by the United States or by a state, which is used for the disposal of any such byproduct material, or is essential to ensure the long term stability of such disposal site, shall be transferred to the United States or the state in which such land is located, at the option of the State. In view of the fact that physical isolation must be the primary means of long term control, and government land ownership is a desirable supplementary measure, ownership of certain severable subsurface interests, for example mineral rights, may be determined to be unnecessary to protect the public health and safety and the environment. Unless it has been determined that government ownership of subsurface interests is unnecessary to protect the health and safety and environment, the applicant/operator must demonstrate a serious effort to obtain such subsurface rights, and must, in the event that certain rights cannot be obtained, provide notification in local public land records of the fact that the land is being used for the disposal of radioactive material and is subject to either a U.S. Nuclear Regulatory Commission general or specific license prohibiting the disruption and disturbance of the tailings. In some rare cases, such as may occur with deep burial where no ongoing site surveillance will be required, surface land ownership transfer requirements may be waived, with the approval of the Department and the U.S. Nuclear Regulatory Commission. For licenses issued before November 8, 1981, the Department shall take into account the status of the ownership of such land, and interest therein and the ability of a licensee to transfer title and custody thereof to the United States or the state. Subsequent renewals shall not disqualify licensees otherwise eligible for such consideration under this criterion.

(c) The State may permit use of the surface or subsurface land transferred to it if the U.S. Nuclear Regulatory Commission subsequent to title transfer determines that use of the surface or subsurface estates, or both, of the land transferred to the United States or the State will not endanger the public health, safety, welfare, or environment. If the U.S. Nuclear Regulatory Commission permits such use of such land held by the State, the State will provide at no cost to the person who transferred such land the right of first refusal with respect to such use of such land.

(d) Material and land transferred to the United States or the State in accordance with this criterion shall be transferred without cost to the United States or the State other than administrative and legal costs incurred in carrying out such transfer.

(e) The requirements for transfer of title and custody to land and tailings and waste shall not apply in the case of lands held in trust by the United States for any Indian tribe or lands owned by such Indian tribe subject to a restriction against alienation imposed by the United States. In the case of such lands which are used for the disposal of byproduct material, as defined in RH 1.6, the licensee shall enter into arrangements with the U.S. Nuclear Regulatory Commission as may be appropriate to assure the long term surveillance of such lands by the United States.

11.0 REFERENCES

HOW TO USE RADIATION CONTROL'S INDEX SYSTEM

The attached lists are in chronological order by author--see list below for author code.

1. Sample index number.

   a. If you want to find a project-specific document from the Colorado Geological Survey (CGS) dated April 14, 1980, you would look for:

   15-800414

   Author Year Month Day

   b. If there is more than one document dated for a single day, an additional pair of numbers is added:

   15-800414-02

   Second document that day

   c. If the document is a general reference, the letter "G" is inserted after the index number.

If you have questions, please contact the Radiation Control Division, (303) 331-4800.

00. License Applicant
01. AG
02. Gov./Lt. Gov.
03. -
04. Other Officials
05. Treasurer
06. Agriculture
07. APCD
08. Chemistry
09. WMD
10. RCD-Consultants
11. WQCD
12. Other CDH
13. Highways
14. Local Affairs
15. CGS
16. Div. of Mines
17. Water Resources
18. Wildlife
19. Water Cons. Board
20. MLR
21. Other CDNR
22. Arch./Hist.
23. Other State
24. County Gov'ts
25. County Health Dep.
26. -
27. Regional Gov't
28. Muni. Gov't
29. Other Local Gov't
30. IAEA
31. NRC
32. EPA
33. FS-USDA
34. DOE
35. HHS
36. HUD
37. BLM
38. Bureau of Mines
39. Reclamation
40. F&W Svc.
41. USGS
42. Outdoor Rec.
43. Nat. Park Services
44. Other Interior Dept.
45. MSHA-Labor
46. DOT
47. Federal Courts
48. Other Federal Agencies
49. Fed. Legislators
50. State Legislators
51. News Media
52. Citizens Group
53. Indiv. Citizens
54. Repositories
55. Pvt. consultants
61. COSC
62. EDF
63. FUTURE
64. NWF
65. Sierra Club
66. Western Colo. Congress
67. WSMA

2. Acronymns used (for brevity) are listed on the next page.

LIST OF ACRONYMS

AAI	Acres American, Inc. (UCC/Umetco Consultant)
AGO	Attorney General's Office
APCD	Air Pollution Control Division, CDH
BLM	U.S. Bureau of Land Management
CDH	Colorado Department of Health
CDNR	Colorado Department of Natural Resources
CDPS	Colorado Discharge Permit System (Water Quality)
CGS	Colorado Geological Survey, CDNR
COSC	Colorado Open Space Council
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DWR	Division of Water Resources, CDNR
EDF	Environmental Defense Fund
ERI	ERI Logan, Inc.
EPA	Environmental Protection Agency
FELRS	Final Executive Licensing Review Summary
FS	Forest Service of the U.S. Department of Agriculture
F&WS	Fish and Wildlife Service of the U.S. Department of Interior
FUTURE	FUTURE, an environmental organization
GJRAP	Grand Junction Remedial Action Program
HHS	U.S. Department of Health and Human Services
HUD	U.S. Department of Urban Development
IAEA	International Atomic Energy Agency
IECO	International Engineering Company, Inc. (UCC/Umetco consultant)
IOC	Inter-Office Communication (memo)
MILDOS	NRC computer model for uranium mill radiation dose
MLR	Mined Land Reclamation Division
MSHA	Mine Safety and Health Administration of the U.S. Dep. of Labor
NEPA	National Environmental Policy Act
NRC	U.S. Nuclear Regulatory Commission
NWF	National Wildlife Federation
NUS	NUS Corporation (UCC/Umetco consultant)
OHP	Office of Health Protection
PELRS	Preliminary Executive Licensing Review Summary
RCD	Radiation Control Division, CDH
UCC	Union Carbide Corporation
Umetco	Umetco Minerals Corporation
USGS	U.S. Geological Survey
WMD	Waste Management Division
WQCD	Water Quality Control Division
WSMA	Western Small Miners Association

11.1 RECORD REFERENCES

00-740301
UCC, R. Beverly. March 1, 1974. Letter to A. Hazle, RCD, CDH. Transmittal of 1984 "Report of Construction, Operation, and Abandonment Design Studies, Uranium Tailings Disposal Area, Uravan, Colorado" by Dames and Moore. (CDH Exhibit A8-p. 001)

00-740703
UCC, R. Beverly. July 3, 1974. Letter to J. Montgomery, RCD, CDH. (CDH Exhibit A8-p. 034)

00-750620
UCC. June 20, 1975. Letter to requesting renewal of Lic. No. SUA-673. (CDH Exhibit A8-p. 036)

00-780831
UCC: Dames and Moore. August 31, 1978. Environmental Report, Uravan Uranium Project. [excerpts not included in UCC 1982 update; see PELRS, p. 7-3, LC 11.7] (CDH Exhibit A8-p. 039)

00-790105
UCC: Dames and Moore. January 5, 1979. Handling and Placement Characteristics of Belt-Filtered Tailings, Uravan Uranium Mill, Uravan, Colorado, for Union Carbide Corporation. (CDH Exhibit B)

00-790917
UCC, R. Beverly. September 17, 1979. Letter to NRC. Informing NRC of slough in tailings dike. (CDH Exhibit A8-p. 110)

00-800100
UCC: Acres American, Inc. January, 1980. Uravan Mill Alternative Tailings and Effluent Disposal--Phase IV Report. (CDH Exhibit A8-p. 111)

00-800118
UCC: NUS Corp., T. Conway. January 18, 1980. A Preliminary Evaluation of 40 CFR 190 Related Radiological Doses to the Uravan Uranium Mill. NUS-3515. (CDH Exhibit A8-p. 154)

00-800530
UCC: IECO. May 1984. Preliminary Geotechnical Investigation of the Proposed Spring Creek Mesa Tailings and Effluent Disposal Site near Uravan, Colorado. (CDH Exhibit B)

00-800530-00
UCC, L. Twitchell. May 30, 1980. Letter to A. Hazle, RCD, CDH. Background information for May 30, 1980 meeting plus 13 attachments. (CDH Exhibit A8-p. 150)

00-800530-01
UCC, L. Twitchell. May 30, 1980. Proposed Timetable for new Tailings and Effluent Area. (CDH Exhibit A8-p. 152)

00-800530-06
UCC: NUS Corp. May 30, 1980. 40 CFR 190 Related Radiological Doses Due to the Operation of the Uravan Uranium Mill. (CDH Exhibit A8-p. 190)

00-800530-07
UCC: NUS Corp. May 30, 1980. Facilities Stack Audit, Uravan, Colorado. (CDH Exhibit A8-p. 265)

00-800530-09
UCC: NUS Corp. May 30, 1980. A Review of Meteorological Data Representative of the Uravan Uranium Mill Site Vicinity. (CDH Exhibit A8-p. 284)

00-800725-01
UCC, R. Beverly. July 25, 1980. Letter to S. Miller, DOE. Additional information on Uravan and Gas Hills tailings piles. (CDH Exhibit A8-p. 303)

00-800725-02
UCC, T. Kagetsu. July 25, 1980. Letter to A. Hazle, RCD, CDH. July 9, 1980 technical meeting on "...Tailings Stabilization Program, additional test results by Dr. N.Y. Chang..., details of 'seepage collection and containment'...", report by Dames and Moore titled "Handling and Placement Characteristics, Belt-Filtered Tailings". (CDH Exhibit A8-p. 317)

00-800828
UCC, Acres American, Inc. August 8, 1980. Uravan Tailings Disposal Stabilization Program, Phase II Geotechnical Report Supplement for Phase IIB. (UCC Exhibit U-6)

00-800828
UCC, Acres American, Inc. August 8, 1980. Uravan Tailings Disposal Stabilization Program, Phase II Geotechnical Report Supplement for Phase IIB.

00-800905
UCC: Acres American, Inc. August 8, 1980. Uravan Tailings Disposal Stabilization Program, Phase II Geotechnical Report Supplement for Phase IIB, Appendix D Finite Element Earthquake Analysis. (UCC Exhibit U-6B)

00-801027
UCC, R. Beverly. October 27, 1981. Letter to S. Miller, DOE. Deposition of Clifford Hiett. (CDH Exhibit A8-p. 333)

00-810223-01
UCC, P. Rekemeyer. February 23, 1981. Letter to A. Hazle, RCD, CDH. Response to December 29, 1980 letter requesting MILDOS information. (CDH Exhibit A8-p. 357)

00-810427
UCC, P. Rekemeyer. April 27, 1981. Letter to F. Trayler, CDH. (CDH Exhibit A8-p. 359)

00-810624
UCC, P. Rekemeyer. June 24, 1981. Letter to A. Hazle, RCD, CDH. Heap leach amendment. (CDH Exhibit A8-p. 361)

00-810721
UCC, E. Kantz. July 21, 1981. Letter to A. Hazle, RCD, CDH. Experimental heap leach program. (CDH Exhibit A8-p. 369)

00-810904
UCC, R. Folkman. September 4, 1981. Letter to A. Hazle, RCD, CDH. Reply to proposed enforcement action, Reclamation Surety Agreement Alternatives - Self Bonding.

00-810904
UCC, R. Folkman. September 4, 1981. Letter to A. Hazle, RCD, CDH. Reclamation surety agreement alternatives--self-bonding. (CDH Exhibit A8-p. 371)

00-810916
UCC: Kirkland & Ellis, H. Ipsen. September 22, 1981. Cover letter to K. Weaver, RCD, CDH. Reclamation surety agreement. (CDH Exhibit A8-p. 375)

00-811008
UCC, R. Folkman. October 8, 1981. Cover letter to A. Hazle, RCD, CDH. Reclamation surety agreement. (CDH Exhibit A8-p. 376)

00-820331-00
UCC, P. Rekemeyer. March 31, 1982. Letter to A. Hazle, RCD, CDH. (CDH Exhibit A8-p. 399)

00-820331-01
UCC, R. Beverly. Updated License Renewal Application for Source Material License SUA-673. (CDH Exhibit A8-p. 403)

00-820331-02
UCC. March 31 1982. Uravan Operating Plan, LC 11.3. (CDH Exhibit A8-p. 405)

00-820331-03
UCC: Acres American, Inc. March, 1982. Uravan Tailings Disposal Stabilization Program--Supplement for Phase IIB, p. 9, table 1 figure 4. (UCC Exhibit U-6A)

00-820331-05
UCC. March 31, 1982. Procedures Manual for Plant Operations at Uravan, Revision 0. LC 11.2. (UCC Exhibit U-8)

00-820331-06
UCC: Dravo Engineers and Constructors. March 19, 1982. Uravan, Colorado Flood Study. (UCC Exhibit U-5)

00-820331-08
UCC: NUS Corporation, B. Bartram & S. Tammara. March 31, 1982. An Updated Evaluation of 40 CFR 190 Related Radiological Doses Due to Uravan Uranium Mill. NUS-3992. (CDH Exhibit A8-p. 409)

00-820331-10
UCC. March 31 1982. Uravan Reclamation Schedule. (CDH Exhibit A8-p. 407)

00-820331-13
UCC. March 31, 1982. Updated Environmental Report, Uravan Uranium Project, Montrose County, Colorado. (UCC Exhibit U-1)

00-820331-14
West End Economic Adjustment Committee. Crises in The West End. (UCC Exhibit U-7)

00-820331-16
UCC. March 31, 1982. Radon Daughter Concentrations in the Restricted Areas of the Uravan Mill, 1981. (CDH Exhibit A8-p. 454)

00-820400
UCC: Arix, T. Tappan. April 1982. Undisturbed Surface Soil Radon-222 Flux Rates at the Union Carbide Corporation Spring Creek Mesa Project. (UCC Exhibit SCM-6)

00-821206-03
UCC: Envirologic Systems, Inc. December 6, 1982. Report. Spring Creek Mesa Geohydrology, September 1982. (UCC Exhibit SCM-4)

00-821206-04
UCC: R. Pyrih and Associates. December 6, 1982. Report. Spring Creek Mesa Geotechnical Program, November 1982. (UCC Exhibit SCM-5)

00-821206-05
UCC: Gibbs and Hill. December 6, 1982. Report. Union Carbide Corporation's Proposed Spring Creek Mesa Disposal Facility-Socioeconomic Impact Assessment, September 1982. (UCC Exhibit SCM-8)

00-821206-06
UCC: N. Savignac, Ph D. December 6, 1982. Licensing and Regulatory Consultant Report. Union Carbide Corporation Spring Creek Mesa - MILDOS Computer Assessment of Dose Commitments, September 1982. (UCC Exhibit SCM-7)

00-821206-07
UCC: Arix. December 6, 1982. Report. Undisturbed Surface Soil Radon-222 Flux Rates at the Union Carbide Corporation Spring Creek Mesa Project, April 1982. (UCC Exhibit SCM-6)

00-830204
UCC, R. Jones. February 4, 1983. Evaporation Study Results, Uravan. (CDH Exhibit B)

00-830207
UCC: R. Ryrih and Associates. February 7, 1983. Spring Creek Mesa Geochemical Program, Supplementary Report. (UCC Exhibit SCM-5A)

00-830324
UCC: R. Pyrih and Associates. March 24, 1984. Additional pH data from the long-term column percolation testwork. (CDH Exhibit B)

00-830707
UCC, R. Jones. July 7, 1983. 1982 Off-Site radiation dose report and garden vegetative update. (CDH Exhibit A8-p. 470)

00-830711
UCC: Chen. July 11, 1983. Integrated Analysis, The Effect of Potential Seepage from Union Carbide Corporation's Proposed Spring Creek Mesa Tailings and Effluent Disposal Facility, Uravan, Colorado. (CDH Exhibit B)

00-830927
UCC, R. Jones. September 27, 1983. Letter to K. Weaver, RCD, CDH. Offsite dose to Uravan residents. (CDH Exhibit A8-p. 567)

00-831007-3
UCC, J. Frost. October 7, 1983. Letter to K. Weaver, RCD, CDH. Update an epidemiology study. (CDH Exhibit A8-p. 565)

00-831013
UCC: Dravo. October 13, 1983. Uravan License Renewal, Additional Calculations. (CDH Exhibit B)

00-831130-03
UCC, R. Jones. November 30, 1983. Radiation Dose Commitment Assessment: Town of Uravan, Colorado. (UCC Exhibit U-9)

00-831130-04
UCC, R. Jones. November 30, 1983. Letter to RCD, CDH. Compliance schedule for off-site dose reduction. (CDH Exhibit A8-p. 577)

00-831216-02
UCC. December 16, 1983. Plans and estimated costs for ponds and tailings reclamation and mill decommissioning at the Uravan mill for surety purposes. (UCC Exhibit U-12)

00-831216-03
UCC: Chen and Associates. December 16, 1983. Report on Geotechnical Evaluation and Reclamation Plan for Existing Facilities. (UCC Exhibit U-2)

00-831216-04
UCC: Envirologic Systems, Inc. December 16, 1983. Report on Water Quality Investigation: Club Ranch Ponds and Atkinson Creek area. (UCC Exhibit U-4)

00-831216-05
UCC: Envirologic Systems, Inc. December 16, 1983. Summary report on geohydrological and geochemical conditions, with recommended groundwater monitoring program. (UCC Exhibit U-3)

00-840124
UCC: Dravo Corporation by Chen and Associates, Inc.; Envirologic Systems, Inc.; Roman Z. Pyrih and Associates. January 24, 1984. Integrated Report and Geohydrology, Potential Fluid Migration, and Ground Water Monitoring Program for Occupation and Post Reclamation Periods for Proposed Spring Creek Mesa Tailings and Effluent Disposal Facility, Union Carbide Corporation. (UCC Exhibit SCM-3)

00-840206-01
UCC: Gibbs and Hill. February 6, 1984. Amendment to the Environmental Report for the Proposed Spring Creek Mesa Tailings and Effluent Impoundment, Dated January, 1984. (UCC Exhibit SCM-1)

00-840206-02
UCC: Chen and Associates. February 6, 1984. Report, Summary of Geotechnical Investigations with Recommendation for the Spring Creek Mesa Tailings and Effluent Disposal Facilities. (UCC Exhibit SCM-2)

00-840206-03
UCC: Chen and Associates. February 6, 1984. Summary of Geotechnical Investigation with Recommendations for Spring Creek Mesa Tailings and Effluent Disposal Facility, Appendices B and C to SCM-2. (UCC Exhibit SCM-2B)

00-840206-04
UCC: Chen and Associates. February 6, 1984. Summary of Geotechnical Investigation with Recommendations for Spring Creek Mesa Tailings and Effluent Disposal Facility, Appendix A. (UCC Exhibit SCM-2)

00-840206-05
UCC: Gibbs and Hill. February 6, 1984. Environmental Report - Spring Creek Mesa Tailings and Effluent Impoundment, January 1984: Appendix (maps and drawings). (UCC Exhibit SCM-1A)

00-840227
UCC, J. Frost. February 27, 1984. Letter to A. Hazle, RCD, CDH. Response to revised CDH policy. (CDH Exhibit A8-p. 611)

00-840229-00
UCC, O. Calloway. February 29, 1984. Cover letter to A. Hazle RCD, CDH. Laboratory Quality Assurance Manual. (UCC Exhibit U-11)

00-840301-02
UCC, F. McMillan. March 1, 1984. Letter to A. Hazle, RCD, CDH. Request to transfer license; surety update without appendices. (CDH Exhibit A8-p. 579)

00-840320
UCC. March 20, 1984. Letter to A. Hazle, RCD, CDH. Request to transfer license. (CDH Exhibit A8-p. 618)

00-840326
UCC, Envirologic. March 26, 1984. Additional support information related to Spring Creek Mesa work. (CDH Exhibit B)

00-840330
UCC, C. Dudnick. March 30, 1984. Letter to A. Neblett, AGO. Assurance concerning license transfer. (CDH Exhibit A8-p. 620)

00-840411
Holme, Roberts and Owen, H. Ipsen. April 11, 1984. Cover letter A. Neblett, AGO. Final draft of revised surety agreements: Reclamation and Long Term Monitoring and Maintenance. (CDH Exhibit A8-p. 622)

00-840416
UCC: Dravo, V. Vinych. April 16, 1984. Cover letter for report on control of surface runoff, hillside seepage and sediment loadings at the Uravan mill. (CDH Exhibit A8-p. 671)

00-840416-01
UCC: Dravo, V. Vinych. April 16, 1984. Report on Control of Surface Runoff, Hillside Seepage and Sediment Loadings at the Uravan Mill. (CDH Exhibit A8-p. 672)

00-840507
UCC, J. Frost. May 7, 1984. Letter to A. Hazle, RCD, CDH. Amendment 20 comments. (CDH Exhibit A8-p. 683)

00-840514
UCC, J. McDonald. May 14, 1984. Letter to RCD, CDH. March 31, 1984 reclamation surety agreement. (CDH Exhibit A8-p. 688)

00-840625-00
UCC. June 25, 1984. 1983 Off-Site Radiation Dose Report. (p. 353, August 22, 1984 transcript) (CDH Exhibit B1, p. 353)

00-840629
UCC, J. Frost. June 29, 1984. Letter to K. Weaver, RCD, CDH. 40 CFR 190 compliance schedule. (CDH Exhibit A8-p. 700)

00-840724
UCC, W. Alesio. July 24, 1984. Letter to R. Arnott, RCD, CDH. Re: special conference on July 20, 1984. (CDH Exhibit B)

00-840730
UCC, J. Frost. July 30, 1984. Letter to A. Hazle, RCD, CDH. Options to be evaluated by Umetco. (CDH Exhibit B)

00-840808-01
UCC: D. McWhorter. August, 1984. Analysis of potential for lateral spreadings and perchings of seepage, Spring Creek Mesa Disposal Facility, Uravan, Colorado. (UCC Exhibit SCM-9)

00-840808-01
UCC. August 8, 1984. Updated Metes and Bounds. (August 22, 1984 transcript). (UCC Exhibit U-27).

00-840808-02
UCC: D. McWhorter et al. August, 1984. Alternative Hydrologic Model and Containment Transport Analysis, Spring Creek Mesa Disposal Area. (SCM-10)

00-840809-10
Umetco. August 9, 1984. Environmental Monitoring Procedures Manual, Volume Two. (UCC Exhibit U-10B)

00-840809-11
Umetco. August 9, 1984. Environmental Monitoring Procedures Manual, Volume One. (UCC Exhibit U-10A)

00-840809-13
UCC. August 9, 1984. Proposed Surety Agreements: Reclamation and Long Term Care. (UCC Exhibit U-13)

00-840809-14
Umetco. August 9, 1984. Tabulation of Water Rights - Uravan Mill. (UCC Exhibit U-14)

00-840809-15
UCC, R. Jones. August 9, 1984. Memorandum to J. Frost, UCC. Long-term monitoring and maintenance costs for Uravan. (UCC Exhibit U-15)

00-840809-16
UCC. August 8, 1984. Project Location Map With Overlays. (UCC Exhibit U-16)

00-840809-17
UCC. August 8, 1984. Liquid Waste Disposal Diagram. (UCC Exhibit U-17)

00-840809-18
UCC. August 8, 1984. Reclamation Schedule and Costs. (UCC Exhibit U-18)

00-840809-19
UCC. August 8, 1984. Map of Club Mesa with Monitoring Wells. (UCC Exhibit U-19)

00-840809-20
UCC. August 8, 1984. Existing Facility Reclamation Plan. (UCC Exhibit U-20)

00-840809-21
UCC. August 8, 1984. Club Ranch and Atkinson Creek Monitoring Wells. (UCC Exhibit U-21)

00-840809-22
UCC. August 8, 1984. Existing Club Ranch Ponds Typical Section. (UCC Exhibit U-22)

00-840809-23
UCC. August 8, 1984. Reclaimed Club Ranch Ponds Typical Section. (UCC Exhibit U-23)

00-840809-24
UCC. August 8, 1984. Club Mesa Hydrogeologic Section. (UCC Exhibit U-24)

00-840809-25
UCC. August 8, 1984. Uravan Housing Area. (p. 287, August 22, 1984 transcript) (UCC Exhibit U-25)

00-840809-61
UCC. August 9, 1984. Chart depicting potential radiological exposure pathways from Spring Creek Mesa tailings disposal site to man. (UCC exhibit SCM-11)

00-840809-62
UCC. August 9, 1984. Site map showing the disposal site and the locations designated in Table 5.2-4. (UCC exhibit SCM-12)

00-840809-63
UCC. August 9, 1984. Table showing only the "Location" column, the "Child's Bone" column and the "Child's Lung" column. (UCC exhibit SCM-13)

00-840809-64
UCC. August 9, 1984. Table showing only the "Location" column, the "Child's Bone" column and the "Child's Lung" column. (UCC exhibit SCM-14)

00-840809-65
UCC. August 9, 1984. Spring Creek Mesa Alternative Tailings Disposal Sites. (UCC exhibit SCM-15)

00-840809-66
UCC. August 9, 1984. Spring Creek Mesa Typical Exterior Embankment Section. (UCC exhibit SCM-16)

00-840809-67
UCC. August 9, 1984. Spring Creek Mesa Plan: Tailings Impoundment. (UCC exhibit SCM-17)

00-840809-68
UCC. August 9, 1984. Spring Creek Mesa Longitudinal Hydrogeologic Section. (UCC exhibit SCM-18)

00-840809-69
UCC. August 9, 1984. Spring Creek Mesa Transverse Hydrogeologic Section. (UCC exhibit SCM-19)

00-840809-70
UCC. August 9, 1984. Spring Creek Mesa Geologic Sections. (UCC exhibit SCM-20)

00-840809-71
UCC. August 9, 1984. Spring Creek Mesa Typical Section Pond Liner System. (UCC exhibit SCM-21)

00-840809-72
UCC. August 9, 1984. Spring Creek Mesa Typical Section Pond Liner System. (UCC exhibits SCM-22)

00-840809-73
UCC. August 9, 1984. Spring Creek Mesa Typical Section Pond Liner System. (UCC exhibits SCM-23)

00-840809-74
UCC. August 9, 1984. Spring Creek Mesa Typical Liner Pond. (UCC exhibits SCM-24)

00-840809-75
UCC. August 9, 1984. Spring Creek Mesa Groundwater Monitoring Wells. (UCC exhibits SCM-25)

00-840813-02
UCC, J. Frost. August 13, 1984. Letter to K. Green, NWF. Liner agreement. (CDH Exhibit B, NWF Exhibit 10)

00-840814-01
UCC: D. McWhorter. August 14, 1984. Summary of results of seepage modelling. (CDH Exhibit B)

00-840814-03
UCC, L. Brown. August 14, 1984. Request for copies of hearing documents. (CDH Exhibit B)

00-840814-04
UCC, L. Brown. August 14, 1984. U.S. Macroeconomic Forecasts and Analysis: Real Interest Rates. (UCC Exhibit U-26)

00-840815
UCC, L. Brown. August 15, 1984. Motion for protective order. (CDH Exhibit B)

00-840816
UCC, Chen & Associates, C. Seally. August 16, 1984. "Alternative Hydrogeologic Model and Contaminant Transport Analysis, Spring Creek Mesa Disposal Facilities". (p. 457, August 22, 1984 transcript) (CDH Exhibit B, SCM Exhibit 10A)

00-840820
Umetco, J. Frost. August 20, 1984. Letter to F. Green: NWF. Confirmation of Agreement. (NWF Exhibit 12)

00-840822
Umetco. August 22, 1984. Modifications to the Proposed License and Alternative License Conditions by Umetco and EDF. (p. 288, August 22, 1984 transcript) (UCC Exhibit U-28, p. 288).

00-840906
Umetco: H. Ipsen. September 6, 1984. Reply to NRC PELRS comments. (CDH Exhibit B)

00-841009
Umetco: Holme, Roberts & Owen, L. Brown. October 9, 1984. To CDH. Proposed findings of Fact, Conclusions of Law and Order of Umetco Minerals Corporation.

00-841012
Umetco. October 12, 1978. Plans and Estimated Costs for Tailings Reclamation and Pipeline Recommissioning at Spring Creek Mesa (Uravan Mill) for Severity Purposes.

00-841012-01
Umetco. October 12, 1984. Plans and Estimated Costs for Tailings Reclamation and Pipeline Decommissioning at Spring Creek Mesa (Uravan Mill) for Surety Purposes. (CDH Exhibit B)

00-841012-02
Umetco. October 12, 1984. Estimate of the Long-Term Monitoring and Maintenance Costs for the Spring Creek Mesa Facility. (CDH Exhibit B)

00-841012-03
Umetco. October 12, 1984. Plans and Estimated Costs for Tailings Reclamation and Pipeline Recommissioning at Spring Creek Mesa (Uravan Mill) for Surety Purposes. (Umetco Exhibit SCM-28)

00-841102
Umetco: Bishop, Brogdin and Rumph, Inc. November 2, 1984. Burro Canyon Formation Perched Aquifer Investigation, Spring Creek Mesa, Colorado. (Umetco Exhibit SCM-26)

00-841105-00
Umetco: Holmes, Roberts & Owen, H. Ipsen. November 5, 1984. To CDH. Supplemental Prehearing Statement by Umetco Minerals Corporation.

00-841105-77
Umetco: Envirologic Services, J. Rouse. October 5, 1984. Radiochemical Age Dating of Spring Creek Mesa Perched Groundwater System. (typo on p. 3, Figure for well H-27 -- changed to "greater than" 34.2.2 [meaning older]; p. 17 and 100, November 19, 1984 transcript) (Umetco Exhibit SCM-27)

00-841105-79
UCC. November 5, 1984. Table I: Estimate of the Long-Term Monitoring and Maintenance Costs for the Spring Creek Mesa Facility and Basis for Long-Term Monitoring Cost Estimate for the Spring Creek Mesa Facility. (Umetco Exhibit SCM-29)

00-841105-80
UCC. November 5, 1984. Table I: Comparison of Various Design Options for the Spring Creek Mesa Facility. (Umetco Exhibit SCM-30)

00-841119
Umetco. November 19, 1984. R. Brogden Resume. (p. 70, November 19, 1984 transcript) (UCC Exhibit)

00-850210
Umetco, D. Sparling. Letter to A. Hazle, RCD, CDH. February 10, 1985. Response to 1984 inspection noncompliance letter.

00-850419
Umetco, H. Stephens. Letter to A. Hazle, RCD, CDH. April 19, 1985. Additions to user's list.

00-850501-00
Umetco, J. Frost. Letter to A. Hazle, RCD, CDH. May 1, 1985. Evidence of Title, Uravan Site.

00-850515
Umetco. Report. May 15, 1985. Annual Environmental Monitoring Data Review (for 1984).

00-850517
Umetco, R. Jones. Report. May 17, 1985. Uravan Radon-222 Analysis.

00-850522
Umetco, R. Beverly. Letter to A. Hazle, RCD, CDH. May 22, 1985. Followup response to 1984 inspection corrective action letter.

00-850605
Umetco, R. Beverly. Letter to A. Hazle, RCD, CDH. June 5, 1985. Appeal of Amendment 23.

00-850618
UCC, C. Dudnick. June 18, 1985. Mass tort compensation aid comparisons.

00-850628
Umetco, J. Frost. Letter to A. Hazle, RCD, CDH. June 28, 1985. Adjustment in Uravan financial assurance cost estimate.

00-850709-04
Umetco, R. Jones. July 9, 1985. Letter to K. Weaver, RCD, CDH. Transmittal of liner quality control installation plan.

00-850725
Umetco, G.L. Swanson. July 25, 1985. Letter to B. DeBrine, Colorado Division of Water Resources. Transmittal of permit application form for new well V-763-SA.

00-851023-01
Umetco. October 23, 1985. Salvage material report, House G-13.

00-851023-02
Umetco. October 23, 1985. Salvage material report, House G-16.

00-851107-01
Umetco. November 7, 1985. Salvage material report, House G-21.

00-851107-02
Umetco. November 7, 1985. Salvage material report, House G-26.

00-851107-03
Umetco. November 7, 1985. Salvage material report, House G-34.

00-851220
Umetco, R. Beverly. December 20, 1985. Letter to A. Hazle, RCD, CDH. Discrete source removal in Uravan town area.

00-860211
Holme Roberts & Owen, H. Ipsen. February 11, 1986. Letter to A. Hazle, RCD, CDH. Request for hearing on Amendment 22.

00-860506
Umetco, R. Jones. May 6, 1986. Letter to A. Hazle, RCD, CDH. CDH 40 CFR 190 Assessment.

00-861027
Umetco, R. Jones. October 27, 1986. Letter to K. Weaver, RCD, CDH. Documentation for Supplemental License Record.

01-851130
Colorado Department of Law, H. Kenison; Union Carbide Corporation, H. Ipsen; and CDH, W. Jacobi. Memorandum of Understanding. Attachment 1 to 01-861030.

01-860301
AGO: ERI. Report. March 1, 1986. Summary of Surface Media Background Information.

01-860701
AGO: RA Consultants. Report. July 1986. Qualitative Health Risk Assessment.

01-860811-01
AGO: ERI. Report. August 11, 1986. Final Report - Winter Baseline Investigation of Surface Media in the Vicinity of the Uravan Uranium Mill, Uravan, Colorado, Volume I.

01-860811-02
AGO: ERI. Report. August 11, 1986. Final Report - Winter Baseline Investigation of Surface Media in the Vicinity of the Uravan Uranium Mill, Uravan, Colorado, Volume II.

01-861030
AGO, J. Berardini. IOC to File. October 30, 1986. Summary of discussions concerning RML 660-02S in Uravan CERCLA settlement negotiations.

06G-820000
Colorado Department of Agriculture. 1982. Impacts on Agricultural Lands. (CDH Exhibit A7)

07-841019
CDH, APCD, R. Katani. October 19, 1984. IOC: Review of Umetco Minerals Proposal for Spring Creek Mesa Impoundment. (CDH Exhibit C6)

07-841105
CDH, APCD, R. Katani. November 11, 1984. IOC: Radiation Division Comments on the Spring Creek Mesa Impoundment. (CDH Exhibit C6)

07G-831001
APCD. Are You Doing Business in Colorado: You May Need An Air Permit. (CDH Exhibit A7)

08-840600
CDH, Chemistry. June 1984. Consumer Price List for Analyses. (CDH Exhibit C6)

09G-821117
WMD. November 17, 1982. Solid Waste Disposal Sites and Facilities Regulations. (CDH Exhibit A7)

10-680719-01
CDH, RCD. July 19, 1968. Amendment No. 8. (CDH Exhibit A2- p. 001)

10-680923-01
CDH, RCD. September 23, 1969. Amendment No. 10. (CDH Exhibit A2-p. 007)

10-690626-01
CDH, RCD. June 26, 1969. Amendment No. 9. (CDH Exhibit A2-p. 005)

10-701019-01
CDH, RCD. October 19, 1970. Amendment No. 11. (CDH Exhibit A2-p. 009)

10-710824-01
CDH, RCD. August 24, 1971. Amendment No. 12. (CDH Exhibit A2-p. 011)

10-720713-01
CDH, RCD. July 13, 1972. Amendment No. 13. (CDH Exhibit A2-p. 013)

10-740314
CDH. March 14, 1974. Summary and comments on Dames and Moore Report. (CDH Exhibit A4-p. 001)

10-740611
CDH, RCD, J. Montgomery. June 11, 1974. Letter to R. Beverly, UCC. Amendment to license by referencing Dames and Moore Report "Report of Construction, Operation and Abandonment Design...". (CDH Exhibit A4-p. 007)

10-740725-01
CDH, RCD. July 25, 1974. Amendment No. 14. (CDH Exhibit A2-p. 015)

10-750609
CDH, RCD, A. Hazle. June 9, 1975. Letter to R. Beverly, UCC. Notice of license expiration - July 31, 1975. (CDH Exhibit A3-p. 009)

10-750909
CDH, RCD, L. Grossman. September 9, 1975. Letter to R. Beverly, UCC. New environmental assessment requirement. (CDH Exhibit A4-p. 011)

10-761001-01
CDH, RCD, A. Hazle. October 1, 1976. Letter to G. Kerr, NRC. (CDH Exhibit A4-p. 013)

10-761001-02
CDH, RCD, A. Hazle. October 1, 1976. Letter to P. Smith, EPA. (CDH Exhibit A4-p. 015)

10-761001-03
CDH, RCD, A. Hazle. October 1, 1976. Letter to H. Sherman, CDNR. (CDH Exhibit A4-p. 017)

10-761001-04
CDH, RCD, A. Hazle. October 1, 1976. Letter to P. Schmuck, CDLA. (CDH Exhibit A4-p. 019)

10-761001-05
CDH, RCD, A. Hazle. October 1, 1976. Letter to J. Rold, CGS. (CDH Exhibit A4-p. 021)

10-761001-06
CDH, RCD, J. Montgomery. October 1, 1976. IOC to file. Air Pollution Review of Environmental Report (ER). (CDH Exhibit A4-p. 023)

10-770202
CDH, RCD, A. Hazle. February 2, 1977. Letter to R. Beverly, UCC. Review of old ER and requirement of new, more complete ER. (CDH Exhibit A4-p. 025)

10-770217
CDH, RCD, J. Montgomery. February 17, 1977. IOC to file. Division reviews of ER. (CDH Exhibit A4-p. 027)

10-770601
CDH, RCD, A. Hazle. February 2, 1977. Letter to R. Beverly, UCC. General requirement of ER. (CDH Exhibit A4-p. 029)

10-771122
CDH, RCD, J.Montgomery. November 22, 1977. Letter to P. Rekemeyer, UCC. Notification of need for cost/benefit analysis. (CDH Exhibit A4-p. 031)

10-780615
CDH, RCD, A. Hazle. June 15, 1978. Letter to P. Rekemeyer, UCC. Extension for filing ER. (CDH Exhibit A4-p. 033)

10-790109-01
CDH, RCD, A. Hazle. January 9, 1979. ER agency review/comment list and respective areas of review. (CDH Exhibit A4-p. 035)

10-790117-01
CDH, RCD, A. Hazle. January 17, 1979. Letter to P. Smith, EPA. Transmittal of ER and background information. (CDH Exhibit A4-p. 039)

10-790117-02
CDH, RCD, A. Hazle. January 17, 1979. Letter to G. Kerr, NRC. Transmittal of ER and background information. (CDH Exhibit A4-p. 037)

10-790129
CDH, RCD, A. Hazle. December 29, 1979. Letter to N. Reams, Montrose County Board of Commissioners. Transmittal of ER and CDH options. (CDH Exhibit A4-p. 041)

10-790619-01
CDH, RCD. June 19, 1979. Amendment No. 15. (CDH Exhibit A2-p. 017)

10-790900
CDH, RCD, J. Montgomery. September xx, 1979. IOC to K. Weaver & R. Gamewell, RCD, CDH. Response to tailings stability question. (CDH Exhibit A4-p. 045)

10-791016
CDH, RCD, A. Hazle. June 19, 1979. Letter to NRC. Regarding tailings stability review. (CDH Exhibit A4-p. 047)

10-791207
CDH, RCD, J. Montgomery. December 7, 1979. IOC to A. Hazle, RCD, CDH. Meeting notes on tailings dam stability. (CDH Exhibit A4-p. 049)

10-800102
CDH, RCD, K. Weaver. January 2, 1980. IOC to file. Meeting with Water Resources, cooperative review. (CDH Exhibit A4-p. 053)

10-800108
CDH, RCD, A. Hazle. January 8, 1980. Letter to R. Beverly, UCC. Authorization to discharge into Pond 1. (CDH Exhibit A4-p. 055)

10-800121
CDH, RCD, K. Weaver. January 21, 1980. IOC to J. Montgomery, RCD, CDH. Memo on status of Uravan mill license. (CDH Exhibit A4-p. 057)

10-800207
CDH, RCD, K. Weaver. February 7, 1980. IOC to Uravan file. Technical meeting. (CDH Exhibit A4-p. 061)

10-800208-01
CDH, RCD, K. Weaver. February 8, 1980. IOC to Uravan file. Uravan buttressing permits. (CDH Exhibit A4-p. 063)

10-800208-02
CDH, RCD, K. Weaver. February 8, 1980. IOC to Uravan file. Uravan timetable. (CDH Exhibit A4-p. 065)

10-800219-01
CDH, RCD, A. Hazle. February 19, 1980. Letter to R. Beverly, UCC. Concerning tailings pond use. (CDH Exhibit A4-p. 067)

10-800219-02
CDH, RCD, K. Weaver. February 19, 1980. IOC to file. February 13, 1980 meeting. Extension of Pond 1 use, Pond 2 horizontal drains, timetable for pond 2 phases. (CDH Exhibit A4-p. 071)

10-800221
CDH, RCD, A. Hazle. February 21, 1980. Letter to R. Beverly, UCC. Authorization to discharge into Pond 1. (CDH Exhibit A4-p. 075)

10-800222
CDH, RCD, K. Weaver. February 22, 1980. IOC to file. Ponds 1, 2, 3 stability. (CDH Exhibit A4-p. 077)

10-800303-01
CDH, RCD, K. Weaver. March 3, 1980. IOC to file. Telcon D. Fox, AQCD, with R. Gamewell, RCD, CDH. Toe Buttresses, air quality permit for new gravel pit to provide borrow material. (CDH Exhibit A4-p. 079)

10-800304-01
CDH, RCD, K. Weaver. March 4, 1980. IOC to file. Telcon N. Reams, Montrose County Commissioner. Air emission permit and regular open mining (MLR) permit. (CDH Exhibit A4-p. 081)

10-800304-02
CDH, RCD, A. Hazle. March 4, 1980. Letter to C. Berry, MLR. Notification that Pond 3 is not being discharged into until remedial actions are taken. (CDH Exhibit A4-p. 083)

10-800304-03
CDH, RCD, A. Hazle. March 4, 1980. Letter to R. Beverly, UCC. Transmittal of Air Quality Control and Mined Land Reclamation letters, tailings stabilization. (CDH Exhibit A4-p. 085)

10-800311
CDH, RCD, K. Weaver. March 11, 1980. IOC to file. Telcon P. Rekemeyer, UCC. Request to extend discharge into Pond 1; list of consultants and their additional reports. (CDH Exhibit A4-p. 087)

10-800312
CDH, RCD, K. Weaver. March 12, 1980. IOC to file. Telcon J. Giedt, EPA to answer P. Rekemeyer, UCC questions. EPA radon standards. (CDH Exhibit A4-p. 089)

10-800320
CDH, RCD, A. Hazle. March 20, 1980. Letter to R. Beverly, UCC. Conditions on tailings discharge into Pond 1. (CDH Exhibit A4-p. 091)

10-800410
CDH, RCD, K. Weaver. April 10, 1980. IOC to file. Meeting with UCC on renewal review and surety requirements. (CDH Exhibit A4-p. 093)

10-800416
CDH, RCD, A. Hazle. April 16, 1980. Letter to R. Scarano, NRC. Update aid request for information regarding Ponds 2 and 3 stability. (CDH Exhibit A4-p. 097)

10-800418
CDH, RCD, A. Hazle. April 18, 1980. Letter to P. Rekemeyer, UCC. Division questions on "Quality Control Plan for Operation of Tailings Ponds 2 and 3". (CDH Exhibit A4-p. 099)

10-800429
CDH, RCD, A. Hazle. April 29, 1980. Letter to R. Beverly, UCC. Authorization of lift, but not use, of Pond 3; begin lift Pond 2. (CDH Exhibit A4-p. 103)

10-800507
CDH, RCD, A. Hazle. May 7, 1980. Letter to R. Scarano, NRC. Request for Argonne National Laboratory study results. (CDH Exhibit A4-p. 105)

10-800508
CDH, RCD, K. Weaver. May 8, 1980. IOC to file. Telcon L. Twichell, UCC. Status report on UCC submissions and discussion of groundwater questions. (CDH Exhibit A4-p. 107)

10-800515
CDH, RCD, A. Hazle. May 15, 1980. Letter to R. Beverly, UCC. Order and authorization of discharge into Pond 3. (CDH Exhibit A4-p. 109)

10-800623
CDH, RCD, K. Weaver. June 23, 1980. IOC to file. Telcon A. Pearson, Water Resources. Pond 3, Phase IIA Design, 3:1 vs. 2.5:1 slopes. (CDH Exhibit A4-p. 113)

10-800721
CDH, RCD, K. Weaver. July 21, 1980. IOC to file. Telcon with R. Griffith, AGO. Mandatory license expiration. (CDH Exhibit A4-p. 115)

10-800922-02
CDH, RCD, A. Hazle. September 22, 1980. Letter to J. Frost, UCC. Order and authorization of discharge tailings into Pond 2 through December 15, 1980. (CDH Exhibit A4-p. 117)

10-800923-01
CDH, RCD, K. Weaver. September 23, 1980. Letter to P. Rekemeyer, UCC. Correction of telcon with respect to sub-surface disposal permit. (CDH Exhibit A4-p. 121)

10-801015-01
CDH, RCD, K. Weaver. October 15, 1980. IOC to file. Telcon J. Odell, MSHA Technical Support Center. UCC's decision on Spring Creek Mesa as preferred site; MSHA Phase II buttressing analysis near completion. (CDH Exhibit A4-p. 125)

10-801015-02
CDH, RCD, A. Hazle. October 15, 1980. Letter to R. Scarano, NRC. Condition for renewing license timetable and requirements and request for information. (CDH Exhibit A4-p. 123)

10-801020-01
CDH, RCD, K. Weaver. October 20, 1980. IOC to file. Telcon G. Graff, BLM. Status of BLM involvement in Uravan via UCC filing application or alternative disposal site; sale of Spring Creek Mesa. (CDH Exhibit A4-p. 127)

10-801028
CDH, RCD, A. Hazle. October 28, 1980. Letter to R. Scarano, NRC. Re-request for Argonne National Laboratory study results. (CDH Exhibit A4-p. 129)

10-801118-02
CDH, RCD, K. Weaver. November 18, 1980. IOC to file. Telcon with R. Person, NRC. (CDH Exhibit A4-p. 131)

10-801118-03
CDH, RCD, K. Weaver. November 18, 1980. IOC to file. Telcon with R. Person & J. Linehan, NRC. (CDH Exhibit A4-p. 133)

10-801201
CDH, RCD, K. Weaver. December 1, 1980. Letter to P. Rekemeyer, UCC. Request for NRC MILDOS data and meteorological data. (CDH Exhibit A4-p. 135)

10-801201-00
CDH, RCD, A. Hazle. December 1, 1980. Letter to E. Kantz, UCC. Regarding License Amendment No. 16. (CDH Exhibit A3-p. 001)

10-801201-01
CDH, RCD. December 1, 1980. Amendment No. 16. (CDH Exhibit A2-p. 019)

10-801202
CDH, RCD, K. Weaver. December 2, 1980. Letter to P. Rekemeyer, UCC. Request for information on groundwater and stability studies. (CDH Exhibit A4-p. 137)

10-801205-01
CDH, RCD, A. Hazle. December 5, 1980. Letter to R. Scarano, NRC. Request for additional visit by NRC consultant. (CDH Exhibit A4-p. 139)

10-801205-02
CDH, RCD, A. Hazle. December 5, 1980. Letter to R. Scarano, NRC. Notification of meeting on future waste management systems and questions for review. (CDH Exhibit A4-p. 141)

10-801224
CDH, RCD, A. Hazle. December 24, 1980. Letter to P. Rekemeyer, UCC. Extension of discharge into tails ponds subject to September 15, 1980 order. (CDH Exhibit A4-p. 143)

10-801231
CDH, RCD, A. Hazle. December 31, 1980. IOC to file. Concern that Uravan school built on tails; however, does not exceed GJTRP remedial action criteria. (CDH Exhibit A4-p. 145)

10-810113
CDH, RCD, A. Hazle. January 13, 1981. Letter to R. Beverly, UCC. Authorization to test/operate through March 31, 1981 the "seven hearth rotary furnace". (CDH Exhibit A4-p. 147)

10-810121
CDH, RCD, A Hazle. January 21, 1981. Letter to R. Beverly, UCC. Status of meteorological and MILDOS data. (CDH Exhibit A4-p. 149)

10-810409
CDH, RCD, A. Hazle. April 9, 1981. Letter to R. Scarano, NRC. Request for opinion: Spring Creek Mesa as "preferred alternative". (CDH Exhibit A4-p. 151)

10-810514-01
CDH, RCD, K. Weaver. May 14, 1981. IOC to K. Waesche, R. Shukle, C. Roberts, CDH. Preparation for May 28 and 29, 1981 meeting. (CDH Exhibit A4-p. 163)

10-810514-02
CDH, RCD, K. Weaver. May 14, 1981. IOC to R. Arnott, CDH. Background for May 28 and 29, 1981 meeting; includes key attachments. (CDH Exhibit A4-p. 161)

10-810514-03
CDH, RCD, A. Hazle. May 14, 1981. Letter to R. Beverly. Request for response to annotated copy of NRC consultant report on tailings stability. (CDH Exhibit A4-p. 155)

10-810514-04
CDH, RCD, A. Hazle. May 14, 1981. Letter to R. Scarano. Meeting schedule. (CDH Exhibit A4-p. 157)

10-810514-05
CDH, RCD, A. Hazle. May 14, 1981. Letter to R. Beverly. Meeting schedule. (CDH Exhibit A4-p. 159)

10-810515
CDH, RCD, A. Hazle. May 15, 1981. Letter to R. Beverly, UCC. Requests regarding waste management options. (CDH Exhibit A4-p. 169)

10-810609
CDH, RCD, K. Weaver. June 9, 1981. IOC to file. Agenda for meeting and notes. (CDH Exhibit A4-p. 171)

10-810609
CDH, RCD, K. Weaver. June 9, 1981. IOC to file. Meeting notes from June 3, 1981. (CDH Exhibit A4-p. 191)

10-810610
CDH, RCD, K. Weaver. June 10, 1981. IOC to file. Meeting of May 29, 1981. Phase 2B design, reclamation, surety, alternative long range plans, licensing agency requirements, mill and off-site radiological aspects. (CDH Exhibit A4-p. 175)

10-810612
CDH, RCD, A. Hazle. June 12, 1981. Letter to R. Beverly, UCC. Requests and conditions regarding Ponds 2 and 3 discharge, report on reclamation of surety and deadlines (with 4 key attachments). (CDH Exhibit A4-p. 197)

10-810624
CDH, RCD, A. Hazle. June 24, 1981. Letter to R. Beverly, UCC. Tantalum-columbium special ores. (CDH Exhibit A4-p. 231)

10-810902
CDH, RCD, K. Weaver. September 2, 1981. Transmittal slip and copy of generic draft license conditions in use by RCD. (CDH Exhibit A4-p. 235)

10-810902-01
CDH, RCD, A. Hazle. September 2, 1981. Letter to D. Nussbaumer, NRC. Request for information on NRC approach to UCC on 40 CFR 190. (CDH Exhibit A4-p. 233)

10-810922-00
CDH, RCD, A. Hazle. September 22, 1981. Letter to R. Beverly, UCC. Regarding License Amendment No. 17. (CDH Exhibit A3-p. 003)

10-810922-01
CDH, RCD. September 22, 1981. Amendment No. 17. (CDH Exhibit A2-p. 021)

10-810923-01
CDH, RCD, A. Hazle. September 23, 1981. Letter to R. Beverly, UCC. Authorization for individuals to use radioactive materials. (CDH Exhibit A4-p. 281)

10-810923-02
CDH, RCD, A. Hazle. September 23, 1981. Letter to K. Hamill, NRC. Request for information from NRC on financial assurance test method. (CDH Exhibit A4-p. 283)

10-811015
CDH, RCD, K. Weaver. October 15, 1981. IOC to file. Telcon with E. Kantz, UCC on July 7, 1981. Heap leach, need more time for lab tests. (CDH Exhibit A4-p. 285)

10-811023-01
CDH, RCD, A. Hazle. September 23, 1981. Letter to R. Beverly, UCC. Re: Ta-Co special ores. (CDH Exhibit A4-p. 287)

10-811023-02
CDH, RCD, A. Hazle. September 23, 1981. Letter to R. Beverly, UCC. Meeting on UCC appeal of Amendment 17. (CDH Exhibit A4-p. 289)

10-811123-01
CDH, RCD, A. Hazle. November 23, 1981. Letter to S. Spann, DWR, CDNR. Request that all 1981 tailings reports be reviewed. (CDH Exhibit A4-p. 291)

10-811123-02
CDH, RCD, A. Hazle. November 23, 1981. Letter to W. Junge, CGS, CDNR. Request that all 1981 tailings reports be reviewed. (CDH Exhibit A4-p. 293)

10-811123-03
CDH, RCD, A. Hazle. November 23, 1981. Letter to K. Waesche, CDH. Request that all 1981 tailings reports be reviewed. (CDH Exhibit A4-p. 295)

10-811202
CDH, RCD, K. Weaver. December 2, 1981. IOC to Pioneer file: Ground Water Protection. (CDH Exhibit A10)

10-811221
CDH, RCD, W. Jacobi. IOC to R. Arnott: Equivalency between HB 1468 & Radiation Regulations. (CDH Exhibit A10)

10-820118
CDH, RCD, A. Hazle. January 18, 1982. IOC to K. Waesche, WMD, CDH. Operation of Uravan mill in regard to tails piles. (CDH Exhibit A4-p. 297)

10-820127
CDH, RCD, K. Weaver. January 27, 1982. IOC to file. BLM role in licensing/EIS. (CDH Exhibit A4-p. 299)

10-820209
CDH, RCD, A. Hazle. February 9, 1982. IOC to file. CDH/UCC meeting of February 9, 1982. Discussion of renewal process. (CDH Exhibit A4-p. 301)

10-820217
CDH, RCD, K. Weaver. February 17, 1982. IOC to file. CDH/UCC meeting of February 17, 1982. Groundwater questions. (CDH Exhibit A4-p. 311)

10-820331
CDH, RCD, K. Weaver. March 31, 1982. IOC to Technical Review Committee. (CDH Exhibit A4-p. 315)

10-820511
CDH, RCD, K. Weaver. May 11, 1982. Telcon B. Flinn. BLM/CDH working agreements. (CDH Exhibit A4-p. 317)

10-820715
CDH, RCD: J. Smith. July 15, 1982. IOC to K. Weaver outlining Uravan 25 mrem/y evaluation. (CDH Exhibit A4-p. 319)

10-820715
CDH, RCD, K. Weaver. July 15, 1982. IOC to Technical Review Committee. Uravan strategy meeting. (CDH Exhibit A4-p. 321)

10-820824
CDH, RCD, K. Weaver. August 24 1982. Letter to P. Rekemeyer, UCC. Request for radiological data for J. Smith. (CDH Exhibit A4-p. 323)

10-820901
CDH, RCD, K. Weaver. September 1, 1982. IOC to file Telcon with Rowena Rogers, Secretary to State Land Board. Request by L. Thomas, Montrose County Commissioner to transfer BLM land to State via Land Board's "in lieu" selection program. (CDH Exhibit A4-p. 325)

10-820907
CDH, RCD, A. Hazle. September 7, 1982. Letter to M. Jones, BLM. Intention of becoming cooperating agency in EIS. (CDH Exhibit A4-p. 327)

10-821007
CDH, RCD, K. Weaver. October 7 1982. Letter to R. Jones, UCC. Request to modify piezometer monitoring program. (CDH Exhibit A4-p. 329)

10-821012-01
CDH, RCD, K. Weaver. October 12 1982. Letter to W. McDonald, Colorado Water Conservation Board. Request to review flood study. (CDH Exhibit A4-p. 332)

10-821012-02
CDH, RCD, K. Weaver. October 12 1982. IOC to J. Clouse, APCD. Offsite radiation doses via dust. (CDH Exhibit A4-p. 331)

10-821230
CDH, RCD, J. Smith - Consultant. December 30, 1982. Evaluation of Offsite Radiation Doses Due to the Uravan Uranium Mill. [mistakenly entered here out of order; report completed December 1982.] (CDH Exhibit A4-p. 423)

10-830125-00
CDH, RCD, A. Hazle. January 25, 1983. Letter to R. Beverly, UCC. Regarding License Amendment No. 18. (CDH Exhibit A3-p. 007)

10-830131-01
CDH, RCD. January 31, 1983. Amendment No. 18. (CDH Exhibit A2-p. 063)

10-830308-01
CDH, RCD, K. Weaver. March 8, 1983. Letter to R. Beverly, UCC. Administrative appeal of housekeeping amendment 18. (CDH Exhibit A4-p. 335)

10-830315
CDH, RCD, D. Brown. March 15, 1983. IOC to K. Weaver, RCD, CDH. Comments on mill in-plant and environmental procedures manual. (CDH Exhibit A4-p. 337)

10-830322-01
CDH, RCD. March 22, 1983. Amendment No. 19. (CDH Exhibit A2-p. 071)

10-830330
CDH, RCD, K. Weaver. March 30, 1983. Letter to R. Beverly, UCC. License schedule. (CDH Exhibit A4-p. 351)

10-830404
CDH, RCD, K. Weaver. April 4, 1983. Letter to R. Beverly, UCC. Provided initial draft of renewed license for comment. (CDH Exhibit A4-p. 353)

10-830419
CDH, RCD, C. Dogue. April 19, 1983. IOC to file. Provided initial draft of renewed license for comment. (CDH Exhibit A4-p. 353)

10-830510
CDH, RCD, A. Hazle. May 10, 1983. Letter to R. Beverly, UCC. Reclamation of existing wastes; CDH needs commitments. (CDH Exhibit A4-p. 357)

10-830511
CDH, RCD, A. Hazle. May 11, 1983. Letter to R. Beverly, UCC. New waste disposal area application shortcoming and CDH requirements. (CDH Exhibit A4-p. 361)

10-830520
CDH, RCD, K. Weaver. May 20 1983. IOC to Geotechnical Review Committee. Meeting with UCC on May 26, 1983 and two main topics of discussion on Spring Creek: groundwater, borrow clay. (CDH Exhibit A4-p. 365)

10-830621
CDH, RCD, K. Weaver. June 21 1983. IOC to file. Initial review of offsite dose projections for Uravan. (CDH Exhibit A4-p. 367)

10-830628
CDH, RCD, K. Weaver. June 28 1983. Letter To R. Lawrence, NWF. Participation in license renewal. (CDH Exhibit A4-p. 369)

10-830802-02
CDH, RCD, K. Weaver. August 2, 1983. Letter To R. Beverly, UCC. Order to report revised tailings tonnages. (CDH Exhibit A4-p. 371)

10-830808
CDH, RCD. August 8, 1983. Letters to repositories. Checking which documents on file at libraries. (CDH Exhibit A4-p. 373)

10-830822-01
CDH, RCD, K. Weaver. August 22, 1983. Letter to W. Junge, CGS, CDNR. Request for review of tailings monument data. (CDH Exhibit A4-p. 377)

10-830823-01
CDH, RCD, K. Weaver. August 23, 1983. Letter to R. Lawrence, NWF. Notification of August 24, 1983 meeting. (CDH Exhibit A4-p. 379)

10-830829
CDH, RCD, K. Weaver. August 29, 1983. IOC to D. Brown, RCD, CDH. Plan for Uravan air particulate data review. (CDH Exhibit A4-p. 381)

10-830830
CDH, RCD, K. Weaver. August 30, 1983. Letter to K. Green, NWF. Invitation for radiation protection meeting, early September. (CDH Exhibit A4-p. 383)

10-830831
CDH, RCD, K. Weaver. August 31, 1983. Letter to R. Beverly, UCC. Offsite radiation dose to Uravan residents. (CDH Exhibit A4-p. 385)

10-830908
CDH, RCD, K. Weaver. September 8, 1983. IOC to M. Jones. Uravan benefit/cost. (CDH Exhibit A4-p. 387)

10-830914
CDH, RCD, K. Weaver. September 14, 1983. IOC to A. Hazle, RCD, CDH. Unresolved issues and related schedules. (CDH Exhibit A4-p. 389)

10-830921
CDH, RCD, K. Weaver. September 21, 1983. IOC to file. M. Puls telcon. (CDH Exhibit A4-p. 391)

10-831003-01
CDH, M. Jones. October 3, 1983. Letter to M. Puls, FUTURE. Transmittal of requested CDH documents. (CDH Exhibit A4-p. 395)

10-831003-02
CDH, RCD, K. Weaver. October 3, 1983. Letter to R. Jones, UCC. Follow-up regarding Rn-222 data provided September 27th. (CDH Exhibit A4-p. 393)

10-831017
CDH, RCD, K. Weaver. October 17, 1983. Letter to R. de Hollander, UCC. Uravan radiation control. (CDH Exhibit A4-p. 397)

10-831025-01
CDH, RCD, K. Weaver. October 25, 1983. Letter to R. Lawrence. (CDH Exhibit A4-p. 403)

10-831101
CDH, RCD, K. Weaver. November 1, 1983. IOC to W. Jacobi, CDH. Uravan schedule update. (CDH Exhibit A4-p. 413)

10-831115
CDH, RCD, K. Weaver. November 15, 1983. Letter to R. Lawrence-NWF and R. Yuhnke-EDF. Uravan radiation control analysis request. (CDH Exhibit A4-p. 415)

10-831201-01
CDH, RCD, A. Hazle. December 1, 1983. Letter to R. Jones, UCC. Revisions to UCC Environmental Procedures Manual. (CDH Exhibit A4-p. 405)

10-831212
CDH, RCD, A. Hazle. December 12, 1983. Letter to J. Frost, UCC. Interim stabilization. (CDH Exhibit A4-p. 417)

10-831214
CDH, RCD, A. Hazle. December 14, 1983. IOC to file. Summary of December 12, 1983 government officials meeting in Montrose on licensing status. (CDH Exhibit A4-p. 419)

10-831221
CDH, RCD, A. Hazle. December 21, 1983. Letter to R. Jones, UCC. Revisions to UCC Environmental Procedures Manual. (CDH Exhibit A4-p. 421)

10-840112
CDH, RCD, K. Weaver. January 12, 1984. IOC to T. Vernon, CDH. Uravan relicensing schedule. (CDH Exhibit A4-p. 424)

10-840206
CDH, RCD, A. Hazle. February 6, 1984. Letter to J. Frost, UCC. Policy clarifying rules revised schedule. (CDH Exhibit A4-p. 426)

10-840224
CDH, RCD, K. Weaver. February 24, 1984. IOC to file. Still receiving changes to UCC documents. (CDH Exhibit A4-p. 432)

10-840308
CDH, RCD, K. Weaver. March 8, 1984. Letter to R. Lawrence, NWF. Schedule clarification. (CDH Exhibit A4-p. 434)

10-840310-01
CDH, RCD, K. Weaver. March 10, 1984. IOC to T. Vernon, CDH. Action time frames for uranium mills. (CDH Exhibit A4-p. 436)

10-840310-02
CDH, RCD, K. Weaver. March 10, 1984. IOC to T. Vernon, CDH. Town of Uravan radiation dose, with attachment dated May 22, 1980 on use of emergency orders. (CDH Exhibit A4-p. 440)

10-840321
CDH, RCD, M. Jones-M. K. Jones. March 21, 1984. IOC to file. Minutes of January 12, 1984 licensing logistics meeting. (CDH Exhibit A4-p. 448)

10-840328-01
M. K. Jones & Associates, M. Jones. March 28, 1984. IOC to A. Hazle, RCD, CDH. Environmental Group participation in the UCC Uravan licensing process. (CDH Exhibit A4-p. 454)

10-840329-00
CDH, RCD, A. Hazle. March 29, 1984. Cover letter to R. Beverly, UCC. Regarding License Amendment No. 20. (CDH Exhibit A3-p. 013)

10-840329-01
CDH, RCD, A. Hazle. March 29, 1984. License amendment 20.

10-840330
CDH, RCD, E. Kray. March 30, 1984. Letter to Owen Calloway, UCC. Comments on quality assurance manual revisions. (CDH Exhibit A4-p. 456)

10-840331-01
CDH, RCD. March 31, 1984. Amendment No. 20. (CDH Exhibit A2-p. 073)

10-840423
CDH, RCD, K. Weaver. April 23, 1984. IOC to R. Arnott. Uravan Rn levels. (CDH Exhibit A4-p. 460)

10-840427
CDH, RCD, A. Hazle. April 27, 1984. Letter to J. Frost, Umetco. (p. 89 and 97, November 19, 1984 transcript.) (CDH Exhibit A10 p. 89 & 97)

10-840427
CDH, RCD, A. Hazle. April 27, 1984. Letter to J. Frost, Umetco. (p. 89 and 97, November 19, 1984 transcript) (CDH Exhibit A10)

10-840430
CDH, RCD, E. Kray. April 30, 1984. IOC on Uravan Radon issue. (CDH Exhibit A5)

10-840522-00
CDH, RCD, A. Hazle. May 22, 1984. Notice of Hearing. (CDH Exhibit A5-p. 464)

10-840522-01
CDH, A. Hazle & K. Weaver. May 22, 1984. Preliminary Executive Licensing Review Summary. (CDH Exhibit A1)

10-840522-02
CDH, RCD, A. Hazle. May 22, 1984. Transmittal of PELRS to interested persons. (CDH Exhibit A5-p. 468)

10-840529
CDH, RCD, K. Weaver. June 29, 1984. IOC to the Uravan File. Telecon with M. Puls, Future.

10-840531
CDH, RCD, M. Jones. May 31, 1984. PELRS distribution list. (CDH Exhibit A5-p. 476)

10-840614
CDH, RCD, K. Weaver. June 14, 1984. Notice of meeting June 21, 1984. (CDH Exhibit A5-p. 478)

10-840627
CDH, RCD, A. Hazle. June 27, 1984. Letter to R. Yuhnke, EDF, and F. Green, NWF, in response to May 15, 1984 letter to T. Vernon, CDH. (CDH Exhibit A5-p. 482)

10-840629
CDH, RCD, K. Weaver. June 29, 1984. IOC on EDF letter of 5/24/84. (CDH Exhibit A5)

10-840629
CDH, RCD, K. Weaver. June 29, 1984. Notice of meeting July 10, 1984. (CDH Exhibit A5-p. 479)

10-840629
CDH, RCD, K. Weaver. June 29, 1984. IOC to file. Telcon with M. Puls, FUTURE. (CDH Exhibit A5-p. 502)

10-840712
CDH, RCD, A. Hazle. July 12, 1984. IOC to file. Ex parte communication with J. Frost, Umetco. (CDH Exhibit A5-p. 504)

10-840731
CDH, RCD, K. Weaver. July 31, 1984. IOC to file. Present Uravan LCs related to off-site dose. (CDH Exhibit A5-p. 506)

10-840801
CDH, RCD, K. Weaver. August 1, 1984. IOC to file. Proposed Uravan LCs related to off-site dose. (CDH Exhibit A5-p. 512)

10-840814
CDH, RCD. August 14, 1984. IOC to J. Martin, EDF. Reply to July 3, 1984 EDF letter. (p. 348, August 22, 1984 transcript). (CDH Exhibit A5 p. 348)

10-840817-00
CDH, RCD. August 17, 1984. Supplemental Exhibit List.

10-840817-01
CDH, RCD: R. Junge. August 17, 1984. Resume and written testimony on Reclamation of Existing Facilities. W. Junge Resume. (p. 213 August 21, 1984 transcript).

10-840817-02
CDH, RCD: M. Galloway. August 17, 1984. Resume and written testimony. (p. 206, August 21, 1984 transcript) (CDH Exhibit C1)

10-840817-03
CDH, RCD, K. Weaver. August 17, 1984. Resume and written public hearing testimony concerning Financial Assurance Arrangements for Reclamation and Long-Term Care. (p. 248, August 21, 1984 transcript)

10-840821-01
CDH. August 21, 1984. Reporter's Transcript, Vol. 1.

10-840821-02
CDH. August 21, 1984. Reporter's Transcript, Vol. 2.

10-840821-03
CDH. August 21, 1984. Reporter's Transcript, Vol. 3.

10-840821-04
CDH. August 21, 1984. Reporter's Transcript, Vol. 4.

10-840821-05
CDH. August 21, 1984. Reporter's Transcript, Vol. 5.

10-840918
CDH, RCD, X. Weaver. September 18, 1984. Letter to J. Frost, Umetco. New Disposal Area Technical Summary Meeting to be held October 12, 1984. (CDH Exhibit A10)

10-840920
CDH, RCD, A. Hazle. September 20, 1984. IOC to file: Ex Parte Communication. (CDH Exhibit A10)

10-840921-06
CDH, RCD, M. Jones. September 21, 1984. IOC to file: M. Puls hearing comments. (CDH Exhibit A10)

10-840925
CDH, RCD, M. Jones. September 25, 1984. IOC to file: Clarification of M. Puls hearing question. (CDH Exhibit A10)

10-840927
CDH, RCD, D. Stephens. September 27, 1984. Letter concerning hydrogeology of Spring Creek Mesa and ex parte conversation with D. McWhorter. (CDH Exhibit A10)

10-841016
CDH, RCD. October 16, 1984. Indirect Cost Rates. (CDH Exhibit A3)

10-841105-01
CDH, D. Stephens. November 5, 1984. Resume. (p. 287, November 20, 1984 transcript) (CDH Exhibit A3)

10-841105-02
CDH, F. Phillips. November 5, 1984. Resume. (CDH Exhibit A3)

10-841119-01
CDH. November 19, 1984. Reporter's Transcript, Vol. 1.

10-841119-02
CDH. November 19, 1984. Reporter's Transcript, Vol. 2.

10-841119-03
CDH. November 19, 1984. Reporter's Transcript, Public Testimony.

10-841119-04
CDH. November 19, 1984. M. Gdovin Resume. (p. 144, November 19, 1984 transcript) (CDH Exhibit A10)

10-841119-05
CDH. November 19, 1984. T. Hancock Resume. (p. 176, November 19, 1984 transcript) (CDH Exhibit A10)

10-850110
CDH, RCD, A. Hazle. January 10, 1985. Letter to D. Sparling, Umetco. Inspection of July 9-13, 1984.

10-850116
CDH, RCD, A. Hazle. January 16, 1985. Letter to R. Beverly, Umetco. Uravan mill compliance issues.

10-850425
CDH, RCD, A. Hazle. April 25, 1985. Letter to D. Sparling, Umetco. Uravan 1984 inspection corrective actions.

10-850426
CDH, RCD, A. Hazle. April 26, 1985. Letter to J. Frost, Umetco. Annual Reports: Non-Compliance.

10-850510-00
CDH, RCD, A. Hazle. May 10, 1985. Letter to J. Frost, Umetco. Transmittal of Amendment 22, Concerning Irrevocable Letter of Credit.

10-850510-01
CDH, RCD. May 10, 1985. Amendment No. 22, RML SUA-673.

10-850513
CDH, RCD, K. Weaver. May 13, 1985. IOC to A. Hazle, RCD, CDH. Compliance follow-up.

10-850514-00
CDH, RCD, A. Hazle. May 14, 1985. Letter to J. Frost, Umetco. Transmittal of Amendment 23, Interim and Final Residue Disposal.

10-850514-01
CDH, RCD, A. Hazle. May 14, 1985. Amendment 23, RML SUA-673.

10-850606-01
CDH, RCD, K. Weaver. June 6, 1985. Letter to J. Frost, Union Carbide Corporation. Consumer Price Index figures used in calculating inflation.

10-850822
CDH, RCD, K. Weaver. August 22, 1985. IOC to Uravan File, RCD, CDH. Uravan Inspection.

10-851107
CDH, RCD, A. Hazle. November 7, 1985. IOC to Uravan File, RCD, CDH. House removals.

10-851112
CDH, RCD, E. Kray. November 12, 1985. IOC to Uravan File, RCD, CDH. Release of houses from G-Block.

10-860130
CDH, RCD, A. Hazle. January 30, 1986. Letter to J. Frost, Umetco. Proposed amendment #22; Administrative Hearing.

10-860311-00
CDH, RCD, A. Hazle. March 11, 1986. Letter to J. Frost, Umetco. 1984 Off-Site Dose Assessment.

10-860404
CDH, RCD, A. Hazle. April 4, 1986. Letter to R. Jones, Umetco. 1986 Annual Report.

10-860416
CDH, RCD, A. Hazle. April 16, 1986. Letter to R. Jones, Umetco. 1985 Annual Report.

10-860821-01
CDH, RCD. August 21, 1986. Reporter's Transcript of Public Hearing, Nucla, Colorado. (Tr.-1, Vol. I)

10-860821-02
CDH, RCD. August 21, 1986. Reporter's Transcript of Public Hearing, Nucla, Colorado. (Tr.-1, Vol. II)

10-860821-03
CDH, RCD. August 21, 1986. Reporter's Transcript of Public Hearing, Nucla, Colorado. (Tr.-1, Vol. III)

10-860821-04
CDH, RCD. August 21, 1986. Reporter's Transcript of Public Hearing, Nucla, Colorado. (Tr.-1, Vol. IV)

10-860825
CDH, RCD. August 25, 1986. Radioactive materials license 660-02S. Attachment 2 to 01-861030.

10-860919
CDH, RCD. September 19, 1986. Radioactive materials license 660-02S. Attachment 3 to 01-861030.

10-861020
CDH, RCD. October 20, 1986. Radioactive materials license 660-02S. Attachment 4 to 01-861030.

10-861119
CDH, RCD. November 19, 1986. Reporter's Transcript of Public Hearing, Montrose, Colorado. (Tr.-2, Vol. I)

10-861120
CDH, RCD. November 20, 1986. Reporter's Transcript of Public Hearing, Montrose, Colorado. (Tr.-2, Vol II)

10G-790700
Cunningham, M.; Ferguson, S.; and Foreman, T. July 1979. Excess Cancer Incidence in Mesa County, Colorado. (CDH Exhibit A7)

10G-820201
CDH, RCD. Contents, Source Material Milling Packet. (CDH Exhibit A7)

10G-820701-01
CDH, RCD. Transmittal Letter, Source Material Milling Packet. (CDH Exhibit A7)

10G-820701-02
CDH, RCD. Colorado Uranium Mill Licensing Guide. July 1, 1982. (CDH Exhibit A7)

10G-820701-06
CDH, RCD. Decontamination Guide. (CDH Exhibit A7)

10G-820701-07
CDH, RCD. Staging Diagram for Colorado Department of Health Review Process for Uranium Mills. (CDH Exhibit A7)

10G-831027-01
CDH, RCD. October 27, 1983. Policy on Financial Assurance Tests for Source Material Mill Radioactive Materials Licenses. (CDH Exhibit A3)

10G-831027-01
CDH, RCD. October 27, 1983. Soil Contamination Guidance Policy. (CDH Exhibit A6)

10G-831027-01
CDH, RCD. October 27, 1983. Policy on Financial Assurance Tests for Source Material Mill Radioactive Materials Licenses. (CDH Exhibit A6)

10G-831031-01
CDH, RCD. October 31, 1983. Guidelines for Agriculture Department Review for Uranium Mill Projects, Revision 1. (CDH Exhibit A7)

10G-831031-02
CDH, RCD. October 31, 1983. Guidelines for Local Affairs Review for Uranium Mill Projects, Revision 1. (CDH Exhibit A7)

10G-831031-03
CDH, RCD. October 31, 1983. Guidelines for Colorado Geological Survey Review for Uranium Mill Projects, Revision 1. (CDH Exhibit A7)

10G-831031-04
CDH, RCD. October 31, 1983. Guidelines for Wildlife Division Review for Uranium Mill Projects, Revision 1. (CDH Exhibit A7)

10G-831031-05
CDH, RCD. October 31, 1983. Guidelines for Mined Land Reclamation Division Review for Uranium Mill Projects, Revision 1. (CDH Exhibit A7)

10G-831031-06
CDH, RCD. December 31, 1983. Guidelines for Colorado Historical Society Review for Uranium Mill Projects, Revision 0. (CDH Exhibit A7)

10G-831031-12
CDH, RCD. October 31, 1983. Policy on Elements of Long-Term Care Agreements. (p. 250, August 21, 1984 transcript) (CDH Exhibit A6)

10G-831116
CDH, RCD. November 16, 1983. Radiation Control Division Uranium Operating Plan. (CDH Exhibit A7)

10G-831201-01
CDH, RCD. December 31, 1983. Guidelines for Air Pollution Control Division Review for Uranium Mill Projects, Revision 0. (CDH Exhibit A7)

10G-831201-02
CDH, RCD. December 31, 1983. Guidelines for Epidemiology and Disease Control Division Review for Uranium Mill Projects, Revision 0 effective December 1, 1983. (CDH Exhibit A7)

10G-831201-03
CDH, RCD. December 31, 1983. Guidelines for Laboratory Division Review for Uranium Mill Projects, Revision 0. (CDH Exhibit A7)

10G-831201-06
CDH, RCD. December 31, 1983. Guidelines for Office of Health Protection Review for Uranium Mill Projects, Revision 0. (CDH Exhibit A7)

10G-831201-07
CDH, RCD. December 31, 1983. Guidelines for Highway Department Review for Uranium Mill Projects, Revision 0. (CDH Exhibit A7)

10G-831201-08
CDH, RCD. December 31, 1983. Guidelines for Colorado Division of Water Resources Review for Uranium Mill Projects, Revision 0. (CDH Exhibit A7)

10G-831201-09
CDH, RCD. December 31, 1983. Guidelines for Review for Uranium Mill Projects (Colorado Department of Natural Resources Executive Director's Office Staff), Revision 0. (CDH Exhibit A7)

10G-831201G-10
CDH, RCD. December 31, 1983. Guidelines for State Board of Land Commissioner Review for Uranium Mill Projects, Revision 0. (CDH Exhibit A7)

10G-831201G-11
CDH, RCD. December 31, 1983. Guidelines for State Water Conservation Board Review for Uranium Mill Projects, Revision 0. (CDH Exhibit A7)

10G-831213
CDH, RCD, M. Jones. December 13, 1983. Long Term Monitoring and Maintenance Option Draft. (p. 252, August 21, 1984 transcript) (CDH Exhibit A6)

11-811221
CDH, WQCD, G. Broetzman. December 21, 1981. IOC to W. Jacobi, J. Love: Equivalency between HB 1468 and Radiation Regulations. (CDH Exhibit C6)

11-811229
CDH, WQCD, M. Luizzi. December 29, 1981. IOC to G. Broetzman thru J. Love: Equivalency between 1468 and Radiation Regulations. (CDH Exhibit C6)

11-830000
CDH, WQCD. 1983. Suggested Guidelines Only. (CDH Exhibit C6)

11-840730
CDH, WQCD, M. Luizzi. July 30, 1984. Letter to R. Junge. Ref. Statement of Testimony for August 21-23 Hearings for Uravan Sites. (CDH Exhibit C6)

11-841024
CDH, WQCD, D. Simpson. October 24, 1984. IOC to K. Weaver, RCD, CDH. Review and comments for Spring Creek Mesa PELRS Supplement. (CDH Exhibit C6)

11-841105-01
CDH, WQCD, M. Liuzzi. November 5, 1984. Resume. (CDH Exhibit C6)

11-841105-02
CDH, WQCD, M. Gdovin. November 5, 1984. Resume. (CDH Exhibit C6)

11G-790104
WQCD. January 4, 1979. Regulation 9.1.10, Guidelines for the Design, Operation and Maintenance of Mill Tailings Ponds to Prevent Water Pollution. (CDH Exhibit A7)

11G-840100
CDH, WQCD, M. Gdovin. January 1984. Economic Reasonableness: Exploration of the Issues. Draft Copy. (CDH Exhibit A7)

11G-840700
CDH, WQCD, M. Gdovin. January 1984. Economic Reasonableness: Principles and Guidelines. Draft Copy. (CDH Exhibit A7)

12-841010
CDH, R. Arnott. October 10, 1984. Letter to C. Albrecht, Friends of the Earth. (CDH Exhibit C6)

12-860729
CDH, OHP, R. Arnott. July 29, 1986. Notice of Reopening of Record.

12-861031
CDH, OHP, G. Broetzman. October 31, 1986. Supplement to the Record.

12-861125
CDH, OHP, G. Broetzman. November 25, 1986. Order extending period for comment on Supplement to the Record.

12G-671001
CDH. Instructions For Preparation of Application For Radioactive Material License, Form AORG-RHG-11. (CDH Exhibit A7)

12G-740319
CDH, Division of Administration. March 19, 1974. Water Quality Standards and Stream Classification. Effective June 19, 1974. As subsequently revised. (CDH Exhibit A7)

12G-761101
CDH. Application for Radioactive Materials License, Form AORG-RHG-11. (CDH Exhibit A7)

12G-771213
CDH, Division of Administration. December 13, 1977. Primary Drinking Water Regulations for the State of Colorado. As subsequently revised. (CDH Exhibit A7)

12G-800101
CDH. Title 25, Article 11, entitled Radiation Control, Colorado Revised Statutes, 1973, as amended. (CDH Exhibit A7)

12G-810819-01
CDH, Colorado Board of Health. August 19, 1981. Amendments to State of Colorado Rules and Regulations Pertaining to Radiation Control. Effective October 1, 1981. (CDH Exhibit A7)

12G-810819-02
CDH, Colorado Board of Health. August 19, 1981. Rational of the Amendments to the Colorado Rules and Regulations Pertaining to Radiation Control, list of commentors attachment. (changed from "Statement of Basis and Purpose" p. 91 & 96, November 19, 1984 transcript) (CDH Exhibit A7)

12G-810819-03
CDH, Colorado Board of Health. August 19, 1981. Transcript of Board of Health Deliberation August 19, 1981. (CDH Exhibit A7)

12G-820316
CDH. February 16, 1982. Memorandum of Understanding: Radioactive Materials License Reviews for Source Material Milling Operations. (CDH Exhibit A7)

12G-820325
CDH. March 25, 1982. Directive Concerning Radioactive Material License Reviews for Source Material Milling Operations. (CDH Exhibit A7)

12G-820420
CDH. April 20, 1982. Agreement and Amended Agreement between the State of Colorado and the U.S. Nuclear Regulatory Commission. (CDH Exhibit A7)

12G-820920-01
CDH, Division of Administration. September 20, 1982. Proposed Rule: Exemption for Nuclear or Radioactive Wastes From the Requirement for a Permit Under C.R.S. 1973, 25-8-506 (Supp. 1981). (CDH Exhibit A7)

12G-820920-02
CDH, Division of Administration. September 20, 1982. Rationale for the Colorado Department of Health Division of Administration Proposal With Respect To 25-8-506(3) Determination. (CDH Exhibit A7)

12G-820920-03
CDH, Colorado Board of Health. September 20, 1982. Transcript of Board of Health Deliberation September 20, 1982.. (CDH Exhibit A7)

12G-821214-01
CDH, Division of Administration. December 14, 1982. Exemption for Nuclear or Radioactive Wastes From the Requirement for a Permit Under C.R.S. 1973, 25-8-506 (Supp. 1981). Effective January 30, 1983. (CDH Exhibit A7)

12G-821214-02
CDH, Division of Administration. December 14, 1982. Statement of Basis and Purpose for Division of Administration Determination Under C.R.S. 1973, 25-8-506 (Supp. 1981). (CDH Exhibit A7)

12G-830700
CDH. July 1983. Title 25, Article 8, Colorado Water Quality Control Act. (CDH Exhibit A7)

12G-841029
CDH, T. Vernon. October 29, 1984. Memorandum on Groundwater Quality Protection. (CDH Exhibit A7)

13G-800000
Colorado State Highway Commission, Regulation 42-4-1208, Spilling Loads on Highways Prohibited. (CDH Exhibit A7)

13G-810101
Colorado State Department of Highways, Traffic Regulations Governing the Use of the Eisenhower Memorial Tunnels, effective January 1, 1981. (CDH Exhibit A7)

13G-820000
Colorado State Department of Highways, Rules and Regulations Pertaining to Special Permits for Movement or Operation of Vehicles of Excess Size or Weight of Vehicle or Load on the State Highway System and for Mobile Homes on Any Highway in the State. (CDH Exhibit A7)

13G-820715
Colorado State Highway Commission, The State Highway Access Code, adopted July 16, 1981, amended July 15, 1982. (CDH Exhibit A7)

15-841105-01
CGS, W. Junge. November 5, 1984. Alternatives Discussed with Umetco on Facility Design, Spring Creek Mesa. (CDH Exhibit C6)

15-841105-02
CGS, W. Junge & M. Galloway. November 5, 1984. Seepage Summary of Potential Disposal Systems, Spring Creek Mesa, Uravan, Colorado. (CDH Exhibit C6)

15-850913
CDNR, CGS, W. Junge. September 13, 1985. Letter to K. Weaver, RCD, CDH. Quality Control Inspection, Uravan.

15G-791010
CGS. October 10, 1979. Recommended Guidelines for Preparing Engineering Geologic Reports for Uranium Mill Siting, Radioactive Tailing Storage and Associated Land Use Changes. (CDH Exhibit A7)

15G-830600
CGS, W. Junge and L. Duzman. June, 1983. An Analysis of Control Standards for the Long-Term Containment of Uravan Tailings. (CDH Exhibit A7)

17-841022
CDNR, DWR, J. Romero. October 10, 1984. Letter to M. Jones. Review of Umetco Spring Creek Mesa proposal. (CDH Exhibit C6)

17G-750000
Division of Water Resources. 1975. Colorado Water Laws, Vol. II, Chapter IV, Section 5, Abandonment Regulations. (CDH Exhibit A7)

20-811106
MLR. November 6, 1981. Reclamation cost estimate, Quinn Coal Company, Tomahawk Mine. (p. 223, August 21, 1984 transcript) (CDH Exhibit C1)

20G-760000
MLR. 1976. Mined Land Reclamation Act, House Bill 1065. (CDH Exhibit A7)

22G-730000
Colorado Historical, Prehistorical and Archeological Resources Act of 1973. (CDH Exhibit A7)

24-840809-00
Montrose County Commissioners, J. Brooks. August 9, 1984. Pre-Hearing Statement.

24-840809-01
Montrose County Commissioners, Assessor. August 9, 1984. Top Ten Taxpayers in Montrose County, dated December 29, 1983. (Montrose County Commissioners Exhibit 1)

24-840809-02
Montrose County Commissioners, Assessor. August 9, 1984. Table of Production Tax in Montrose County. (Montrose County Commissioners Exhibit 2)

24-840809-03
Montrose County Commissioners: District 10 Regional Planning Commission. August 9, 1984. Socio-Economic Conditions in the West End of Montrose and San Miguel Counties. (Montrose County Commissioners Exhibit 3)

24-840809-04
Montrose County Commissioners: District 10 Regional Planning Commission. August 9, 1984. Full-time Workforce, Table No. 5. (Montrose County Commissioners Exhibit 4)

24-840821
San Miguel County Commissioners, R. Snyder. August 21, 1984. Letter to A. Hazle, RCD, CDH. (CDH Exhibit C6)

24-840821-02
Montrose County Commissioners, R. Corey. August 21, 1984. Written testimony.

24-840821-02
San Miguel County Commissioner, R. Snyder. August 21, 1984. Letter to A. Hazle, RCD, CDH.

28-840910
City of Grand Junction, M. Pecheco, Mayor. September 10, 1984. Letter to R. Arnott, OHP.

30G-760000-01
IAEA. 1976. Manual on Radiological Safety in Uranium and Thorium Mills. IAEA Safety Series No. 43. (CDH Exhibit A7)

30G-760000-02
IAEA. 1976. Management of Wastes from Mining and Milling Uranium and Thorium Ores. IAEA Safety Series No. 44. (CDH Exhibit A7)

31-840213
NRC, D. Smith. February 13, 1984. 40 CFR 192, EPA Standards. (CDH Exhibit C6)

31-840813
NRC, D. Smith. August 13, 1984. Letter to A. Hazle, RCD, CDH. NRC comments on the Uravan PELRS. (p. 249, August 21, 1984 transcript). (p. 249) (CDH Exhibit C3)

31-840813
NRC, D. Smith. August 13, 1984. Letter to A. Hazle, RCD, CDH. Comments on April 27, 1984 letter of CDH to Umetco. (p. 249, August 21, 1984 transcript) (CDH Exhibit C6)

31-840816
NRC. August 16, 1984. Uravan, Colorado, Radiation Regulations Report by Special Study Staff. (p. 355, August 22, 1984 transcript). (CDH Exhibit C3)

31-840816
NRC, J. Collins. August 16, 1984. Uravan, Colorado Radiation and Regulation (Report by Special Study Staff). (p. 355, August 22, 1984 transcript). (CDH Exhibit C3)

31-860224
NRC, D. Nussbaumer. February 24, 1986. Letter to Texas, New Mexico, Washington, and Colorado. Financial assurances for uranium recovery licensees.

31-861014
NRC, R. Smith. October 14, 1986. Letter to A. Hazle, RCD, CDH. NRC review of Uravan RAP.

31G-720217
NRC. February 17, 1972. Safety Guide 23, Onsite Meteorological Programs. (CDH Exhibit A7)

31G-740600
NRC. June 1974. Regulatory Guide 8.11, Applications of Bioassay for Uranium. (CDH Exhibit A7)

31G-750900
NRC. September 1975. Regulatory Guide 8.10, Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable, Revision 1. (CDH Exhibit A7)

31G-751100
NRC. November 1975. Regulatory Guide 8.13, Instructions Concerning Prenatal Radiation Exposure, Revision 1. (CDH Exhibit A7)

31G-761000-01
NRC. October 1976. Regulatory Guide 8.15, Acceptable Programs for Respiratory Protection. (CDH Exhibit A7)

31G-761000-02
NRC. October 1976. Manual of Respiratory Protection Against Airborne Radioactive Materials. (CDH Exhibit A7)

31G-771200
NRC. December 1977. Regulatory Guide 3.11, Design, Construction, and Inspection of Embankment Retention Systems For Uranium Mill, Revision 2. (CDH Exhibit A6)

31G-780306
NRC. March 6, 1978. Branch Position, Contents of Applications for Uranium Ore-Buying Station Licenses. (CDH Exhibit A7)

31G-780400
NRC. April 1978. Regulatory Guide 1.138, Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants. (CDH Exhibit A7)

31G-780700
NRC. July 1978. Regulatory Guide 8.22, Bioassay at Uranium Mills. (CDH Exhibit A7)

31G-790200
NRC. February 1979. Regulatory Guide 4.15 Quality Assurance for Radiological Monitoring Program (Normal Operations) - Effluent Streams and the Environment, Revision 1. (CDH Exhibit A6)

31G-790300
NRC. March 1979. Regulatory Guide 1.132, Site Investigations for Foundations of Nuclear Power Plants, Revision 1. (CDH Exhibit A7)

31G-800400
NRC. April 1980. Regulatory Guide 4.14, Radiological Effluent and Environmental Monitoring at Uranium Mills, Revision 1. (CDH Exhibit A6)

31G-800800
NRC. May, 1983. Regulatory Guide, 8.31, Information Relevant To Ensuring That Occupational Radiation Exposures at Uranium Mills Will Be As Low As Is Reasonably Achievable. (CDH Exhibit A6)

31G-800900
NRC. September 1980. Final Generic Environmental Impact Statement on Uranium Milling. NUREG-0706, V. 1, 2 & 3. (CDH Exhibit A7)

31G-801000
NRC. October 1980. Regulatory Guide 3.11.1, Operational Inspection and Surveillance of Embankment Retention Systems for Uranium Mill Tailings, Revision 1. (CDH Exhibit A6)

31G-810400
NRC. April 1981. MILDOS - A Computer Program for Calculating Environmental Radiation Doses from Uranium Recovery Operations. NUREG/CR-2011. (CDH Exhibit A7)

31G-810700
NRC. July 1981. Regulatory Guide 8.29, Instruction Concerning Risk From Occupational Radiation Exposure. (CDH Exhibit A7)

31G-810800
NRC. August, 1981. Regulatory Guide 3.5, Standard Format and Content of License Applications For Uranium Mills, Revision 2. (CDH Exhibit A6)

31G-820200
NRC. February 1982. Compliance Determination Procedures for Environmental Radiation Protection Standards for Uranium Recovery Facilities - 40 CFR 190, NUREG-0859. (CDH Exhibit A6)

31G-820201
NRC. February 1, 1982. Draft Staff Technical Position WM-8201, Hydrologic Design Criteria for Tailings Retention Systems. (CDH Exhibit A7)

31G-820300
NRC. March 1982. Regulatory Guide 3.51 (Task RH 802-4), Calculational Models For Estimating Radiation Doses to Man From Airborne Radioactive Materials Resulting From Uranium Milling Operations. (CDH Exhibit A6)

31G-820600
NRC. June 1982. Draft Regulatory Guide, 3.46, Standard Format and Content of License Applications, Including Environmental Reports, for In Situ Uranium Solution Extraction. (CDH Exhibit A7)

31G-820800
NRC. August 1982. Uranium Mill Appraisal Program. NUREG-0883. (CDH Exhibit A7)

31G-821000
NRC. October 1982. Regulatory Guide 3.8, Preparation of Environmental Reports For Uranium Mills, Revision 2. (CDH Exhibit A6)

31G-821100
NRC. November 1982. Draft Regulatory Guide, MS 146-4, Design, Installation, and Inspection of Seepage Control Liners at Uranium Tailings Facilities. (CDH Exhibit A7)

31G-830500
NRC. May 1983. Regulatory Guide 8.31, Information Relevant to Ensuring that Occupational Radiation Exposure at Uranium Mills Will Be As Low as Reasonably Achievable. (CDH Exhibit A7)

31G-830600
EPA; CDH, D. Ouimette, S. Ferguson, et al., June 1983. An Epidemiologic Study of Selected Malignant Neoplasms in Mesa County, Colorado 1970-1979. (CDH Exhit t A7)

31G-830619
NRC. June 19, 1983. Regulatory Guide 8.30, Health Physics Surveys in Uranium Mills. (CDH Exhibit A6)

31G-840200
NRC. February 1984. Occupational Radiological Monitoring at Uranium Mills. NUREG/CR-3598. (CDH Exhibit A6)

31G-840300
NRC. March 1984. Designing Vegetation Covers for Long-Term Stabilization of Uranium Mill Tailings. NUREG/CR-3674. (CDH Exhibit A7)

31G-840400
NRC. April 1984. Laboratory Testing of Chemical Stabilizers for Control of Fugitive Dust Emissions from Uranium Mill Tailings. NUREG/CR-3697. (CDH Exhibit A7)

32-780900
EPA. September 1978. Water Movement in Uranium Mill Tailings Profiles. PB-291 688. (CDH Exhibit C5)

32-840720
EPA, J. Kolb. July 20, 1984. Letter transmitting appendices B through D to the Guidelines for Preparing Regulatory Impact Analyses. (CDH Exhibit C6)

32G-730300
EPA. March 1973. Water Quality Criteria. (CDH Exhibit A7)

32G-760700
EPA. July 1976. Quality Criteria for Water. (CDH Exhibit A7)

32G-781100. (CDH Exhibit A.3-)
EPA. November 1978. A Guide to the Clean Water Act Amendments. (CDH Exhibit A8)

32G-801128
EPA. November 28, 1980. Water Quality Criteria Documents. 45 FR 79318-78379. (CDH Exhibit A7)

32G-801201
EPA. December 1, 1980. Environmental Radiation Protection Standards for Nuclear Power Operations, 40 CFR 190. (CDH Exhibit A6)

32G-810300
EPA; Engineering - Science. March 1981. Records Search of Environmental Data, Uravan Uranium Mill, Uravan, Colorado. (CDH Exhibit A8)

32G-820901
EPA; CDH, S. Ferguson, et al., September 1, 1982. Cytologic Studies in Areas with Atypical Environmental Radon Concentrations (Radon Community Cytology Study). (CDH Exhibit A7)

32G-821100
EPA. November 1982. Development Document for Effluent Limitations Guidelines and Standards for the Ore Mining and Dressing Point Source Category. EPA 440/1-82/061. (CDH Exhibit A8)

32G-830300
EPA. March 1983. Regulatory Impact Analysis of Environmental Standards for Uranium Mill Tailings at Active Sites. EPA 520/1-82-023. (CDH Exhibit A7)

32G-830307
EPA. March 7, 1983. Standards for Remedial Actions at Inactive Uranium Processing Sites, 40 CFR 192 (48 FR 590-606). (CDH Exhibit A7)

32G-830900
EPA. September 1983. Final Environmental Impact Statement for Standards for the Control of Byproduct Materials from Uranium Ore Processing (40 CFR 192). EPA 520/1-83-008-1&-2 and 520/1-83-10. (CDH Exhibit A7)

32G-831007
EPA. October 7, 1983. Environmental Standards for Uranium and Thorium Mill Tailings at Licensed Commercial Processing Sites, Final Rule, 40 CFR 192 (48 F.R. 45926-45947). (CDH Exhibit A6)

32G-831108
EPA. November 8, 1983. Federal Register, V. 48, No. 217, p. 51406-51407. Establishment of Water Quality Standards. (CDH Exhibit A7)

35-860820
HHS, Public Health Service, Agency for Toxic Substances and Disease Registry, M. McGeehin. August 20, 1986. Letter to J. Berardini, CERCLA Section, Colorado Department of Law. Transmittal of Agency for Toxic Substances and Disease Registry's Health Assessment for the Uravan site.

37-840808
BLM, L. Nimmo. August 8, 1984. Letter on land status of Spring Creek Mesa site. (CDH Exhibit C6)

47-861219-00
District Court, J. Carrigan. December 19, 1986. Final Consent Decree, Order, Judgement, and Reference to a Special Master Filed in the United States District Court, Civil Action No. 83C2384, State of Colorado, Plaintiff, vs. Union Carbide Corporation, a New York Corporation, and Umetco Minerals Corporation, a Delaware Corporation, Defendants.

47-861219-01
District Court, J. Carrigan. December 19, 1986. Final Consent Decree, Appendix I - Remedial Action Plan.

47-861219-02
District Court, J. Carrigan. December 19, 1986. Final Consent Decree, Appendix II - Radioactive Materials License 660-02S.

47-861219-03
District Court, J. Carrigan. December 19, 1986. Final Consent Decree, Appendix III - Ownership map.

47-861219-04
District Court, J. Carrigan. December 19, 1986. Final Consent Decree, Appendix IV - Surety for Performance - Definitions.

47-861219-05
District Court, J. Carrigan. December 19, 1986. Final Consent Decree, Appendix V - Allocation of Monetary Payments.

47-861219-06
District Court, J. Carrigan. December 19, 1986. Final Consent Decree, Appendix VI - Uravan Water Trust.

47-861219-07
District Court, J. Carrigan. December 19, 1986. Final Consent Decree, Appendix VII - Contaminant Locations at Colorado School of Mines and Denver Radium Site.

50-840904
State Senate, D. Noble. September 4, 1984. Letter to R. Arnott, OHP, CDH. (CDH Exhibit C6)

50-840907
State Senate, T. Bishop. September 7, 1984. Letter to R. Arnott, OHP, CDH. (CDH Exhibit C6)

52-810224
Red Cedar Woman. February 24, 1981. Letter to K. Weaver, RCD, CDH. (CDH Exhibit C6)

52-840224
Crane, D. February 24, 1981. Letter to RCD, CDH. (CDH Exhibit C6)

53-840821-01
D. Crane. August 21, 1984. Written testimony.

53-840821-02
K. Crane. August 21, 1984. Written testimony.

53-840821-03
L. Taylor. August 21, 1984. Written testimony and petition.

53-841101
Montrose County Commissioner: Neal Reams: S. Schellenbach. November 1, 1984. Petition to Governor Lamm.

55-830914. (CDH Exhibit C5)
Forseth, J. & P. Kmet. September 14, 1983. Flexible membrane liners for solid and hazardous waste landfills - a state of the art review. (CDH Exhibit C5)

55-840000
Abeele, W. 1984. Subsidence and Settlement and Their Effect on Shallow Land Burial. (CDH Exhibit C5)

55G-480000
Childs, E. & N. George. 1948. Soil Geometry and Soil-Water Equilibria. Discussions Faraday Society 3:78-85. (CDH Exhibit C5)

55G-560000
C. Hunt. 1956. Cenozoic Geology of the Colorado Plateau. USGS Professional Paper 279. (CDH Exhibit A7)

55G-620000
G. Richmond. 1962. Quaternary Stratigraphy of the La Sal Mountains, Utah. USGS Professional Paper 324. (CDH Exhibit A7)

55G-640000
A. de Villiers, and J. Windish. 1964. Lung Cancer in a Flourspar Mining Community - I. Radiation, Dust and Mortality Experience. Brit. J. Ind. Med. 21:94. (CDH Exhibit A7)

55G-650000
S. Lohman. 1965. Geology and Artesian Water Supply Grand Junction Area, Colorado. USGS Professional Paper 451. (CDH Exhibit A7)

55G-670000
Pearson, F. 1967. Carbon-14 Ages and Flow Rates of Water in Carrizo Sand, Atascosa County, Texas. Water Resources Research, V. 3. No. 1, 251-261. (CDH Exhibit C5)

55G-690000
W. Keend. 1969. Quaternary Geology of the Grand and Battlement Mesa Area, Colorado. USGS Professional Paper 617. (CDH Exhibit A7)

55G-700000
F. Cater. 1979. Geology of the Salt Anticline Region in Southwestern Colorado. USGS Professional Paper 637. (CDH Exhibit A7)

55G-700000
J. Boyd, R. Doll, and J. Foulds. 1970. Cancer of the Lung and Iron Ore (Haematite) Miners. Brit. J. Ind. Med. 27:97. (CDH Exhibit A7)

55G-721100
National Academy of Sciences. November, 1972. The Effects on Populations of Exposure to Low Levels of Ionizing Radiation. Washington, D.C. (CDH Exhibit A7)

55G-730000
V. Archer, J. Wagoner, and F. Lundin. 1973. Lung Cancer Among Uranium Miners in the United States. Health Physics, 25:351. (CDH Exhibit A7)

55G-740000
J. Snihs. 1974. The Approach to Radon Problems in Non-Uranium Mines in Sweden. Proc. of 3rd Int. IRPA-Cong., Washington, D.C., 1973. (CDH Exhibit A7)

55G-750000
Tamers, M. 1975. Validity of Radiocarbon Dates on Ground Water. Geophysical Surveys 2:217-239. (CDH Exhibit C5)

55G-760000
J. Sevc, E. Kung, and V. Placek. 1976. Lung Cancer in Uranium Mines and Long Term Exposure to Radon Daughters Products. Health Physics 30:433. (CDH Exhibit A7)

55G-770000-01
E. Larson and others. 1975. Late Cenozoic Basic Vulcanism in Northwestern Colorado and its Implications Concerning Tectonics and the Colorado River System in Cenozoic History of the Southern Rocky Mountains. Geological Society of American Memoir 144. (CDH Exhibit A7)255G-840500
Los Alamos Scientific Laboratory, T. Buhl & W. Hansen. May 1984. Estimating the Risks of Cancer Mortality and Genetic Defects Resulting from Exposures to Low Levels of Ionizing Radiation. LA-9893-MS. (CDH Exhibit A6)

55G-770000-01
Prill, R. 1977. Movement of Moisture in the Unsaturated Zone in A Loess-Mantled Area, Southwestern Kansas. USGS Professional Paper 1021. (CDH Exhibit C5)

55G-770000-02
Rabinowitz, D. et al. 1977. Environmental Tritium as a Hydrometeorological Tool in the Roswell Basin, New Mexico, I. Tritium Input Function and Precipitation-Recharge Relation. J. Hydrology 32:3-17. (CDH Exhibit C5)

55G-770000-02
United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR). 1977. Sources and Effects of Ionizing Radiation. United Nations (N.Y.). (CDH Exhibit A7)

55G-770000-03
Rabinowitz, D. et al. 1977. Environmental Tritium as a Hydrometeorological Tool in the Roswell BAsin, New Mexico, II. Tritium Patterns in Groundwater. J. Hydrology 32:19-33. (CDH Exhibit C5)

55G-770000-04
Rabinowitz, D. et al. 1977. Environmental Tritium as a Hydrometeorological Tool in the Roswell BAsin, New Mexico, III. Hydrologic Parameters. J. Hydrology 32:35-46. (CDH Exhibit C5)

55G-781120
Dreesen, D. et al. November 20, 1978. Contaminant transport, revegetation, and trace element studies at inactive uranium mill tailings piles. LA-UR-78-2537. (CDH Exhibit C5)

55G-790400
Fontes, J. & J. Garnier. April 1979. Determination of the Initial 14C Activity of the Total Dissolved Carbon: A Review of the Existing Models and a New Approach. (CDH Exhibit C5)

55G-800000-01
J. Siegel and D. Stephens. 1980. Numerical Simulation of Seepage Beneath Lined Ponds, Symposium on Uranium Mill Tailings Management. Fort Collins, Colorado. (CDH Exhibit A7)

55G-800000-02
D. McWhorter and J. Nelson. 1980. Seepage in the Partially Saturated Zone Beneath Tailings Impoundments, Journal of the Geothechnical Engineering Division. ASCE, V. 105, N GT11. (CDH Exhibit A7)

55G-800000-03
National Academy of Sciense. 1980. The Effects on Populations of Exposure to Low Levels of Ionizing Radiation. Washington, D.C. (CDH Exhibit A7)

55G-800000-04
E. Stranden. 1980. Radon in Dwellings and Lung Cancer - a discussion. Health Physics 38, 304-306. (CDH Exhibit A7)

55G-800100
Davis, S. et al. January 1980. Ground-Water Tracers--A Short Review. Groundwater, V. 18, No. 1, January-February 1980. (CDH Exhibit C5)

55G-810000-01
R. Kirkham and W. Rogers. 1981. Earthquake Potential in Colorado, A Preliminary Evaluation. Colorado Geological Survey Bull 43. (CDH Exhibit A7)

55G-810000-02
N. Harley and B. Pasternack. 1981. A Model for Predicting Lung Cancer Risks induced by Environmental Levels of Radion Daughters. Health Physics 40:307-316. (CDH Exhibit A7)

55G-820000
Thomas, D. and McNeill, K. 1982. Risk Estimates for the Health Effects of Alpha-Radiation. (CDH Exhibit A8)

55G-820000
B. Cohen. 1982. Health Effects of Radon Emissions from Uranium Mill Tailings. Health Physics 42:695-702. (CDH Exhibit A7)

55G-820831
DePoorter, G. et al. August 31, 1982. Shallow Land Burial Technology Development-Arid. LA-UR-82-2535. (CDH Exhibit C5)

55G-830303
Jones, T. et al. March 3, 1983. A Laboratory and Field Evaluation of the Mobility of Cobalt-60/EDTA. In: Proceedings of the Symposium on Waste Management-1983, Tucson, AZ, March 3, 1983. (CDH Exhibit C5)

55G-841001
Phillips, F. et al. October 1, 1984. Chlorine-36 from Atmospheric Nuclear Weapons Testing As a Hydrologic Tracer in the Zone of Aeration in Arid Climates. In: Proceedings of the Int. Conf. on Recent Investigations in the Zone of Aeration, Munich, October 1-4, 1984, in press. (CDH Exhibit C5)

55G-xxxxxx-01
Fontes, J. Environmental Isotopes in Groundwater Hydrology, 75-140. (CDH Exhibit C5)

55G-xxxxxx-02
Tamers. M. Radiocarbc. Ages of Groundwater in an Arid Zone Unconfined Aquifer. In Isotope Applications in Terrestrial Waters, 143-152. (CDH Exhibit C5)

62-840809
EDF, J. Overbaugh. August 9, 1984. Discussion of the Major Health Effects Resulting from Radiation Exposure; and Assessment of Radiation Related Risk to the General Population (Incorporates those references specifically referenced in the text -- Other four pre-hearing documents were not introduced: transcript p. 301 and 306) (EDF Exhibit 1)

62-840813
EDF, J. Martin. August 13, 1984. Letter to A. Neblett, AGO. Request for hearing documents. (CDH Exhibit C6)

63-840721
Future, M. Puls. July 21, 1984. Letter to A. Hazle, RCD, CDH. Request for Party Status.

63-840803
Future, M. Puls. August 3, 1984. Motion for Change of Venue.

63-840809
Future, M. Puls. August 9, 1984. Prehearing Statement.

63-840816
FUTURE, M. Puls. August 16, 1984. Letter to R. Arnott, OHP, CDH. Licensing process. (CDH Exhibit C6)

63-841008
Future, M. Puls. October 8, 1984. Not Submitting Conclusions of Law.

63-850104
FUTURE, M. Puls. January 1984. Letter to A. Hazle, RCD, CDH. Uravan Uranium Mill Licensing Process, Closing Statement.

64-831020
NWF. October 20, 1983. Letter to A. Hazle, RCD, CDH. "Recommendations for Union Carbide Corporation Uravan Mill Renewal License". (NWF Exhibit 8)

64-840514
NWF. May 14, 1984. Letter to A. Hazle, RCD, CDH. "Draft PELRS, Union Carbide Corporation's Uravan Facility". (NWF Exhibit 7)

64-840726
NWF, F. Green. July 26, 1984. Letter to R. Arnott, CDH. Request for Party Status.

64-840809-00
NWF, F. Green. August 9, 1984. Pre-hearing conference: Summary of Claims of National Wildlife Federation and Colorado Wildlife Federation. Summary of Testimony of R. Jeffrey Dunn, attached. (NWF Exhibit 00)

64-840809-01
NWF. August 9, 1984. Resume of R. Jeffrey Dunn. (NWF Exhibit 1)

64-840809-02
NWF: D. Daniel. August 9, 1984. Problems in Predicting the Permeability of Compacted Clay Liners. (NWF Exhibit 2)

64-840809-03
NWF: J. Mitchell, et al. August 9, 1984. Permeability of Compacted Clay. (NWF Exhibit 3)

64-840809-04
NWF: G. Auvinet and J. Espinosa. August 9, 1984. Impermeabilization of a 30 Hectare Cooling Pond. (NWF Exhibit 4)

64-840809-05
NWF: D. Daniel. August 9, 1984. Predicting Hydraulic Conductivity of Clay Liners. (NWF Exhibit 5)

64-840809-06
NWF. August 9, 1984. Biographical Sketch (Resume) of Herbert L. Martin. (NWF Exhibit 6)

64-840809-09
NWF. August 9, 1984. Various Viewgraphs of Charts Adapted from the Above Sources, or Exhibits Presented by Umetco, to Assist in Explanation of Testimony. (NWF Exhibit 9)

64-840814
NWF: K. Green. August 14, 1984. Letter to H. Ipsen, Holme Roberts & Owen: UCC. Spring Creek Mesa License Amendment. (NWF Exhibit 11)

65-840504
Sierra Club, R. Young. May 4, 1984. Letter to A. Hazle, RCD, CDH. Request for Party Status.

65-840814
Sierra Club, Roy Young. August 14, 1984. Response to Umetco's Interrogatories to Sierra Club.

67-840728
Western Small Miners Association, J. Peeso. July 28, 1984. Request for Party Status.

67-840809
Western Small Miners Association, J. Peeso. August 9, 1984. Pre-hearing Statement.

11.2 ADDITIONAL REFERENCES

00-781121
UCC, F. Dedrickson. November 21, 1978. Letter to A. Hazle, RCD, CDH. Response to citation letter received November 6, 1978.

00-791207
UCC, R. Beverly. December 7, 1979. Letter to A. Hazle, RCD, CDH. Reply to CDH request for financial surety arrangements.

00-800106
UCC. January 6, 1980. Letter to A. Hazle, RCD, CDH. Response to December 17, 1979 order.

00-800303
UCC, R. Beverly. March 3, 1980. Letter to A. Hazle, RCD, CDH. Request for partial payment of license fee.

00-800414-02
UCC, P. Rekemeyer. April 15, 1980. Letter to A. Hazle, RCD, CDH. Transmittal or article concerning off-site decontamination responsibility.

00-800414-03
Acres American, Inc. April 14, 1980. Uravan Tailings Disposal Stabilization Program, Phase II Geotechnical Report.

00-800417
NUS, T. Conway. April 17, 1980. Letter to A. Hazle, RCD, CDH. Transmittal of "40 CFR 190 Related Radiological Doses...".

00-800530-02
IECO. May 30, 1980. Preliminary Geotechnical Investigation of the Proposed Spring Creek Mesa Tailings and Effluent Disposal Site Near Uravan, Colorado.

00-800530-03
IECO. May 30, 1980. Cost Estimate for Preliminary Geotechnical Investigation.

00-800530-04
Dames and Moore. May 30, 1980. Tailings Evaporation Pond Evaluation, Long Park and Paradox Valley Sites.

00-800530-05
Dames and Moore. May 30, 1980. Tailings Storage and Evaporation Pond Evaluation, Long Park and Paradox Valley Sites.

00-800530-08
NUS Corp. May 30, 1980. A Correlation Analysis of Variables Affecting Airborne Radioactive Particulate Concentration Near the Uravan Uranium Mill. NUS-3544.

00-800530-10
NUS Corp. May 30, 1980. 1979 Annual Summary of Environmental and Health Physics Monitoring, Uravan, Colorado.

00-800609
UCC, T. Kagetsu. June 9, 1980. Letter to A. Hazle, RCD, CDH. July 9, 1980 technical meeting on "...Tailings Stabilization Program, additional test results by Dr. N.Y. Chang..., details of 'seepage collection and containment'...", report by Dames and Moore titled "Handling and Placement Characteristics, Belt-Filtered Tailings".

00-800612
Acres American, Inc. June 12, 1980. Uravan Tailings Disposal Stabilization Program, Phase II Geotechnical Report Supplement for Phase IIA.

00-800619-02
P. Rekemeyer. June 19, 1980. Letter to A. Hazle, RCD, CDH. Long range plan for processing belt ores.

00-800711
UCC, R. Jones. July 11, 1980. Letter to A. Hazle, RCD, CDH. License amendment request and attachments.

00-800904
UCC, R. Folkman, V.P. Metals Division. September 4, 1981. Letter to A. Hazle, RCD, CDH. Comments on CDH order to provide reclamation surety agreement.

00-800905
Acres American, Inc. August 8, 1980. Uravan Tailings Disposal Stabilization Program, Phase II Geotechnical Report Supplement for Phase IIB, Appendix D, Finite Element Earthquake Analysis.

00-801106
UCC, P. Rekemeyer. November 6, 1980. Letter to A. Hazle, RCD, CDH. Plan for reclamation of existing tailings ponds.

00-801218
UCC, P. Rekemeyer. December 18, 1980. Letter to K. Weaver, RCD, CDH. NRC MILDOS data.

00-801219-01
UCC, P. Rekemeyer. December 19, 1980. Letter to K. Weaver, RCD, CDH. Yellowcake dryer supplementary information.

00-801219-02
UCC, P. Rekemeyer. December 19, 1980. Letter to K. Weaver, RCD, CDH. Status of stability and groundwater studies.

00-810116
S. Smith. January 16, 1981. Long Term Stability at Union Carbide's Tailings Piles at Uravan, Colorado. U. Houston, Houston, Tx.

00-810226
UCC. February 26, 1981. Site Plan of Spring Creek Mesa.

00-810609
UCC, H. Stephens. June 9, 1981. Letter to A. Hazle, RCD, CDH. Submittal of "principal users" resume.

00-810831
UCC, T. Kagetsu. August 31, 1981. IECO, Uravan Ponds Reclamation Report - August, 1981.

00-810922
Kirkland & Ellis. September 22, 1981. Cover letter to K. Weaver, RCD, CDH. Reclamation surety agreement.

00-820331-04
UCC. March 31, 1982. Procedures Manual for the Environmental Monitoring Program at Uravan, Revision 0. LC 11.1.

00-820331-07
International Engineering Co., Inc. March, 1982. Uravan Ponds and Tailings Disposal Near-Term Continued Operations With Respect to Part III, Schedule E, Code of Colorado Regulations 6 CCR 1007-1. Corrected copy submitted April 16, 1982.

00-820331-09
IECO. March 1982. Uravan Ponds and Tailings Reclamation Post Reclamation Conditions With Respect to Part III, Schedule E., Code of Colorado Regulations 6 CCR 1007-1. Corrected copy submitted April 16, 1982.

00-820331-11
UCC. March 31, 1982. Plans and Estimated Costs for Ponds and Tailings Reclamation and Mill Decommissioning.

00-820331-12
UCC. March 31, 1982. Long Term Monitoring and Maintenance Agreement for Radioactive Materials License No. SUA-673.

00-820331-13
UCC. March 31, 1982. Updated Environmental Report, Uravan Uranium Project, Montrose County, Colorado.

00-820331-14
West End Economic Adjustment Committee. Crises in The West End.

00-820331-15
Pyrih and Associates. March 31, 1982. Geochemical Stability of Uravan Clays for Leach Pad Construction, Report on Preliminary Laboratory Test Work.

00-820331-18
UCC. March 31, 1982. Compliance With Criterion 8 of 6 CCR 1007-1.

00-820429-01
UCC, P. Rekemeyer. April 29, 1982. Letter to A. Hazle, RCD, CDH Updated License Renewal Application - corrections.

00-820909
UCC, P. Rekemeyer. September 9, 1982. Letter to A. Hazle, RCD, CDH. "Lower limits of detection for...radionuclides".

00-820920
UCC, P. Rekemeyer. September 20, 1982. Letter to A. Hazle, RCD, CDH. Correction of "lower limits of detection for...radionuclides".

00-820930
UCC, P. Rekemeyer. September 30, 1982. Letter to A. Hazle, RCD, CDH. Comments on the Geotechnical Review Committee Report.

00-821108
UCC, T. Washburn. November 8, 1982. Comments on November 16-20, 1981 inspection letter/report.

00-821103
UCC, P. Rekemeyer. November 3, 1982. Letter to K. Weaver, RCD, CDH. Supplementary information for the Geotechnical Review Committee with attachments.

00-821206-00
UCC, P. Rekemeyer. December 6, 1982. Letter to A. Hazle, RCD, CDH. License Amendment request - Spring Creek Mesa with 9 attachments.

00-821206-01
Dravo; Gibbs and Hill, Inc. December 6, 1982. Environmental Report for the Proposed Spring Creek Mesa Tailings and Effluent Impoundment, November 1982.

00-821206-02
Chen and Associates. December 6, 1982. Geotechnical Investigation with Recommendations for Spring Creek Mesa Tailings and Effluent Disposal Facility, November 1982.

00-821206-08
Chen and Associates. December 6, 1982. Appendix A, Geotechnical Investigation with Recommendations for Spring Creek Mesa Tailings and Effluent Disposal Facility, November 1982.

00-821206-09
Chen and Associates. December 6, 1982. Appendix B and C, Geotechnical Investigation with Recommendations for Spring Creek Mesa Tailings and Effluent Disposal Facility, November 1982.

00-821209
UCC, P. Rekemeyer. December 9, 1982. Letter to A. Hazle, CDH, RCD. Proposed Club Ranch Ponds study to be added to license review.

00-830415
UCC, J. McDonald. April 15, 1983. Letter to RCD, CDH. UCC 1982 Annual Report.

00-830426
UCC. April 26, 1983. Union Carbide Corporation Analytical Laboratory Quality Assurance Mannual.

00-830531-01
UCC, R. Beverly. May 31, 1983. Letter to A. Hazle, RCD, CDH. New waste disposal area application reply.

00-830531-02
UCC, R. Beverly. May 31, 1983. Letter to A. Hazle, RCD, CDH. Reclamation of existing wastes reply.

00-830602-02
UCC, R. Jones. June 2, 1983. Letter to K. Weaver, RCD, CDH. Tailing belt filter test.

00-830621
UCC, R. Jones. June 21, 1983. Annual Land Use Survey.

00-830630
UCC, R. Jones. June 30, 1983. ALARA Report and Data Summary for 1982.

00-831017-01
UCC, R. Jones. October 17, 1983. Letter to K. Weaver, RCD, CDH. Response to letter on radon gas.

00-831111
UCC, J. McDonald. December 11, 1983. Letter to RCD, CDH. Reclamation Surety Agreement/Financial Statement.

00-831125
UCC, J. Frost. November 25, 1983. Letter to the Water Quality Commission and Division. Uravan-Colorado Wastewater Discharge Permit comments.

00-831130-00
UCC, R. Jones. November 30, 1983. Cover letter to RCD, CDH. Radiation dose analyses to Uravan residents.

00-831130-01
UCC, R. Jones. November 30, 1983. Letter to RCD, CDH. Computer dose modeling discussion.

00-831130-02
UCC, R. Jones. November 30, 1983. Letter to RCD, CDH. Meteorological joint frequency distribution analysis.

00-831214
UCC, R. Jones. December 14, 1983. Letter to K. Weaver, RCD, CDH. Revision to the environmental monitoring procedures manual.

00-831216-01
UCC. December 16, 1983. Summary of Plans in Support of Source Material License Renewal for Existing Uravan Mill Facilities.

00-840117
UCC, R. Jones. January 17, 1984. Letter to A. Hazle, RCD, CDH. Revisions to UCC Environmental Procedures Manual.

00-840124
UCC; Dravo Corporation; Chen and Associates, Inc.; Envirologic Systems, Inc.; Roman Z. Pyrih and Associates. January 24, 1984. Integrated Report and Geohydrology, Potential Fluid Migration, and Ground Water Monitoring Program for Occupation and Post Reclamation Periods for Proposed Spring Creek Mesa Tailings and Effluent Disposal Facility, Union Carbide Corporation.

00-840206-00
UCC, J. Frost. February 6, 1984. Cover letter and report to A. Hazle, RCD, CDH. Summary of Plans in Support of Amendment of Source Material License for Spring Creek Mesa Tailings and Effluent Disposal Facility.

00-840215
UCC, H. Stephens. February 15, 1984. Letter to A. Hazle, RCD, CDH. Request to include cesium-137 density gauge controllers on Uravan mill license.

00-840222
UCC: Dravo Engineers, V. Vinych. February 22, 1984. Letter to RCD, CDH and all holders of the January 1984 Environmental Report. Revised instruction sheets and additional pages for the Spring Creek Environmental Report.

00-840229-01
UCC. February 29, 1984. Laboratory Quality Assurance Manual.

00-840301-01
UCC, C. Dudnick. March 1, 1984. Cover letter to A. Hazle, RCD, CDH. Request to transfer license and proposed surety agreement.

00-840309-00
UCC, J. Frost. March 9, 1984. Letter to A. Hazle, RCD, CDH. Request for license amendment to raise retention dike of Ponds 2 and 3.

00-840309-01
UCC: Acres American, Inc. March 1982. Uravan Tailings Disposal Stabilization Program, Supplement for Phase IIB.

00-840327-00
UCC: Dravo, V. Vinych. March 27, 1984. Cover letter to K. Weaver, RCD, CDH. Information and data requested by CDH.

00-840327-01
UCC, R. Jones. March 27, 1984. Evaporation study results.

00-840327-02
UCC. March 27, 1984. UCC Report. Monitoring well results.

00-840327-03
UCC: Envirologic Systems, Inc., J. Rouse. March 27, 1984. Letter to V. Vinych, Dravo, UCC. Spring Creek Mesa perosity values perched water and sampling.

00-840327-04
UCC: Pyrih and Associates, R. Pyrih. March 27, 1984. Letter to V. Vinych, Dravo, UCC. Additional data on long term colum percolation testwork.

00-840327-05
UCC: Envirologic Systems, Inc., R. Moren, J. Rouse. March 27, 1984. Report procedure for collection of water-quality samples and data.

00-840509
UCC. May 9, 1984. Preliminary Data Tables for 1983 Annual Report.

01-800522
AGO. May 22, 1980. Model Emergency Order.

01-840301
AGO, A. Neblett. March 1, 1984. Letter to H. Ipsen, Holme, Roberts & Owen. Financial surety transfer arrangements.

07-790208
CDH, APCD (Planning and Analysis), D. Donahue. February 8, 1979. IOC to A. Bishard, APCD, CDH. "Comments on Environmental Report".

07-790227
CDH, APCD (Enforcement), H. Collier. February 27, 1979. IOC to A. Bishard, APCD, CDH. Comments on Environmental Report.

07-831230
CDH, APCD, R. Fox. December 30, 1983. IOC to K. Weaver, RCD, CDH.

09-791116
CDH, WMD, K. Waesche. November 16, 1979. IOC to A. Hazle and K. Weaver, RCD, CDH. Comments on Environmental Report.

09-791227
CDH, WMD, K. Waesche. December 27, 1979. IOC to A. Hazle, J. Montgomery, RCD, CDH, W. Junge, CGS. On-site evaluation of tailings ponds 2 and 3.

09-830901
CDH, WMD, Technical Review Committee, Scott Winters. September 1, 1983. Letter to A. Hazle, RCD, CDH. Initial review of the existing and proposed facilities.

09-831128
CDH, WMD, S. Winters. November, 28, 1983. Letter to A. Hazle, RCD, CDH. Final review comments.

10-780720
CDH, RCD, R. Gamewell and D. McDaniel. July 20, 1978. 1978 Compliance Inspection Report, RCD, CDH.

10-781128
CDH, RCD, C. Mattson and K. Weaver. November 28, 1978. IOC to file, K. Weaver. Summary of November 28, 1978 visit.

10-790108
CDH, RCD, R. Gamewell. January 8, 1979. IOC to file. Report of Pond 2 tailings pile slump.

10-791109-02
CDH, RCD, A. Hazle. November 9, 1979. Letter to R. Beverly, UCC. Non-compliance of financial surety requirements: notice of violation.

10-791206
CDH, RCD, A. Hazle. December 6, 1979. Letter to Ross Scarano, NRC. Request of independent analysis regarding tailings ponds instability.

10-791217-01
CDH, RCD, A. Hazle. December 17, 1979. Letter to R. Beverly, UCC. Tailings impoundment order.

10-791220
CDH, RCD, A. Hazle. December 20, 1979. Letter to R. Beverly, UCC. Needed data for alternative disposal site and license amendment.

10-791221
CDH, RCD, A. Hazle. December 21, 1979. Letter to UCC. Violation of minimum (300 feet) beach in Pond 3.

10-800401
CDH, RCD, A. Hazle. April 1, 1980. Letter to R. Beverly, UCC. Need to consider "worst case" situation for financial surety.

10-800818-01
CDH, RCD, A. Hazle. August 18, 1980. IOC to file. Uravan visit August 12th; progress report on Ponds 2 and 3.

10-801015-03
CDH, RCD, A. Hazle. October 20, 1980. IOC to file. J. Geidt, EPA. Telcon: completion of data gathering for possible legal action on tailings piles and public exposure by EPA contractor.

10-801030
CDH, RCD, K. Weaver. October 30, 1980. IOC to file. 40 CFR 190 lawsuit against EPA; UCC one of plaintiffs.

10-801118-01
CDH, RCD, A. Hazle. November 18, 1980. IOC to file. Request for receding cliff and groundwater data on existing tails piles.

10-811116
CDH, RCD, C. Mattson, R. Terry. November 16, 1981. 1981 Compliance Inspection Report, RCD, CDH.

10-820901
CDH, RCD, K. Weaver. September 1, 1982. IOC to file. Telcon with R. Rogers, Secretary to State Land Board. Request by L. Thomas, Montrose County Commissioner to transfer BLM land to State via Land Board's "in lieu" selection program.

10-830412
CDH, RCD, W. Somers, K. Weaver, and D. Brown. April 12, 1983. 1982-1983 Compliance Inspection Report, RCD, CDH.

10-831122-01
CDH, RCD, A. Hazle. November 22, 1983. Letter to J. Frost, UCC. Target schedule for license action.

10-831205
CDH, RCD, K. Weaver. December 5, 1983. Letter to R. Jones, UCC. Radiation protection program.

10-840108
CDH, M. Jones-Contractor. February 8, 1984. IOC to file. Personal conversation with T. Tayon, WQCD. Naturita sewer system improvements.

10-840301
CDH, RCD, K. Weaver. March 1, 1984. Letter to T. Washburn, UCC. 1983 inspection letter.

10-840330
CDH, RCD, E. Kray. March 30, 1984. Letter to Owen Calloway, UCC. Comments on quality assurance manual revisions.

11-740400
CDH, WQCD. April, 1974. Report, Water Quality Benthic Investigation of the San Miguel River Basin.

11-810604
CDH, WQCD, M. Dudley. June 4, 1981. IOC to K. Weaver, A. Hazle, RCD, CDH. Long term reclamation comments for UCC letter.

11-810918
CDH, WQCD, M. Dudley. September 18, 1981. IOC to Dr. Traylor, CDH. Uravan briefing.

11-810923
CDH, WQCD, M. Dudley. September 23, 1981. IOC to A. Hazle, RCD, CDH. Reclamation of Club Ranch Ponds/none in place.

11-820607
CDH, WQCD, M. Liuzzi. June 7, 1982. IOC to Technical Review Committee. Review of reports concerning piles 2 and 3, Atkinson Creek, Club Ranch, and River Ponds.

11-831024-01
CDH, WQCD, G. Broetzman. October 24, 1983. UCC Uravan, Discharge Permit.

11-831024-02
CDH, WQCD, G. Broetzman. October 24, 1983. UCC Uravan, Discharge Permit Rationale.

11-831125
UCC, J. Frost. November 25, 1983. Letter to the Water Quality Control Commission and Division. Uravan-Colorado Wastewater Discharge Permit comments.

11-831209
CDH, WQCD, B. Shukle. December 9, 1983. Memo to Jeb Love, WQCD, CDH. Minutes of Club Ranch Ponds Permit meeting.

12-810410
CDH, F. Traylor. April 10, 1981. Letter to P. Rekemeyer, UCC. Department position on license requirements.

12-83C103
CDH, F. Traylor. January 3, 1983. Letter to Monte Pascoe, CDNR. Comments on BLM land trade.

14-800806
Colorado Department of Local Affairs, Division of Impact Assistance, S. Schmitz. August 6, 1980. Letter to K. Weaver, RCD, CDH. Comments on licensing review.

14-830600
District 10 Regional Planning Commission. June, 1983. A study of West Montrose County: residents shopping habits and media use, business practices and attitues, labor force data.

15-780913
CGS, D. Shelton. September 13, 1978. Letter to P. Rekemeyer, UCC. Seismic Risk Analysis for Uravan Tailings Ponds.

15-791210
CGS, W. Junge. December 10, 1979. Letter to A. Hazle, RCD, CDH. Geotechnical considerations to be addressed at December 13, 1979 UCC meeting.

15-800201-02
CGS, W. Junge. February 1, 1980. Memo to K. Weaver, RCD, CDH. Review of Drainage Alternatives for Pond 3 Stabilization.

15-800201-03
CGS, W. Junge. February 1, 1980. Memo to K. Weaver, RCD, CDH. Review of Alternative Tailings and Effluent Disposal Sites.

15-800319
CGS, W. Junge. March 19, 1980. Letter to A. Hazle, RCD, CDH. Uravan Tailings Disposal, Pond 1 Quality Control Plan.

15-800512
CGS, W. Junge. May 12, 1980. Letter to K. Weaver, RCD, CDH. Review of Tailings Reclamation Proposal.

15-800514-01
CGS, W. Junge. May 14, 1980. Memo to K. Weaver, RCD, CDH. Recommendations for Quality Control Plan, Pond 3.

15-800514-02
CGS, W. Junge. May 14, 1980. Memo to K. Weaver, RCD, CDH. CGS Review of Acres American Geotechnical Report, Phase II Stabilization Analysis.

15-800521
CGS, W. Junge. May 21, 1980. Letter to Al Hazle, RCD, CDH. CGS concerns regarding UCC's tailing ponds final stability analysis.

15-800707
CGS, W. Junge. July 7, 1980. Memo to K. Weaver, RCD, CDH. Request for handling and placement characteristics, belt-filter tailings, Uravan uranium mill study.

15-800708
CGS, W. Junge. July 8, 1980. Memo to K. Weaver, RCD, CDH. Field Review, Alternative Tailing Sites.

15-800813
CGS, W. Junge. August 13, 1980. Memo to K. Weaver, RCD, CDH. Concerning interim use Pond 2, Phase II A stabilization.

15-810507
CGS, W. Junge. May 7, 1981. Memo to K. Weaver, K. Waesche, C. Roberts, R. Shukle, CDH; S. Spann, DWR; R. Lucas, MLRB. Announcement of proposed reclamation plan meeting.

15-810722
CGS, W. Junge. July 22, 1981. Letter to K. Weaver, RCD, CDH, concerning Surety Bond.

15-810730
CGS, W. Junge. July 30, 1981. Letter to R. Pearson, NRC. Long Park alternative tailings disposal site.

15-820126
CGS, W. Junge. January 26, 1982. Letter to A. Hazle RCD, CDH. Review of August 8, 1981 reclamation proposal.

15-820216
CGS, W. Junge. February 16, 1982. Letter to K. Weaver, RCD, CDH. Confirmation of basic Spring Creek Mesa plan submission.

15-820617
CGS, W. Junge. June 17, 1982. Letter to A. Hazle, RCD, CDH. Review of updated application. (00-820331).

15-840306
CGS, W. Junge. March 6, 1984. Letter to A. Hazle, RCD, CDH. Additional data needed by Technical Review Committee.

17-790323
CDNR, DWR, J. Danielson. March 23, 1979. Memo to A. Hazle, RCD, CDH. Review of Environmental Report.

17-791220
CDNR, DWR, A. Pearson. December 20, 1979. Memo of Design Review for Phase I and II Stabilization...Tailings Dams.

17-800115
CDNR, DWR, J. Danielson. January 15, 1980. Letter to A. Hazle, RCD, CDH. Tailings dam stability.

17-800116
CDNR, DWR, A. Pearson. January 16, 1980. Letter to K. Weaver, RCD, CDH. Tailings dam data review.

17-800410
CDNR, DWR, A. Pearson. April 10, 1980. Memo to file. Tailings dam after on-site visit.

17-800425
CDNR, DWR, A. Pearson. April 25, 1980. Letter to A. Hazle, RCD, CDH. Tailings Ponds 1 and 2 depth-capacity data discussion.

17-800516
CDNR, DWR, J. Danielson. May 16, 1980. Letter to A. Hazle, RCD, CDH. Design review buttressing Tailings Pond 3.

17-800519
CDNR, DWR, A. Pearson. May 19, 1980. Memo of design review, Tailings Pond 3.

17-800814-01
CDNR, DWR, J. Danielson. August 14, 1980. Letter to A. Hazle, RCD, CDH. Evaluation of tailings dams.

17-800814-02
CDNR, DWR, J. Danielson. August 14, 1980. Letter to A. Hazle, RCD, CDH. Pond 2 Evaluation.

17-801006
CDNR, DWR, A. Pearson. October 6, 1980. Memo to K. Weaver, RCD, CDH. Tailings dam order of September 15, 1980.

17-810122
CDNR, DWR, A. Pearson. January 22, 1981. Letter to K. Weaver, RCD, CDH. Comments on Quality Control Plan, Tailings Ponds 2 and 3.

17-810604
CDWR, J. Van Sciver. June 4, 1981. Inspection Report, Tailings Ponds 1, 2, and 3.

17-810910-01
CDNR, DWR, J. Danielson. September 10, 1981. Letter to A. Hazle, RCD, CDH. Comments on Quality Control Plan Review.

17-820526
CDNR, DWR, J. Romero. May 26, 1982. Letter to S. Winter, WMD, CDH. Review of updated Environmental Report (00-820331-13).

17-820920
CDNR, DWR, J. Danielson. September 20, 1982. Letter to A. Hazle, RCD, CDH. Concerning tailing pond monitoring schedule.

18-800724
CDNR, DWR, C. Grand Pre. July 24, 1980. Cover letter to A. Hazle, RCD, CDH. License review and recommendations.

20-810619-00
CDNR, MLR, J. Lucas. June 19, 1981. Memo to K. Weaver, RCD, CDH. MLR bonding cost calculations, example for surety costs.

20-810619-02
CDNR, MLR, J. Lucas. June 19, 1981. Memo to K. Weaver, RCD, CDH. Comments on reclamation plan surety requirements.

20-811201
CDNR, MLR, D. Shelton. December 1, 1981. Letter to A. Hazle, RCD, CDH. Assessment of tailings disposal alternatives.

22-790307
CHS, A. Townsend. March 7, 1979. Letter to A. Hazle, RCD, CDH. Review of Environmental Report.

23-800312
Department of Military Affairs, Div. of Disaster Emergency Services, W. Martin. March 12, 1980. Letter to A. Hazle, RCD, CDH. Review of disaster response plans.

24-831012
Pitken County Commissioners, M. Kinsley. October 12, 1983. Letter to R. Lamm, Governor. Comments recommending closure of Uravan mill.

31-791116
NRC, R. Scarano. November 16, 1979. Letter to A. Hazle, RCD, CDH. Tailings embankment problem report.

31-791204-01
NRC, G. Kerr. December 4, 1979. Letter to A. Hazle, RCD, CDH. Offer of assistance regarding tailings embankment problem.

31-791204-02
NRC, G. Kerr. December 4, 1979. Letter to A. Hazle, RCD, CDH. NRC Tailings Dam Inspection Report.

31-791231
Geotechnical Engineers, Gonzalo Castro, via NRC telecopy. December 31, 1979. Letter to K. Weaver, RCD, CDH. Tailings Ponds 2 and 3 stabilization program progress.

31-800114
NRC, R. Scarano. January 14, 1980. Letter to A. Hazle, RCD. Transmittal of recommendations on Tailings Ponds 2 and 3.

31-800125
NRC, R. Scarano. January 25, 1980. Letter to T. Lange. Answer to constituent inquiries.

31-800321
NRC, R. Scarano. March 21, 1980. Letter to A. Hazle, RCD. Submittal and summary of dam safety review.

31-800414
NRC, J. Linehan. April 14, 1980. Letter to L. Danielson, NWF. Transmittal of tailings ponds safety review.

31-801203
NRC, R. Scarano. December 3, 1980. Letter to A. Hazle, RCD, CDH. Request for information obtained by NRC Contractor.

31-810409
NRC, R. Scarano. April 9, 1981. Letter to A. Hazle, RCD, CDH. Evaluation of UCC's in-place reclamation alternative for existing tailings.

31-810600
Argonne National Laboratory, M. Momeni. June, 1983. Environment in the Vicinity of Uravan Mill: Characterization of Radioactive Effluents and Airborne Radionuclide Concentrations.

31-810731
NRC, R. Scarano. August 31, 1981. Letter to A. Hazle, RCD, CDH. Tailings ponds inspection results.

31-810925
NRC, R. Scarano. September 25, 1981. Letter to A. Hazle, RCD. Assessment of tailings disposal alternatives for the Union Carbide Uravan mill.

31-811230
NRC, R. Scarano. December 30, 1981. Letter to A. Hazle, RCD, CDH. Radiological assessment of operation impacts.

31-820511
NRC, R. Scarano. May 11, 1982. Letter to A. Hazle, RCD, CDH. Removal of NRC from UCC mailing list.

32-802306
EPA. June 23, 1980. Uravan Case Development Plan.

32-811231
EPA, R. Duprey. December 31, 1981. Letter to A. Hazle, RCD, CDH. Comments on "Assessment of Tailings Disposal Alternatives...".

34-821202
DOE, H. Roser. December 2, 1982. Letter to R. Lamm, Gov. Response to DOE's "Commingled Uranium Tailings Study".

37-800521
BLM, E. Hartley. May 21, 1980. Memo clarifying BLM's jurisdiction over land availability when dealing with residual radioactive materials.

37-800818-03
BLM, H. Martin. August 18, 1980. Memo to Director, CDH. Informing CDH of need to comply with NEPA requirements.

37-800919
BLM, Assistant Director. September 9, 1980. Letter to Director, CDH. Status of State-BLM-NRC roles in licensing action and potential problems.

43-831011
Nat. Park Services, D. Herring. October 11, 1983.
Letter to WMD, CDH. Request for information on possible contamination to National Park lands.

45-800107-01
MSHA, R. Fujimoto. January 7, 1980. Letter to J. Montgomery, RCD, CDH. Comments on Pond 3's closure.

45-800107-02
MSHA, R. Fujimoto. January 7, 1980. Design Guidelines for Mine Waste Piles and Tailings Dams (January 10, 1978).

45-800107-03
MSHA, R. Fujimoto. January 7, 1980. Proposed regulations of mine waste piles and impounding structures for metal and non-metal mines.

45-801022
MSHA, J. Strickland. October 22, 1980. Letter to A. Hazle, RCD, CDH. Review of Tailings Disposal Alternatives.

45-801223
MSHA, J. Odell, R. Dressel. December 23, 1980. Analysis of Geotechnical Tailings Disposal Stabilization Program.

45-811112
MSHA, R. Ferriter. November 12, 1981. Letter to A. Hazle, RCD, CDH. Recommendation of Spring Creek Mesa as alternative tailings disposal site.

45-830317
MSHA, R. Ferriter. March 17, 1983. Letter to K. Weaver, RCD, CDH. Review of Spring Creek Mesa proposal.

45-840320
MSHA, R. Ferriter. March 20, 1984. Letter to K. Weaver, RCD, CDH.

50-830608
State Senate, B. Holme. June 8, 1983. Letter to K. Weaver, RCD, CDH. Inquiry on pending licensing action.

51-840219
Rocky Mountain News, D. Frazier. February 19, 1984. Uranium Wasteland Awaits Rebirth: Company Deserts Town, But Radioactive Refuse Remains.

52-840225
Norwood Economic Development Committee, Clinton W. Booth. February 25, 1984. Letter to A. Hazle, RCD, CDH. Request for hearings to be held in the "West End" of Montrose County.

61-831019
COSC, D. Eberl, R. Young. October 19, 1983. Received at October 19, 1983 meeting by K. Weaver, RCD, CDH. Clay Mineral Society October 2-5, 1983 Meeting Program—Abstracts on Clay Liners.

61-831026-01
COSC, R. Young. October 26, 1983. Excerpts from Final Progress Report No. 3 on Neutralization of Uranium Mill-Tailing Effluents to United Nuclear Corporation...

61-831026-02
COSC, R. Young. October 26, 1983. EDF comments on proposed standards; cost considerations as basis for setting standards.

62-840404
EDF, R. Yuhnke. April 4, 1984. Letter to A. Hazle, RCD, CDH. Comments on Uravan exposure to radiation.

63-781112
FUTURE, M. Puls. November 12, 1978. Letter to D. Nussbaumer, NRC.

63-830627
FUTURE, M. Puls. June 27, 1983. Letter to K. Weaver, RCD, CDH. Comments on licensing process.

63-831010
FUTURE, M. Puls. October 10, 1983. Letter to K. Weaver, RCD, CDH. Comments on licensing process.

64-830506
NWF, L. Danielson. May 6, 1983. Comments on initial draft for license renewal.

64-830517
NWF, K. Green. May 17, 1983. Letter to K. Weaver, RCD, CDH. Request for information.

64-830614
NWF, R. Lawrence. June 14, 1983. Letter to K. Weaver, RCD, CDH. Comments on ground water meeting.

64-830624
NWF, R. Lawrence. June 24, 1983. Letter to A. Hazle, RCD, CDH. NWF participation in technical meetings.

64-830810
NWF, R. Lawrence. August 10, 1983. Letter to K. Weaver, RCD, CDH. Request for meeting on states response to Union Carbide proposal.

64-830923
NWF, R. Lawrence. September 23, 1983. Letter to K. Weaver, RCD, CDH. License renewal schedule.

64-831020
NWF, K. Green, R. Lawrence. October 20, 1983. Letter to A. Hazle RCD, CDH. Recommendations for renewal license.

64-831101-01
NWF, R. Lawrence. November 11, 1983. Letter to K. Weaver, RCD, CDH. Scheduling of license renewal proceedings.

64-831101-02
NWF, R. Lawrence. November 11, 1983. Letter to K. Weaver, RCD, CDH. Offsite radiation dose to Uravan residents.

64-831110
NWF, H. Martin. November 10, 1983. Memo to RCD, CDH and outside parties. Summary of October 26, 1983 meeting.

64-840210
NWF, R. Lawrence. February 10, 1984. Letter to K. Weaver, RCD, CDH. Schedule and possible decoupling of new and old Uravan sites.