CROWNPOINT URANIUM PROJECT
CONSOLIDATED OPERATIONS PLAN

HRI, INC.
2929 Coors Road
Albuquerque, New Mexico

Revision 1.0
May 12, 1997

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CORPORATE ENVIRONMENTAL POLICY

HRI, Inc.'s environmental policy reflects the Company's continual commitment to environmental stewardship in all aspects of its business activities. The Company strives to maintain high standards in its design, construction, operations, and restoration activities in order to consistently operate in a manner that protects the environment. Through a rigorous environmental compliance review procedure, the Company continuously evaluates all aspects of its operations to ensure that it is operating safely, and in compliance with the multi-level state, and federal regulations applicable to the in situ uranium mining process.

This system includes a review of environmental regulations which impact the exploration, development, operation, and restoration/remediation activities of HRI; the development of safety, and environmental procedures, and regular internal audits of these areas to assess compliance; the promotion of waste minimization techniques; the utilization of environmental benign choices in operating strategies; providing leadership in environmental awareness, and emphasizing employee involvement, and effectiveness in safety, and environmental compliance on the job.

CORPORATE ALARA POLICY

HRI, Inc.'s ALARA policy reflects the same commitment stated in the Corporate Environmental Policy, with specific emphasis placed on maintaining occupational exposures to employees, contractors, and visitors, from the radiological, and toxic hazards of uranium, and its daughter products as low as reasonably achievable.

The Company strives to maintain high ALARA standards through engineering design, hands on management, and employee training. It is recognized that a successful ALARA program is the responsibility of everyone in the production of uranium; including management, the Radiation Safety Officer (RSO), and all workers. The Company continually evaluates, and provides the necessary resources, and incentives to ensure ALARA goals are met.

CROWNPOINT URANIUM PROJECT
CONSOLIDATED OPERATIONS PLAN

1.0 GENERAL DESCRIPTION

The Crownpoint Uranium Project (as collectively described in 1.1 below) has been the subject of a number of applications, reports, submittals, correspondence, and various other documentation which has been submitted to the United States Nuclear Regulatory Commission (USNRC). The general chronology of these submittals is specified in 1.2 below.

Because the licensing of the Crownpoint Uranium Project has taken a number of years, and included several additional mine locations with corresponding informational submittals, USNRC has expressed concern that the Application information has become disjointed for the purpose of "tiedown provisions" in the operating license. The purpose of this CONSOLIDATED OPERATIONS PLAN (COP) is to extract, and combine the information in previously submitted documents into one consolidated specification report. This document will contain all the specifications, and representations which have been articulated to NRC in the past under one cover.

1.1 Project Identification

Hydro Resources, Inc., (HRI)* a wholly-owned subsidiary of Uranium Resources, Inc. proposes to develop an in-situ uranium leach operation in McKinley County, New Mexico (Fig 1.1-1). The proposed project will consist of three separate facilities including the Churchrock, and Unit 1 Satellites, and the Crownpoint Central Plant (CCP). Each will have a nominal leaching capacity of 4000 gpm, and production capacity of 1 million Lbs. per year. Collectively, the CCP, and satellite facilities is referred to as the Crownpoint Uranium Project (CUP). The location of each is described separately below:

* Hydro Resources, Inc. is a Delaware Corporation licensed to do business in New Mexico. Because the name "Hydro Resources" was not available, the company operates as HRI, Inc. (also referred to as HRI). All references to Hydro Resources, Inc., and HRI should be considered interchangeable for the purposes of this report.

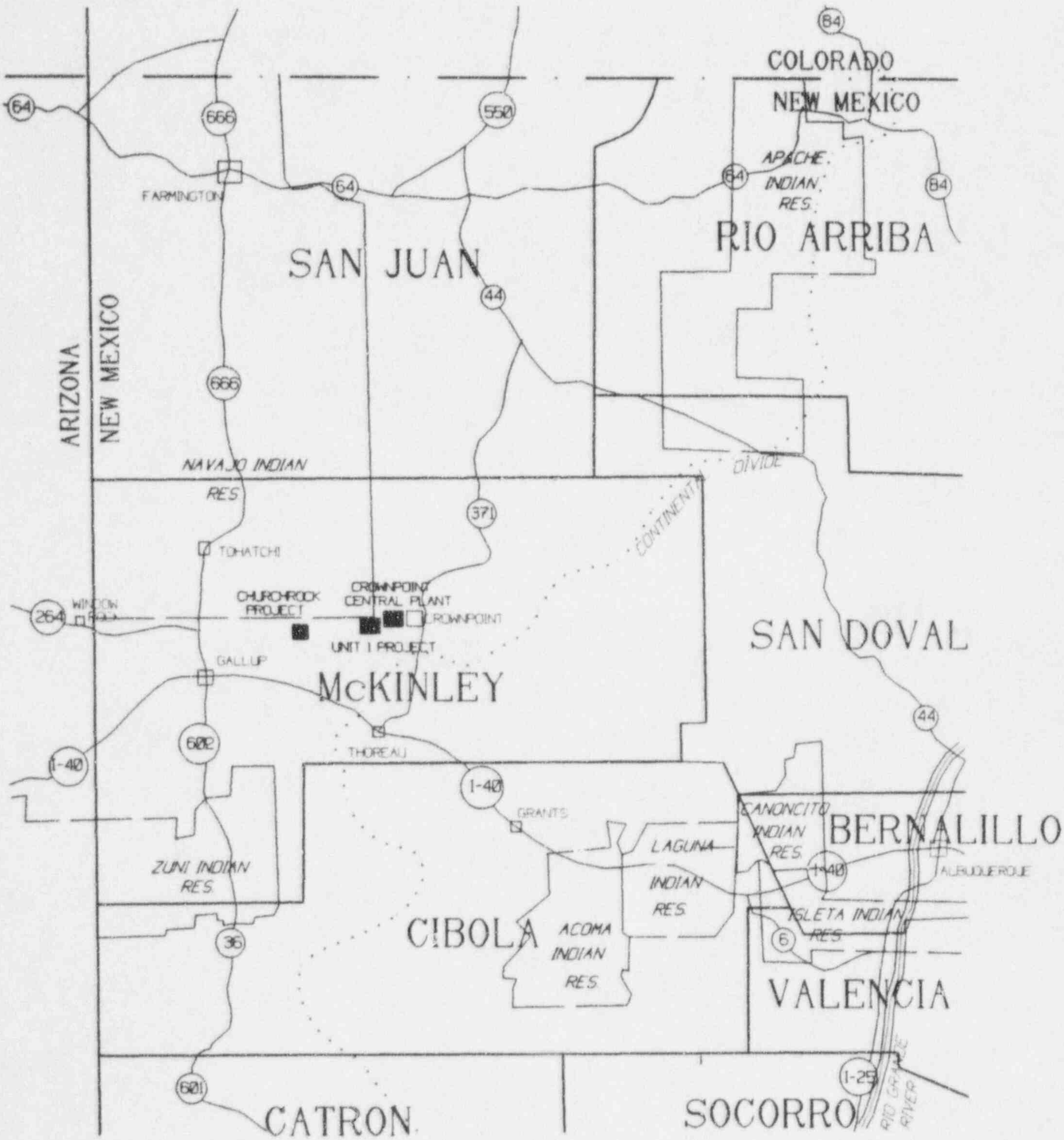


FIGURE 1.1-1
PROJECT AREAS LOCATION MAP

1.1.1 Crownpoint

The Crownpoint Central Plant (CCP) is located on the SE/4 of Section 24, Township 17 North, Range 13 West of McKinley County, New Mexico. Mining activities are anticipated within the license boundary as described herein.

T17N, R12W:

Beginning at a point on the NW corner of the SW/4 of Section 19, go 1,320' East along the North line of the South half of Section 19 to a point at the NE corner of said tract of land;

THENCE South along the East line of said tract 2,640' parallel with the West line to the SE corner of said tract of land;

THENCE West along the South line of said tract 1,320' parallel with the North line of the SW corner of said tract of land;

THENCE North along the West line of said tract 2,640' parallel to the East line to the point beginning for said tract of land located in Section 19.

Additionally,

Beginning at a point 650' South of the NW quarter for a point of beginning for said tract of land located in the West half of Section 29, go 2,640' East along the North line of said tract parallel to the South line of said W/2 of Section 29;

THENCE South along the East line of said tract 4,630' parallel with the West line to the SE corner of said tract of land;

THENCE West along the South line of said tract 2,640' parallel with the North line to the SW corner of said tract of land;

THENCE North along the West line of said tract 4,630' parallel to the East line to the point of beginning for said tract of land located in Section 29.

T17N, R13W:

Beginning at a point on the NW corner of the SW/4 of Section 24, go 5,280' East along the North line of the South half of Section 24 to a point at the NE corner of said tract of the SE/4;

THENCE South along the East line 2,640' parallel with the West line to the SE corner of the SE/4 of said Section 24;

THENCE South along the East line 465′ parallel with the West line to a point on said East line which is the SE corner of said tract in Section 25;

THENCE West along the South line of said tract of land 2,640′ parallel with the North line of said tract;

THENCE North 465′ along the West line parallel with the East line to the NW corner of said tract of land located in Section 25;

THENCE West 2,640′ along the South line parallel with the North line to the SW/4 of Section of 24;

THENCE North along the West line 2,640′ parallel to the East line to the point of beginning.

The location of the Crownpoint mine is illustrated with respect to topography, and cultural features on Figure 1.1-2.

1.1.2 Churchrock

The process facility for the Churchrock satellite will be located in the SE/4, SE/4 of Section 8, T16N, R16W.

Mining could be located on one, or both of the parcels of land owned, or leased to HRI on Section 8, and 17, T16N, R16W as described below:

Section 8

SE/4 - 174.546 ac. Patent Mining Claims

Section 17

200.0 acres being NE/4, and the SE/4 NW/4

The location of the Churchrock property is illustrated with respect to the topography, and cultural features on Figure 1.1-3.

1.1.3 Unit 1

The process facility for the Unit 1 satellite will be located in the NE/4, SE/4 of Section 21, T17N, R13W.

Mining could be located on any of the parcels of land leased to HRI as described below.

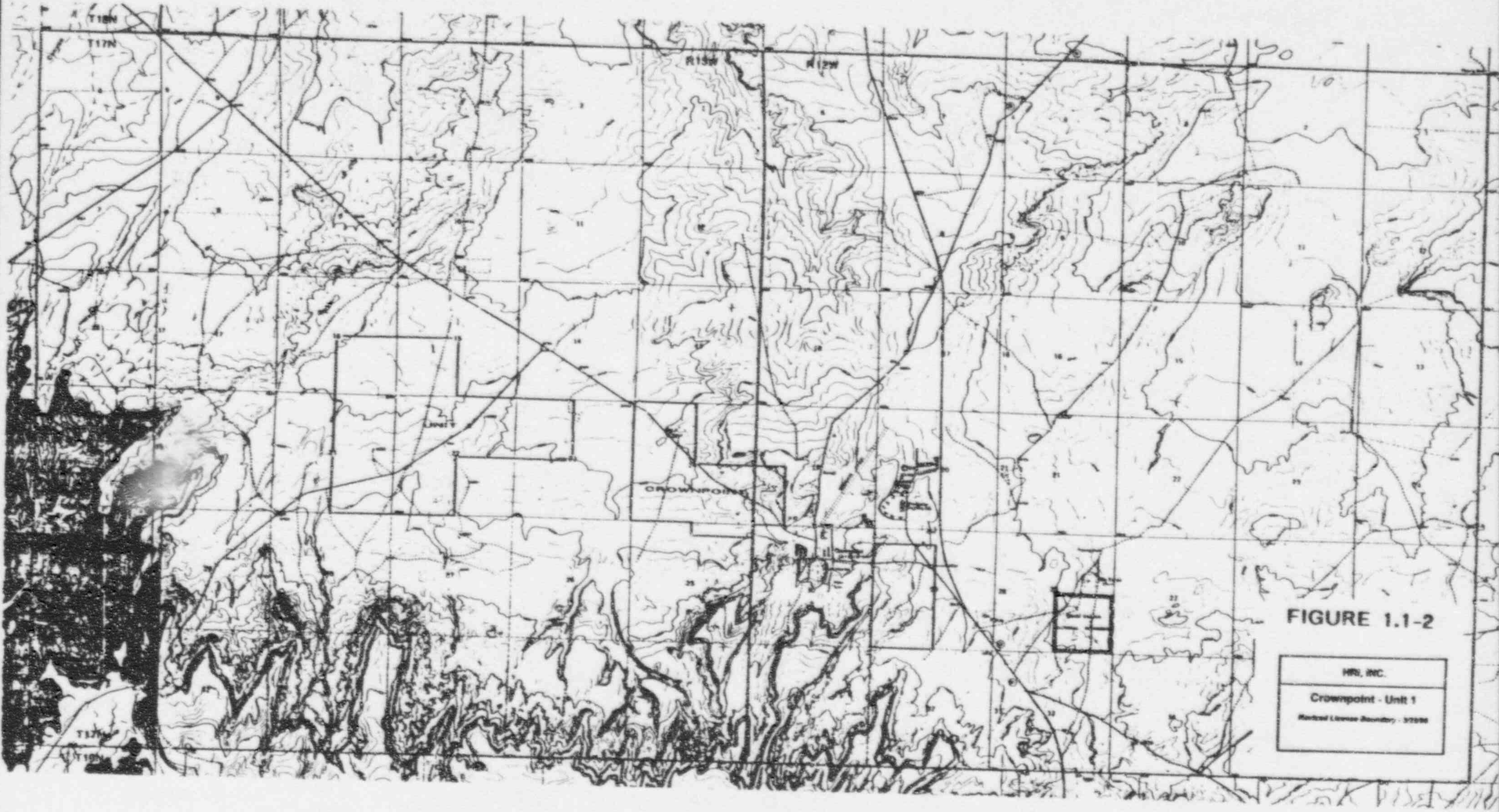
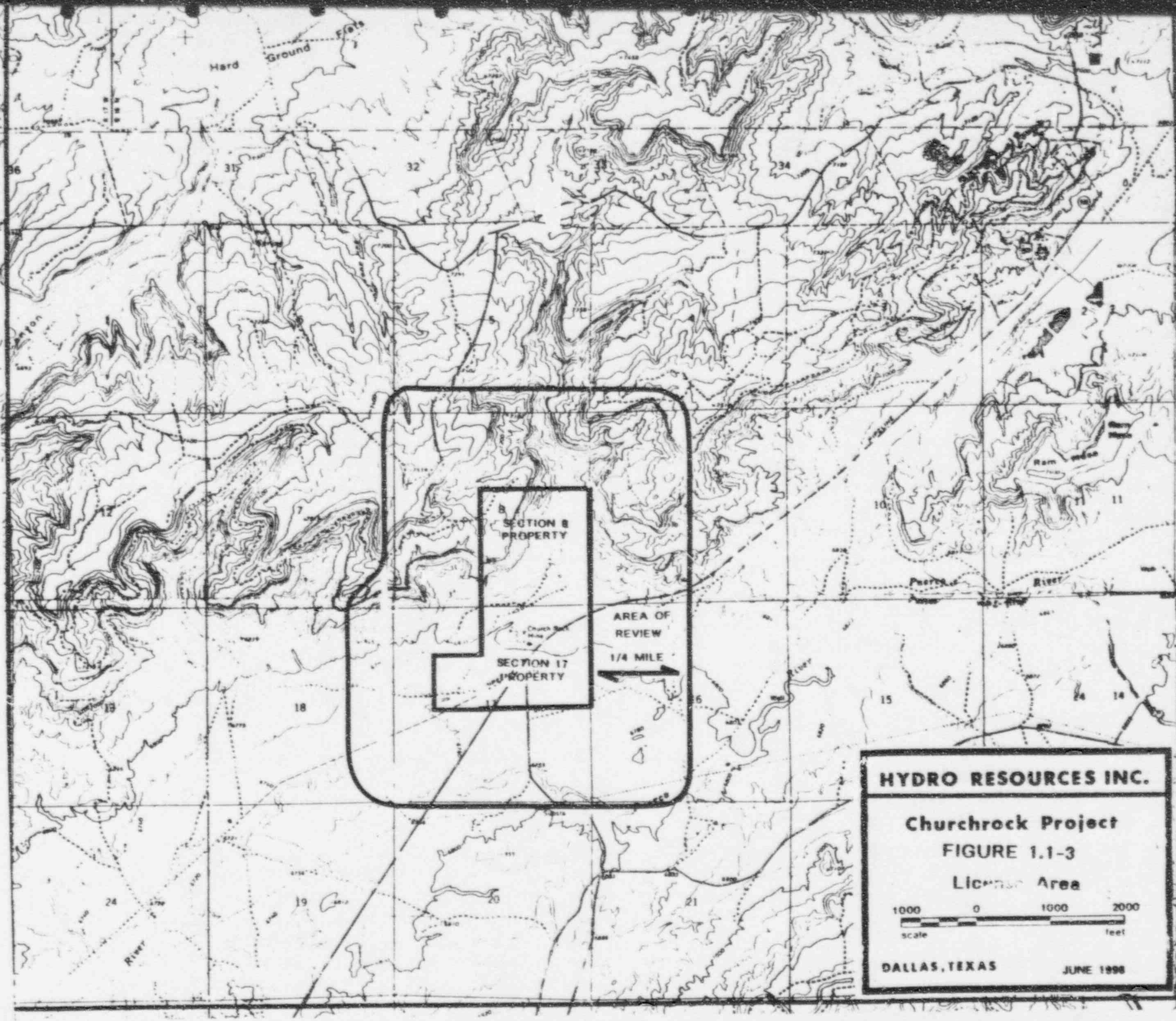

T18N
T17N
R13W
R12W
CROWNPOINT
HRI, INC.
Crownpoint - Unit 1
Revised License Boundary

FIGURE 1.1-2


Hard Ground Flats
36
31
32
34
12
7
8
SECTION 8 PROPERTY
SECTION 17 PROPERTY
AREA OF REVIEW
1/4 MILE
Ram
10
11
Puerco River
15
14
13
18
19
20
21
24
River
HYDRO RESOURCES INC.
Churchrock Project
FIGURE 1.1-3
License Area
1000 0 1000 2000
scale feet
DALLAS, TEXAS
JUNE 1998

Sections 15, 16, 21, 22, 23, and 24, T17N, R13W:

Section 15; SW/4 - 160 acres
Section 16; SE/4 - 160 acres
Section 21; E/2 - 320 acres
Section 22; W/2 NE/4 - 480 acres
Section 23; NW/4 - 160 acres
Section 24; NW/4 - 160 acres

The location of the Unit 1 properties is illustrated with respect to topography, and cultural features in Figure 1.1-2.

1.2 History and Permitting of the Project

HRI initiated its License application in accordance with 10 CFR Part 51.45, by submitting an environmental report (ER) to the NRC by cover letter dated April 13, 1988. The ER was also provided to the BIA, BLM, and others.

An application for a State of New Mexico discharge plan was submitted at the same time the NRC License was initiated. Subsequently, by letter dated April 25, 1988, HRI submitted an application to the NRC for a source material license to commercially produce uranium at its Church Rock ISL project, McKinley County, New Mexico.

On October 12, 1988, HRI announced that it had acquired existing mine facilities in Crownpoint, formerly owned by Conoco, and Westinghouse Corporations, and proposed to conduct uranium recovery processing there. By letter dated May 8, 1989, HRI submitted a Supplemental Environmental Report addressing this change.

Discharge plan DP-558 which authorized in situ mining at the Churchrock section 8 location was approved by the New Mexico Environment Improvement Division (now NMED) on November 2, 1989. This approval was preceded by approval of an aquifer exemption by the US EPA on June 21, 1989.

An application was submitted for water rights at the Churchrock property to the New Mexico State Engineer on February 14, 1991. This application was protested by the Navajo Nation on jurisdictional grounds. On February 13, 1992, the application was conditionally denied because of excessive project water consumption.

The proposed mine plan was expanded when HRI acquired mineral interests involving leases on allotted lands which were designated Unit 1. HRI addressed adding these areas in a new ER dated January 1992, and submitted to the NRC on April 23, 1992. Finally, the proposed project was again expanded to include mineral claims near the former Conoco/Westinghouse underground mine. The environmental report for this addition was submitted on July 31, 1992.

An application was submitted to the New Mexico Environmental Department on June 12, 1992, for authorization to mine on Section 24, and 19 of the Crownpoint Properties. This application was subsequently withdrawn.

A UIC application was submitted to EPA on October 9, 1992 which will authorize in situ mining on Unit 1 properties. This application was subsequently withdrawn.

In March of 1993, HRI submitted an application to amend DP-558 by adding the Section 17 property. A public hearing was conducted in October of 1993 on the amendment. The hearing was convened, and continued from time to time thereafter. The amendment was approved by NMED on October 7, 1994. EPA did not issue the requisite aquifer exemption for the property because of a question over regulatory jurisdiction.

In October, 1994 the Draft Environmental Impact Statement (DEIS) was released by an interagency review group consisting of the U.S. Nuclear Regulatory Commission (NRC), the U.S. Bureau of Land Management (BLM), and the U.S. Bureau of Indian Affairs (BIA). The review group was assisted by input from the Navajo Nation, the State of New Mexico, and other interested parties.

In February, 1995, NRC conducted public hearings on the Draft EIS. Thereafter, NRC compiled public comments, and other questions, and posed these to HRI as requests for additional information by letter dated Jan. 11, 1996, February 9, 1996, and July 15, 1996. HRI's responses to these documents were forwarded on to NRC on February 20, April 1, and August 15 respectively.

In July, 1996, HRI submitted a renewal application to NMED for DP-558. Also, in July, 1996, HRI submitted an application to NMED for a separate discharge plan for the Section 17 property. This bifurcation was designed to clearly distinguish between the two properties (Sections 8 & 17) for the purpose of providing flexibility in dealing with any future jurisdictional questions which might arise.

In August, 1996, HRI submitted an application for a discharge plan which will authorize in situ mining of the Crownpoint Property for the south half of Section 24.

In November, 1996, HRI submitted an application for an EPA UIC permit which will authorize in situ mining of the Unit 1 Property.

In February, 1997, the Final Environmental Impact Statement (FEIS) was released by an interagency review group consisting of the U.S. Nuclear Regulatory Commission (NRC), the U.S. Bureau of Land Management (BLM), and the U.S. Bureau of Indian Affairs (BIA).

1.3 In Situ Mining Technique

In situ mining involves the use of a leaching solution (lixiviant) to extract the mineral of interest from the geologic formation in which it occurs. This is accomplished by injecting the lixiviant through injection wells completed in the zone of interest, dissolving the target minerals, then recovering the pregnant lixiviant, or production fluid by pumping production wells. At HRI's properties, uranium will be extracted from roll front type deposits which contain an average ore grade of approximately 0.15 percent. The ore deposits are usually a few feet in thickness.

Various well patterns are typically used for uranium in situ mining at the CUP. Each wellfield area consists of groups of these patterns which are installed to correspond to the irregular geometry of the ore bodies.

At the CUP, the lixiviant consists of native groundwater to which gaseous carbon dioxide(or some form of sodium bicarbonate), and oxygen have been added. After the lixiviant is injected into injection wells, and recovered through production wells it is piped to the ion exchange facility where the uranium is removed by circulating the pregnant lixiviant through ion exchange resin. The barren lixiviant is returned to the wellfield. At the satellite projects, ion exchange resin, or yellowcake slurry will be transported in appropriate trailers to the CCP where it will be further processed to its final form. If resin is hauled, it will be returned to the IX system for further use after it has been stripped of uranium at the CCP.

Once the economic recovery limit of a mine area is reached, lixiviant injection is stopped, and the affected ground water is treated (restored) to return the water to a quality consistent with baseline as specified in Section 10, and/or as required by NRC, and other controlling regulatory authorities.

An extensive water monitoring program is required for in situ mining. Specifically designated wells are monitored for water level, and sampled for certain water quality parameters on a regular basis to ensure that the injected lixiviant stays within the defined production zone.

The chief components of an in situ uranium recovery facility include:

a. **Mining process**, where a lixiviant stream is continuously recirculated from the recovery plant into injection wells, through ore bearing, and a uranium-rich (pregnant) lixiviant is withdrawn (via production wells)and recirculated to the recovery plant;

b. The **recovery plant**, where uranium in the pregnant lixiviant is extracted, and the resulting barren lixiviant is recirculated through the wellfields.

c. **Yellowcake precipitation**, and **concentration** in the form of oxide (U3O8 or yellowcake) which may be shipped either as a wet solid, or slurry (in appropriate trailers), or as dry powder (in drums).

d. The CUP will utilize a **yellowcake dryer** to finish the dry product.

1.3.1 In Situ Mineral Extraction Preserves the Surface

Uranium mineralization makes up only a small portion of the total mass of uranium ore, therefore, after mining the structural integrity of the host aquifer is maintained, and no land subsidence occurs. However, as part of HRI's site reclamation plan, the company will monitor if depressions appear at the surface due to subsurface collapse, and return the land surface to its general contour as part of the projects surface reclamation activities.

1.3.2 Restoration

Once the economic recovery limit of a mine area is reached, lixiviant injection is stopped, and the affected ground water is treated (restored) to return the quality of water to preoperational baseline conditions, or quality of use, as appropriate.

1.3.3 Advantages of In Situ Uranium Mining

Uranium in situ mining is a proven technology that has been successfully demonstrated commercially in the states of Nebraska, Texas, and Wyoming. URI, HRI's affiliate, has extensive commercial experience in uranium in situ mining in the state of Texas from 1978 to the present. In situ mining of uranium is environmentally superior to conventional open pit uranium mining as evidenced by the following:

a. In situ mining results in significantly less surface disturbance. Mine pits, waste dumps, haul roads, and tailings ponds are not needed.

b. Compared to conventional mining, in situ mining reduces the short- and long-term exposure to the general population to extremely low levels because almost all of the source term remains underground in its natural location. Very little residual radioactive waste is produced, and there are no tailings. Land, and water are returned to their original, pre-mining use, and quality.

c. In situ mining requires much less water than pit, or underground mine dewatering, or conventional milling.

d. The lack of heavy equipment, haul roads, waste dumps, etc., result in virtually no air quality degradation at in situ mines.

e. Fewer employees are needed at in situ mines, thereby reducing transportation, and socioeconomic concerns.

f. Aquifers are not excavated, but remain intact during, and after in situ mining so they remains available for future uses. Not creating large excavations opens the surrounding land for grazing, or raising crops

g. The technology of recirculating mine fluids through the ion exchange facility reduces the amount of solids to a negligible quantity, and tailings ponds are not used, thereby eliminating a major groundwater pollution concern.

1.4 Schedule for Mining Related Activities

Within the wellfield, individual wells will be shut down when they cease to be economically productive. When an entire segment of a wellfield has been depleted of uranium, restoration will be started via ground water sweeping, and/or reverse osmosis treatment, and brine concentration.

The projected general production, and restoration schedule for the CUP is show on Figure 1.4-1. It should be emphasized that this schedule is projected, and will ultimately be impacted by regulatory, and market influences. More detailed production, and restoration schedules are described below.

1.4.1 Crownpoint

The proposed mining plan at the CCP is summarized on Figure 1.4-2. Individual mine areas which are listed on Figure 1.4-2 are shown on 1.4-3.

Prior to the injection of lixiviant at the Crownpoint site, HRI will replace the town of Crownpoint water supply wells NTUA-1, NTUA-2, BIA-3, BIA-5, and BIA-6. In addition, HRI will construct a water system pipeline, and provide funds so that the Navajo Tribal Utility Authority (NTUA), and Bureau of Indian affairs (BIA) water supply systems can be connected. The wells, pumps, pipelines, and any other necessary changes to the existing water supply system will be made so the system can continue to provide the same quantity of water. The new wells will be located so that the water quality at each individual wellhead will not exceed EPA primary, and secondary drinking water standards, and a concentration of 0.44 mg/l uranium as a result of future *in situ* leach mining activities at the Unit 1, and Crownpoint sites. HRI will coordinate with the appropriate agencies, and regulatory authorities, including the BIA, and the Navajo Nation Division of Water Resources, and the Navajo Nation Environmental Protection agency (NNEPA), and the NTUA, to determine the appropriate placement of the new wells. Further, the existing wells will be abandoned, and sealed in accordance with applicable guidelines.

Within the wellfield, individual wells will be shut down when they cease to be economically productive. When an entire segment of a wellfield has been depleted of uranium, restoration will be started via ground water sweep, and/or reverse osmosis treatment, and brine concentration. The estimated productive/restoration life of the wellfields at CCP is about 16 years. All timing is subject to discovery of additional reserves which will, by necessity, extend the mine life before final decommissioning.

CUP Mine Plan

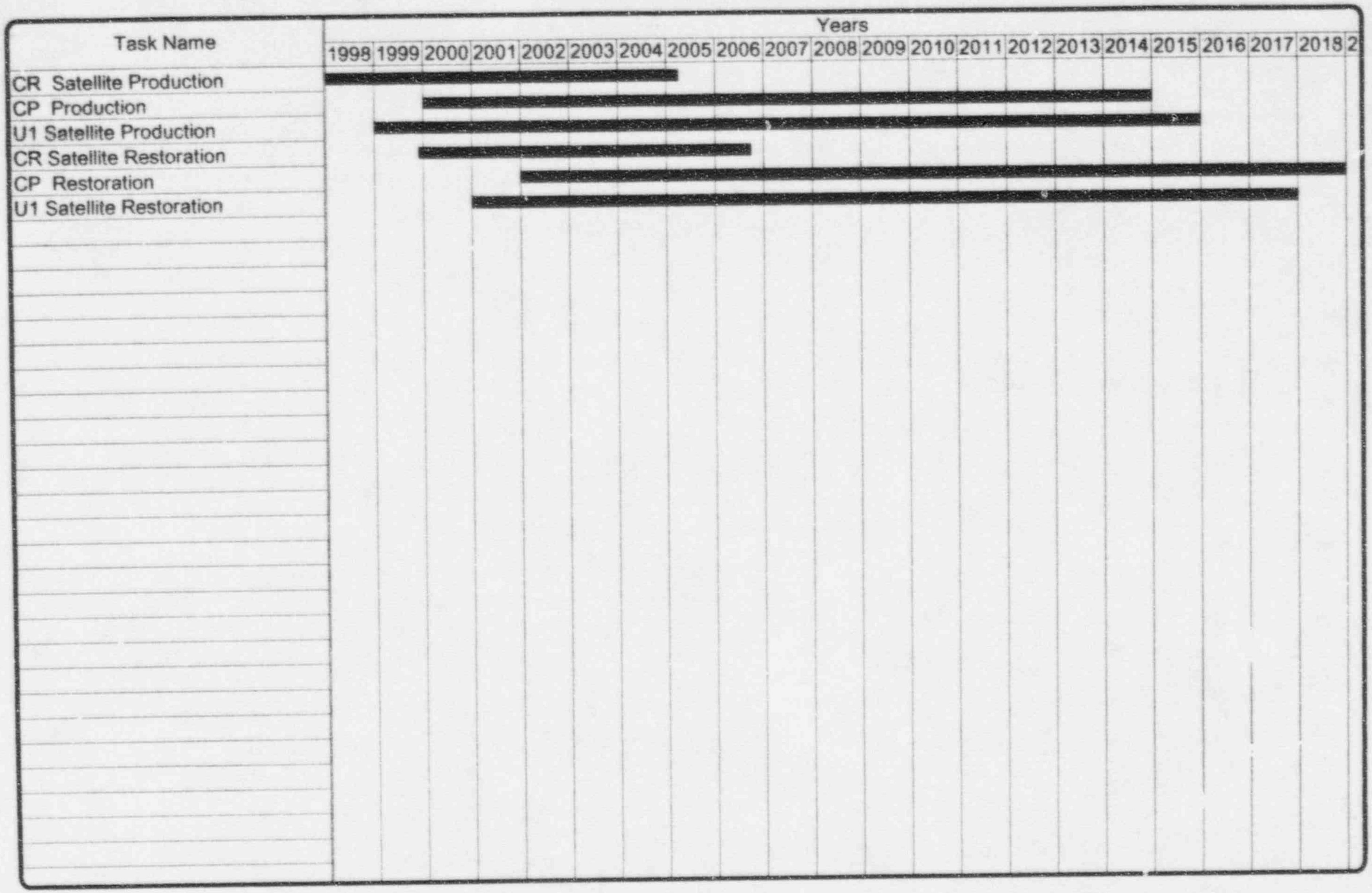


FIGURE 1.4-1

Mine Plan - Crownpoint 24 South 1/2

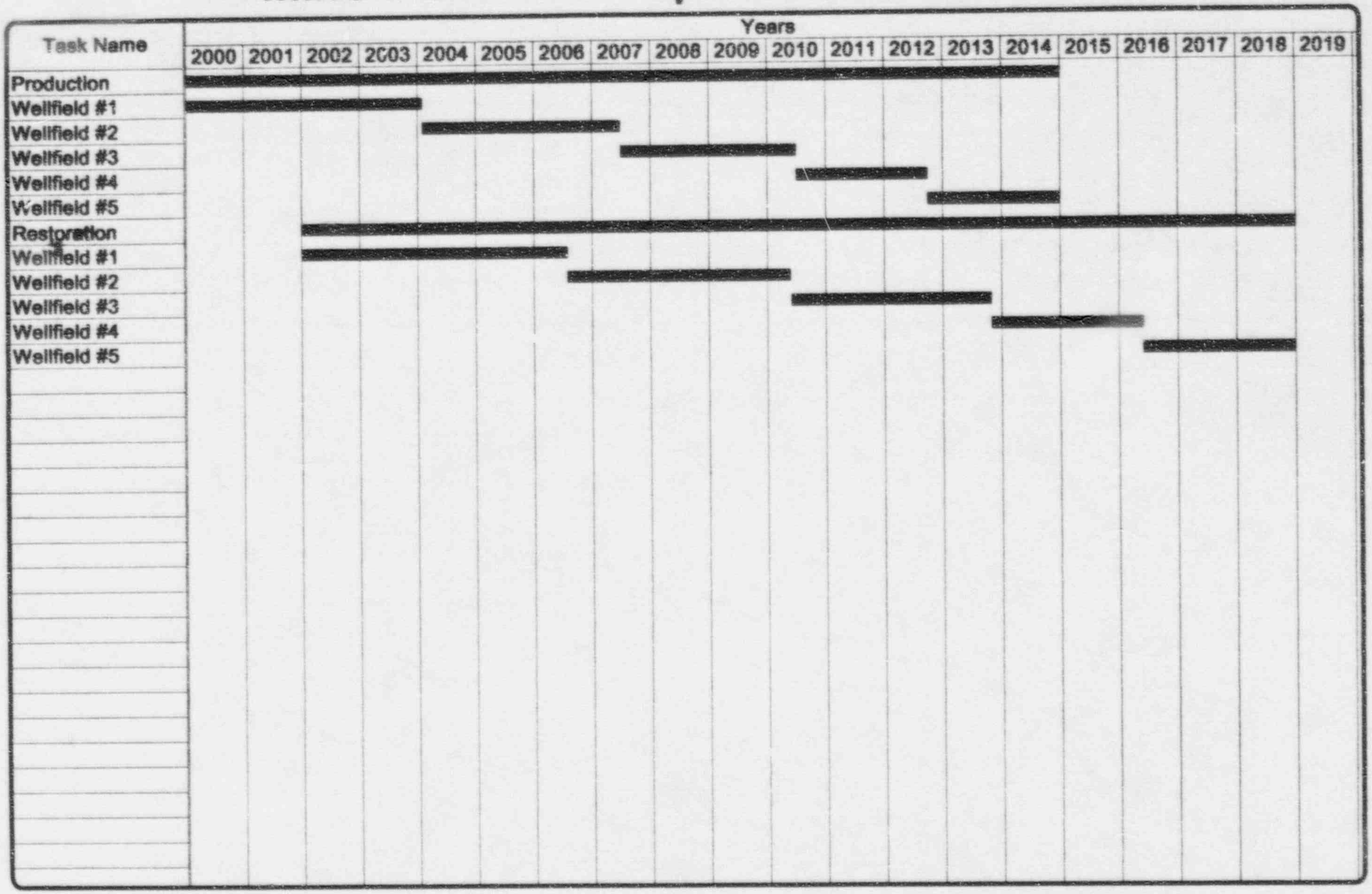
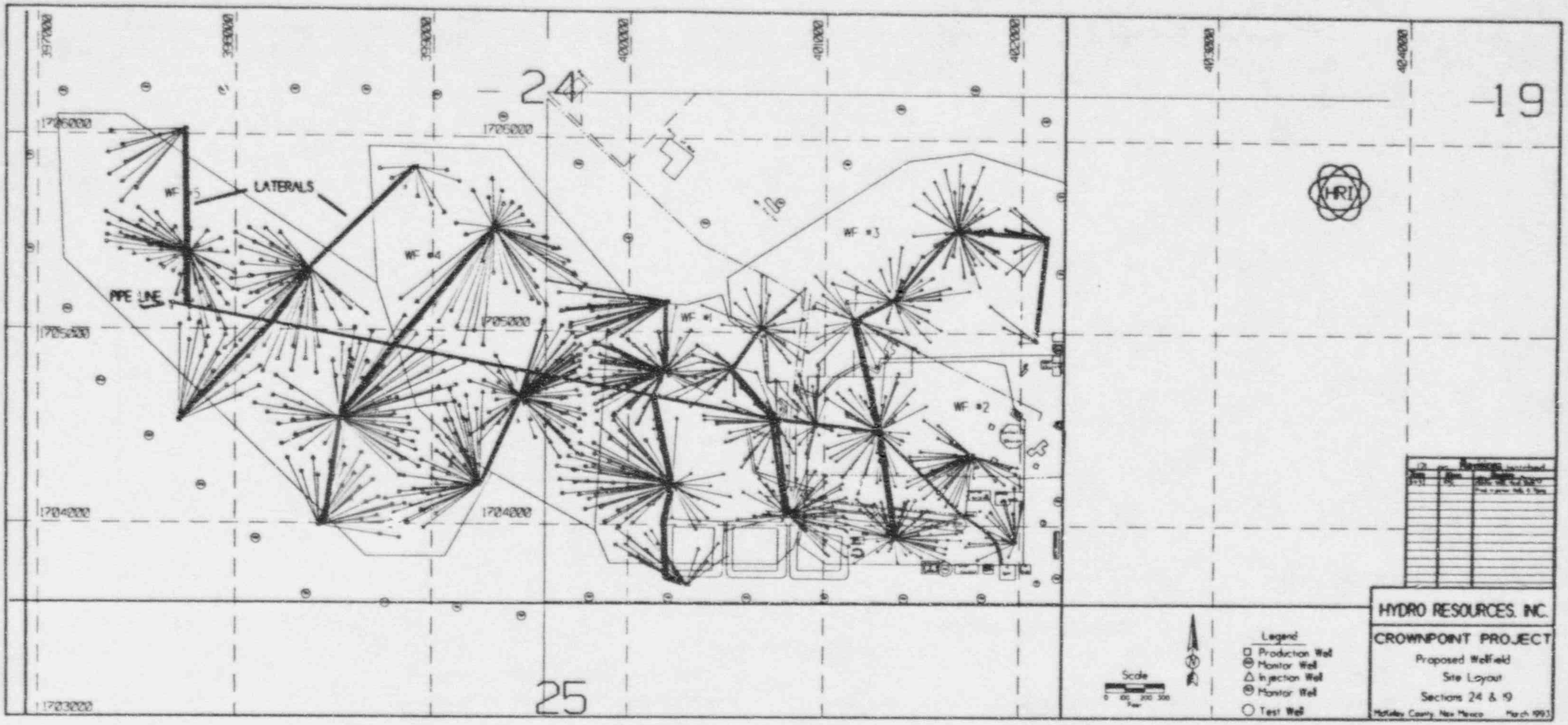


FIGURE 1.4-[illegible]



397000
398000
399000
400000
401000
402000
403000
404000
24
19
25
1706000
1705000
1704000
1703000
LATERALS
PIPE LINE
WF #4
WF #1
WF #3
WF #2
HRI
Scale
Legend
Production Well
Monitor Well
Injection Well
Monitor Well
Test Well
HYDRO RESOURCES, INC.
CROWNPOINT PROJECT
Proposed Wellfield
Site Layout
Sections 24 & 19
McKinley County, New Mexico
March 1993

FIGURE 1.4-3

1.4.2 Unit 1

The proposed mining plan at the Unit 1 Satellite Operating Area #1 is summarized on Figures 1.4-4 and 1.4-5. Within the wellfield, individual wells will be shut down when they cease to be economically productive. When an entire segment of a wellfield has been depleted of uranium, restoration will be started via ground water sweep and/or reverse osmosis treatment and brine concentration. The estimated productive/restoration life of Operating Area #1 is 6.5 years. All timing is subject to discovery of additional reserves which will, by necessity, extend the mine life before final decommissioning.

1.4.3 Churchrock

The proposed mining plan at Churchrock is summarized on Figures 1.4-6 through 1.4-8. Individual mine areas which are listed on Figures 1.4-6 and 1.4-7 are shown on Figure 1.4-8. Production will proceed first on Section 8. Within the wellfield, individual wells will be shut down when they cease to be economically productive. When an entire segment of a wellfield has been depleted of uranium, restoration will be started via ground water sweep and/or reverse osmosis treatment and brine concentration. The estimated productive/restoration life of the wellfields at Churchrock Section 8 is 5.5 years.

Production is scheduled to begin on Section 17 following Section 8 with the same production/restoration criteria stated above. The estimated production/restoration life of the well fields at Churchrock Section 17 is 4.5 years, including final decommissioning on Section 8 at the end of the project. All timing is subject to discovery of additional reserves which will, by necessity, extend the mine life before final decommissioning.

1.5 Waste Disposal

HRI will maintain an area within the restricted area boundary for storing contaminated materials prior to disposal. All contaminated pond residue and other waste will be disposed of at an NRC-or Agreement State-licensed waste disposal site. Prior to beginning operations, HRI will develop and maintain an agreement for the disposal of 11e(2) by-product material with a facility licensed by the NRC or an Agreement State to accept such material. Liquid wastes will be disposed of by either surface irrigation, surface discharge, deep disposal well, or evaporation.

Unit 1 Operating Area 1

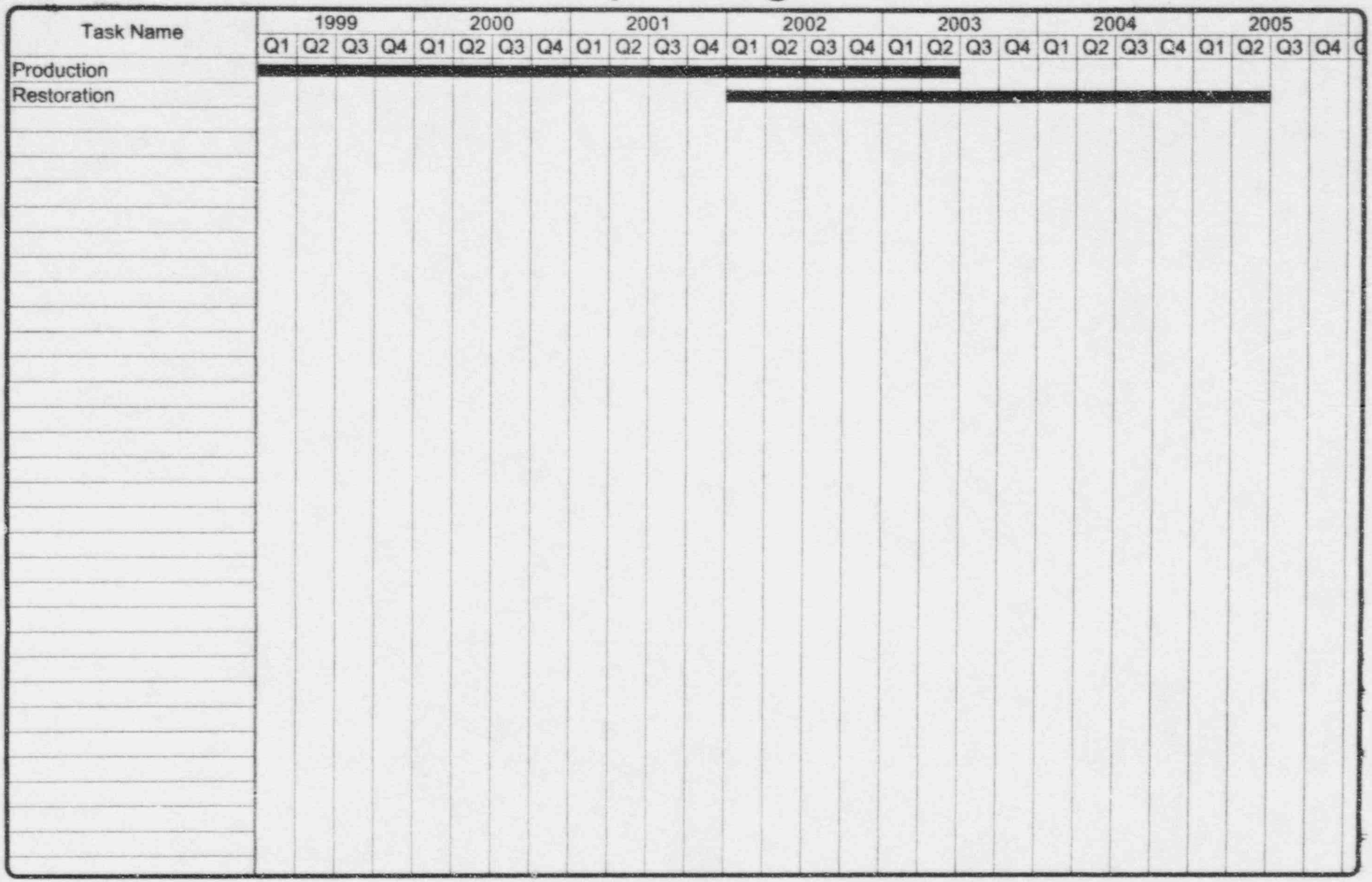


FIGURE 1.4-4

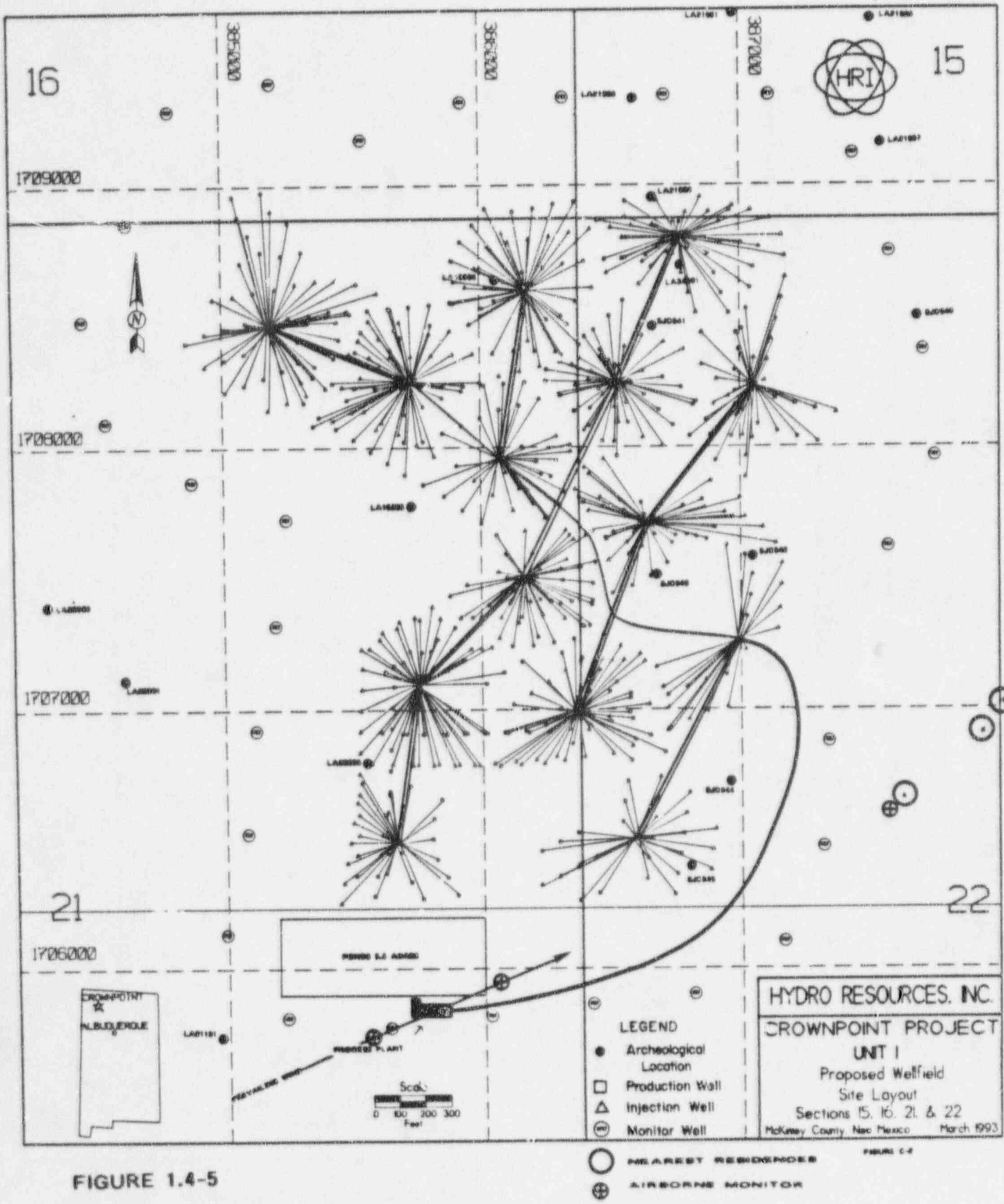

16
15
21
22
HRI
385000
386000
387000
1709000
1708000
1707000
1706000
CROWNPOINT
ALBUQUERQUE
Scale
0 100 200 300
Feet
LEGEND
Archeological Location
Production Well
Injection Well
Monitor Well
HYDRO RESOURCES, INC.
CROWNPOINT PROJECT
UNIT I
Proposed Wellfield
Site Layout
Sections 15, 16, 21, & 22
McKinley County, New Mexico
March 1993
NEAREST RESIDENCES
AIRBORNE MONITOR

FIGURE 1.4-5

Churchrock Section 8 Mine Plan

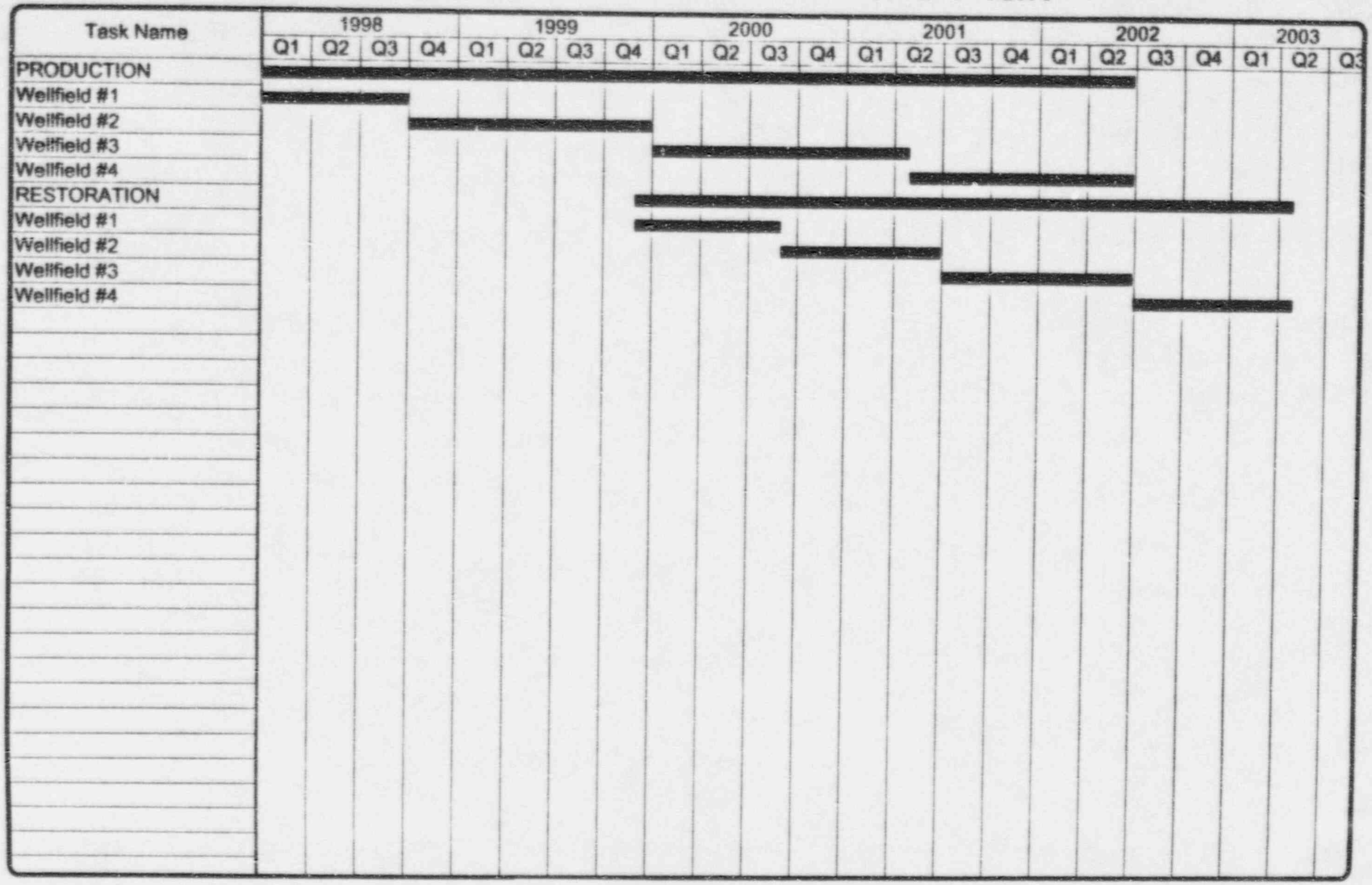


FIGURE 1.4-6

Churchrock Section 17 Mine Plan

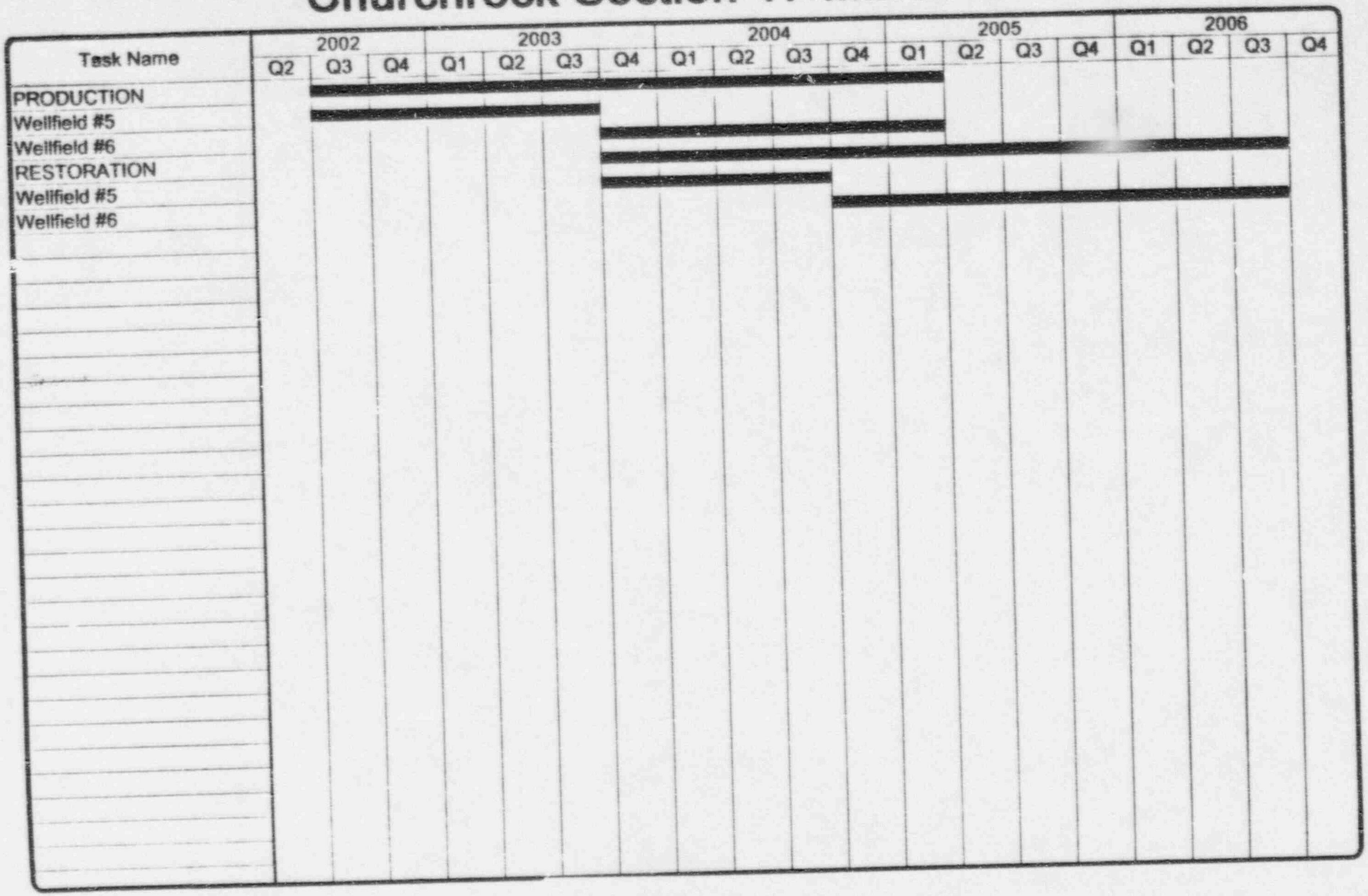
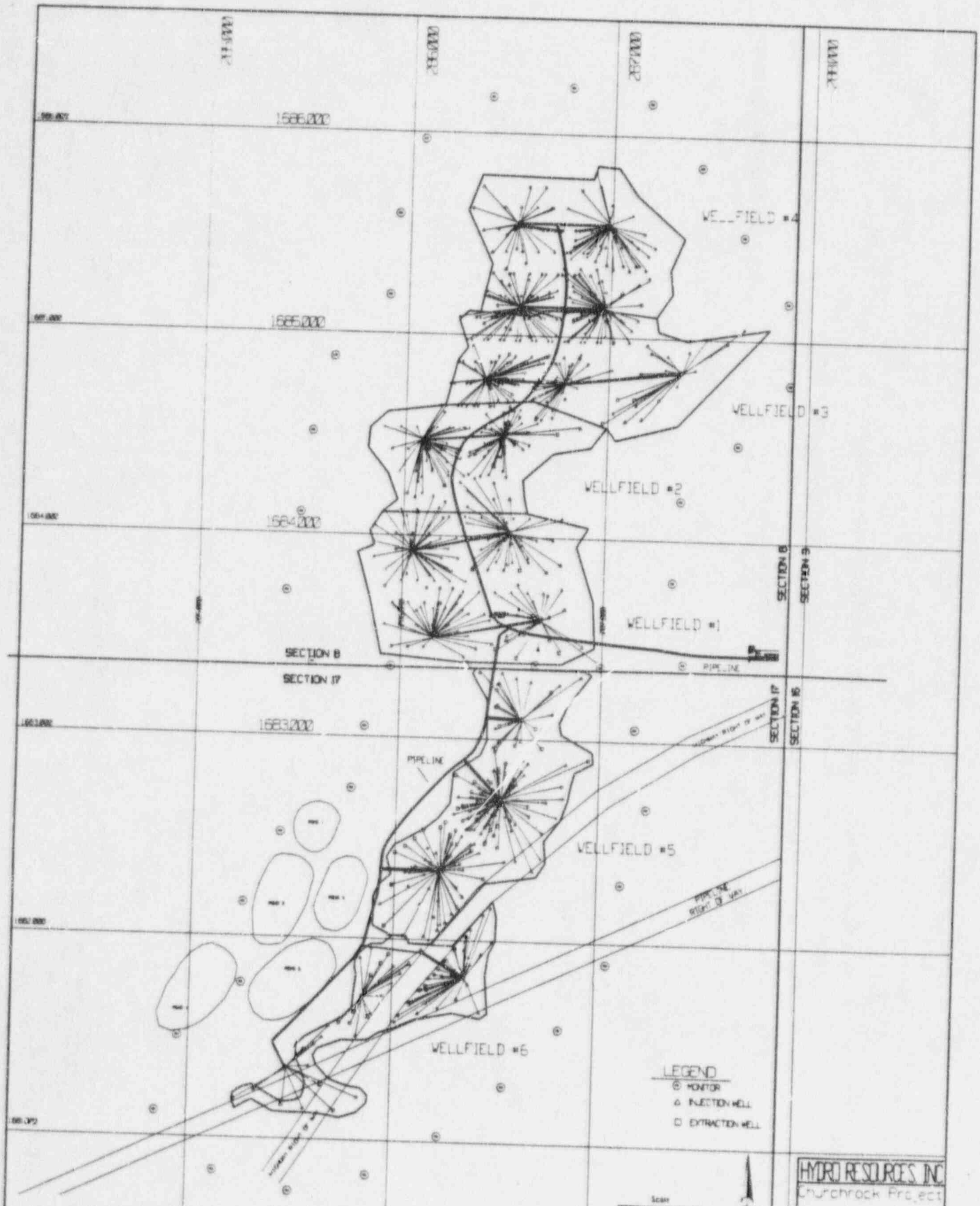


FIGURE 1.4-7



1686,000
1685,000
1684,000
1683,000
WELLFIELD #4
WELLFIELD #3
WELLFIELD #2
WELLFIELD #1
WELLFIELD #5
WELLFIELD #6
SECTION 8
SECTION 17
SECTION 8
SECTION 9
SECTION 17
SECTION 16
PIPELINE
PIPELINE
LEGEND
MONITOR
INJECTION WELL
EXTRACTION WELL
HYDRO RESOURCES INC
Churchrock Project
Sections 8 & 17

FIGURE 1.4-8

1.6 Surety Bonding

HRI will provide financial security for mine closure, including surface, and subsurface restoration, and reclamation. The amount of the surety will be determined by the NRC based on cost estimates for completion of the approved reclamation plan by a third party in the event that HRI defaults. The surety will be reviewed annually by the NRC, and adjusted to reflect expansions in operations, changes in engineering design, and inflation. The amount of surety will also be subject to NMED, and/or EPA regulatory approval, and the form will meet the requirements of NMWQQC 5-210.B.17, and/or 40CFR144.63.

1.7 Cultural Resources Management

HRI will maintain, and implement a final cultural resources management plan for all mineral operating lease areas, and other land affected by licensed activities, pursuant to the National Historic Preservation Act Section 106 review, and consultation process. The plan will provide specific procedures to implement HRI's policy of avoiding cultural resources. The plan will include archaeological, and traditional cultural property surveys of all lease areas, identification of protection areas where human activity will be prohibited, archaeological testing (by an archaeologist contracted to HRI, and holding appropriate permits from the Navajo Nation, and the State of New Mexico) before subsurface disturbance occurs at a specific location, and archaeological monitoring during all ground disturbing construction, drilling, and operation activities. In the event that previously unidentified cultural resources, or human remains are discovered during project activities, the activity in the area will cease, appropriate protective action, and consultation will be conducted, and if indicated, the artifacts, or human remains will be evaluated for their significance.

1.8 NRC Performance Based Licensing (PBL)

Consistent with NRC licensing policy, HRI is planning operations to be consistent with PBL license format. Under the PBL format, HRI will ensure the proper implementation of the Performance Based Condition. Under this format HRI can:

a. Make changes in the facility, or process, as presented in the COP,

b. Make changes in the procedures presented in the COP,

c. Conduct tests, or experiments not presented in the COP, without prior NRC approval, if HRI ensures that the following conditions are met:

1. The change, test, or experiment does not conflict with any requirement specifically stated in the license (excluding material referenced in the Performance Based License Condition), or impair HRI's ability to meet all applicable NRC regulations.

2. There is no degradation in the essential safety, or environmental commitments in the license.

3. The change, test, or experiment is consistent with NRC's conclusions regarding actions analyzed, and selected in the Final Environmental Impact Statement.

If the provisions of 1.8 are not met, HRI is required to submit an application for a License Amendment to the NRC. HRI's determinations whether the above conditions are satisfied will be made by a Safety, and Environmental Review Panel (SERP). The SERP will consist of a minimum of three individuals. One member of the SERP will have expertise in management, and will be responsible for managerial, and financial approval changes; one member will have expertise in operations, and/or construction, and will have expertise in implementation of any changes; and, one will be the Radiation Safety Officer (RSO), or equivalent. Additional members may be included in the SERP as appropriate to address technical aspects in several areas, such as health physics, ground water hydrology, surface water hydrology, specific earth sciences, and others. Temporary members, or permanent members other than the three identified above, may be outside consultants.

1.9 Maintaining Records

HRI will maintain records of any changes made pursuant to the Performance Based License Condition until license termination. The records will include written safety, and environmental evaluations made by the SERP that provide the basis for the determination that the particular change is in compliance with the requirements referred to above. HRI will furnish an Annual Report to NRC that describes such changes, tests, or experiments, including a summary of the safety, and environmental evaluation of each. In addition, HRI will annually revise the COP of the License Application to reflect changes made under this condition.

2.0 SURFACE FACILITIES

The proposed CUP will consist of three separate facilities including the Churchrock, and Unit 1 Satellites, and the Crownpoint Central Plant, or CCP. Each plant of the CUP will contain equipment used for production, and restoration. The CCP, and individual satellite plants will be similar except the CCP will contain a dryer, and yellowcake drum storage area. In Situ mining is planned for each location.

2.1 Processing Plant Equipment

At each site, including the CCP, and satellites, HRI will conduct uranium mineral extraction using columns containing IX resin, vessels to store various solutions, piping, and pumps. The proposed process pumps lixiviant from the wellfield through the columns, and returns it to the wellfield injection circuit. The IX system will be operated in a closed system under low but continuous pressure. When uranium is removed from the resins, the concentrated uranium solution will be stored, and processed in precipitation tanks. Precipitated uranium will be sent through the drying process, where it will be partly dewatered, washed, dried, and packaged for storage, and shipment.

The CCP (Figure 2.1-1), and satellite processing plants (Figure 2.1-2) will contain various vessels to hold, and process liquid solutions. The principal vessels will include IX columns, elution columns, and yellowcake precipitation tanks. Other tanks will hold barren eluant, and yellowcake slurry. HRI's COP includes general specifications for all vessels, and piping. The specifications cite applicable American Society for Testing, and Materials (ASTM) standards for plastic, and fiberglass components, and American Society of Metallurgical Engineers (ASME) guides for all steel vessels that will be operated under pressure.

The satellite facilities at Churchrock, and Unit 1 will produce resin loaded with uranyl carbonate complex, or yellowcake slurry, but the CCP will also include drying, and packaging equipment. Access to the yellowcake storage area will be restricted. Liquid oxygen tanks will be located in the well fields. Other chemical storage tanks may be located on a concrete pad near the retention ponds.

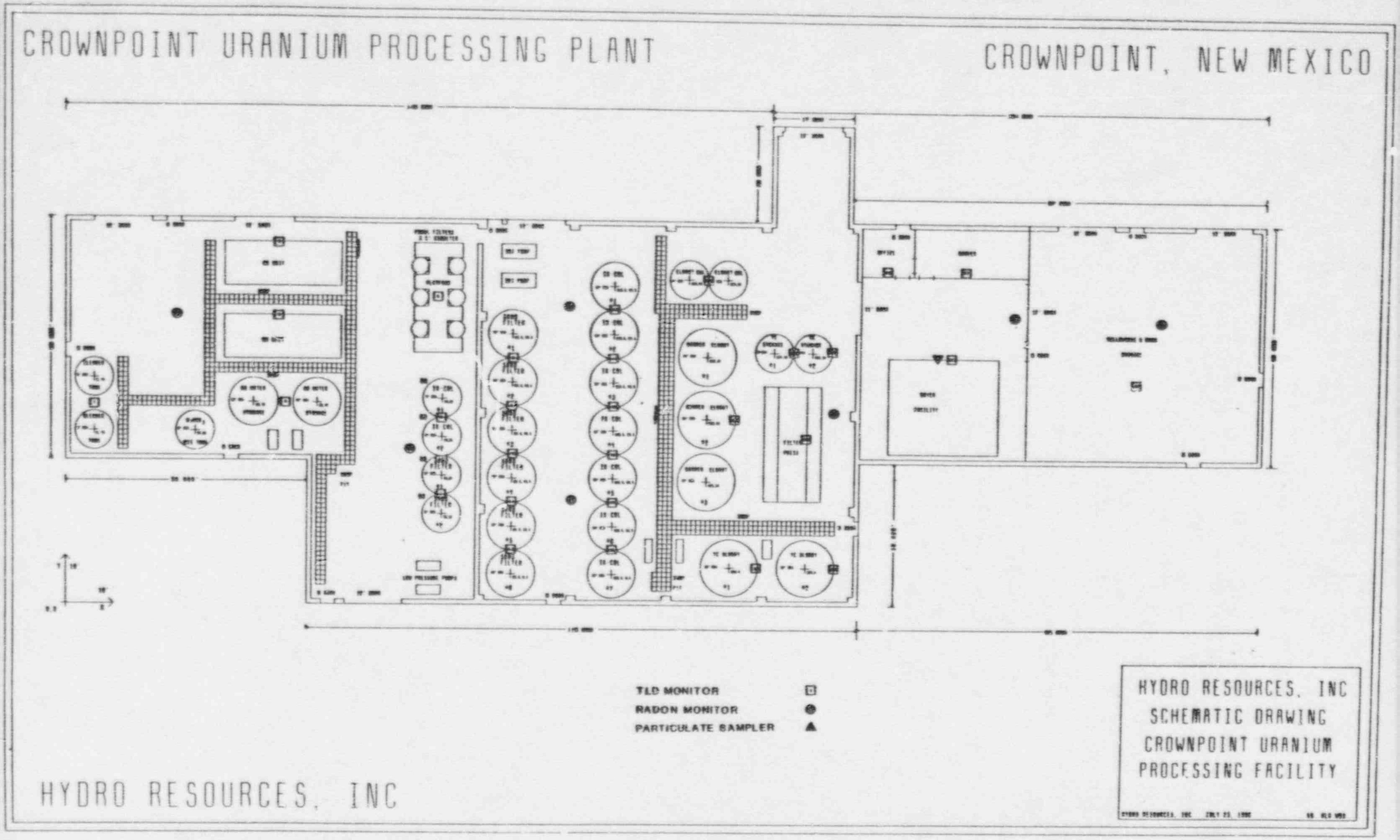

CROWNPOINT URANIUM PROCESSING PLANT
CROWNPOINT, NEW MEXICO
TLD MONITOR
RADON MONITOR
PARTICULATE SAMPLER
HYDRO RESOURCES, INC
SCHEMATIC DRAWING
CROWNPOINT URANIUM
PROCESSING FACILITY
HYDRO RESOURCES, INC

FIGURE 2.1-1

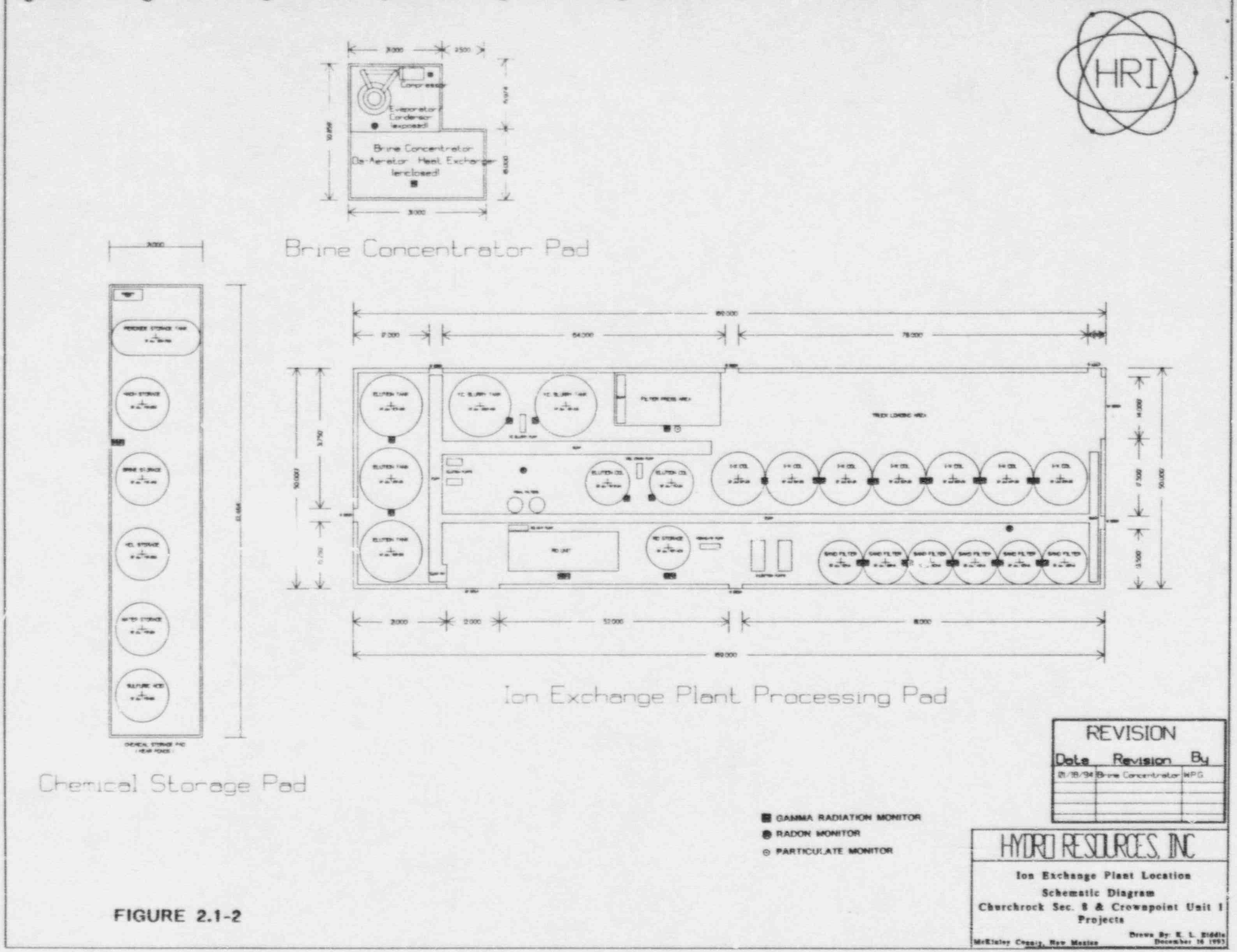

Compressor
Evaporator/
Condensor
(exposed)
Brine Concentrator
De-Aerator Heat Exchanger
(enclosed)
Brine Concentrator Pad
Chemical Storage Pad
Ion Exchange Plant Processing Pad
REVISION
Date Revision By
01/18/94 Brine Concentrator HPG
GAMMA RADIATION MONITOR
RADON MONITOR
PARTICULATE MONITOR
HYDRO RESOURCES, INC
Ion Exchange Plant Location
Schematic Diagram
Churchrock Sec. 8 & Crownpoint Unit 1
Projects
Drawn By: K. L. Biddle
December 16 1993
McKinley County, New Mexico

FIGURE 2.1-2

Major structures to be provided at each facility initially include:

a. process pad, on which uranium ion exchange equipment will be located (Table 2.1-2);

b. waste retention ponds;

c. restoration treatment equipment also located in the processing plant;

d. office, and service building (laboratory control room, workshops, etc.);

e. production chemical storage pad, and;

f. brine concentrator pad.

Table 2.1-2 CUP Processing Equipment.

Restoration Equipment	Processing Equipment
Chemical Tanks	Chemical Tanks
Cleaners	Sand Filters
Mix Tank	Ion Exchange Columns
RO Water Storage	Pumps
Final Filters	Barren Eluant Columns*
RO Units	Yellowcake Slurry Tanks*
RO Ion Exchange	Yellowcake Storage Tanks*
RO Sand Filters	Filter Press*
Brine Concentrator	Dryer**

* If yellowcake is produced
** CCP Only

2.2 Process Pad

The process pad will be made of concrete, and provided with sumps, drains, and at least a 6 inch high curb at the periphery. Thicker footers will be provided where heavy processing equipment, and vessels will be located. The curb will be designed to confine, and hold potential spills in the plant, and potentially contaminated runoff from the processing equipment area. This spilled material will then be transferred into storage tanks, or lined retention ponds. The pad curb, and sump will be adequate to contain the volume of the largest tank on the pad.

2.3 Retention Ponds

Where practical at the CUP, retention ponds will be constructed such that all retained fluid is below ground level. This will eliminate the potential for embankment failure, and the need for NRC Regulatory Guide 3.11 criteria. Retention ponds will be added as needed to accommodate the fluid handling requirements of the operation.

The purpose of retention ponds is to store waste, or restoration water until treatment, promote evaporative loss of water which cannot be discharged to the environment, and maintain control of source, and byproduct material found in the liquid effluents from solution mining. Initially, two, or more retention ponds will be constructed at each site. These ponds will occupy up to 6 acres. If below ground level construction is not possible, HRI commits to design, and construct its pond embankments to meet specifications in NRC Regulatory Guide 3.11, *"Design, Construction, and Inspection of Embankment Retention Systems for Uranium Mills"*.

Sixty days prior to beginning construction of wastewater retention ponds at any CUP production center, HRI will submit for NRC approval, detailed drawings, and analysis/calculations for the pond embankment locations, diversion channels, and erosion protection design. Additionally, HRI will demonstrate through detailed engineering analyses that the ponds, and diversion channels around the ponds will be stable under a probable maximum flood condition, in accordance with NRC Staff Technical Position #WM-8201, *Hydrologic Design Criteria for Tailings Retention Systems*. Included in this submittal will be HRI's planned SOP for inspecting, and maintaining the pond liners, and embankments, diversion channel, etc.

Standard provisions for the ponds will be two impermeable synthetic membrane liners: an inner 30 mil Hypalon liner, or equivalent, and an outer liner 36 mils thick made of Hypalon, or equivalent (1 mil=0.001 inch). A space 4 to 5 inches thick between the two liners will contain sand, or some other (granular) porous medium, and a drainage network of open piping, forming an underdrain leak detection system. The (inner) liner will provide secondary containment for any leakage that may occur. The ponds will be inspected daily for leakage. Fluid of any quantity found in the leak detection system will be cause for immediate corrective action, including immediate notification of NRC by telephone.

2.3.1 Churchrock Pond Design Features

Based on results of surface hydrological engineering analysis which HRI performed for the Chu-chrock Satellite process facility (Espey, Huston & Ass. Inc. 1' , 1996b), HRI concluded that the nearby, unnamed tributary of the Puerco River, and its overbanks do not affect the proposed satellite in the Probable Maximum Precipitation (PMP)/ Probable Maximum Flood (PMF) event. The Puerco River was not considered a flood hazard to the satellite due to its extreme horizontal separation from the site, more than 1 mile to the south. The backwater effects of the Puerco River on the unnamed tributary leading to the site are not considered substantial enough to warrant an in-depth investigation. The study concluded that a riprap diversion channel will be sufficient to route surface water reaching the proposed site. Further detailing of the channel is dependent on the proposed site grading, and will be part of the license condition.

2.3.2 Crownpoint Pond Design Features

In the event that HRI elects to maintain the existing on-site lined impoundments in their current location at the CCP, the channel, and erosion protection improvements as described in the following analysis will be performed.

A surface hydrological engineering analysis was performed to determine the adequacy of the existing drainage channel, and berms south, and west of the three impoundment ponds (Espey, Huston & Ass. Inc., 1996a). This channel was determined to be inadequately sized to carry a PMF event. A proposed solution was selected which is designed to prevent the PMF from overtopping the embankment, and to maintain effective erosion protection along its slope.

Initially, a surface water hydrologic analysis was performed for the site to determine a peak flow rate based on a PMP event. The selection of the PMP as a design storm based on NRC Staff Technical Position WM 8201 "Hydrologic Criteria for Tailings Retention Systems." The particular PMP event selected is based on the criteria stated in Chapter 2: Design Flood Estimation from "Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments" prepared for the U.S. Nuclear Regulatory Commission, and HMR #49 "Probable Maximum Precipitation Estimates, Colorado River, and Great Basin Drainages" prepared by the National Weather Service. From these sources a 6-hour drainage average depth local-storm PMP was determined to be the most conservative PMP for this analysis.

Using USGS topography maps along with on-site 1"=100' scale topography maps, a 2.7 square mile drainage basin was determined for a design point approximately 3500 feet downstream of the existing facility site. This drainage basin was separated into drainage areas to determine how stormwater runoff reaches portions of the site. Soil Conservation Service (SCS) methodology was used to determine Runoff Curve Numbers (CN), and Time of Concentration (T) values. The CN values are conservatively estimated in the range of 87-88. The T values ranged from 20-45 minutes. This data was used in the U.S. Army Corps of Engineers (ACOE) HEC-1 Flood Hydrograph Computer Model, along with the calculated PMP, to calculate runoff hydrographs. From these hydrographs, peak flow rates were selected for use in calculating the PMF. Three rates were selected along the channel, and occur at approximately 2.5 hours into the 6-hour PMP, and are summarized in the Table 2.3-1.

Table 2.3-1 Hydrologic Summary Table

Location	Contributing Drainage Area	Peak Flow Rate for PMP
Upstream end of existing diversion channel (southeast corner of site)	1.37 mi^2	11428 cfs
Confluence of existing diversion channel, and arroyo (southwest corner of site)	1.75 mi^2	14516 cfs
Approximately 3500 feet downstream of the end of the diversion channel	2.73 mi^2	19599 cfs

To determine the PMF water surface profile, and channel velocities, an ACOE HEC-2 Water Surface Profile Computer Model was prepared. Supplemental information was determined using the ACOE HEC-RAS (River Analysis System) Computer Modeling Software. Topographical information for the channel, and its overbanks were determined using 1"=100' scale on-site topography maps. Selection of other variables, such as surface roughness coefficients ('n' values), is based on a sensitivity analysis to determine the most conservative values.

Based on the existing conditions analysis, all three impoundment ponds are inundated by the PMF. The flooding of the westernmost pond (containing drill mud) is due in part by the backwater effect of the road, and culvert just to the northwest. However, the primary reason all three ponds are inundated is that the drainage channel is not adequately sized to accommodate the PMF. The high flows also produce high velocities within the channel as determined by the HEC-2 computer model. These velocities are sufficient to cause erosion of the existing embankment.

A proposed solution was selected that protects the two uppermost ponds, and abandons the use of the lowest pond (containing drill mud). This proposed solution begins by lowering, and widening the existing channel to a 40-foot bottom width with 3:1 sideslopes. The limits of this improvement fall between where the two arroyos reach the channel at the Southeast, and southwest corners of the site. The channel will expand to the south so as not to encroach on the existing embankment between the channel, and impoundment ponds. It will also be lowered to eliminate the concrete pad washout at the southwest corner, and to reduce the elevation of the PMF. Its slope will be approximately 0.005 with several small drops lined with rock riprap. In addition, rock riprap will be laid on the embankment between the impoundment ponds, and the channel to protect that slope from erosive velocities which still occur in this proposed condition, although at a reduced rate. Finally, the existing road, and culvert will be demolished, and converted to a low water crossing.

The riprap design for median rock size (D50), and layer thickness were determined by using methodologies described in "Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites" prepared for the NRC. Using the Safety Factors Method, a D50 size of approximately 16" has been preliminary determined based on flow depth, and channel slope. Additionally, the minimum thickness of the rock layer should be about three feet.

2.3.3 Unit 1 Pond Design Features

A qualitative description, and assessment of the surface water drainage conditions was conducted for the Unit 1 Satellite Site(Espey, Huston & Ass. Inc., 1996c). A portion of the Crownpoint, NM quadrangle, by USGS, and an aerial photo of the site, were used to conduct this qualitative analysis.

The Unit 1 Satellite is located approximately 3.5 miles west of Crownpoint. The proposed site lies on a high ridge between two existing shallow arroyos. These arroyos run from south to north, and begin on the north side of the access road to the site. The proposed site (building, and ponds) is no closer than 500 feet to either arroyo.

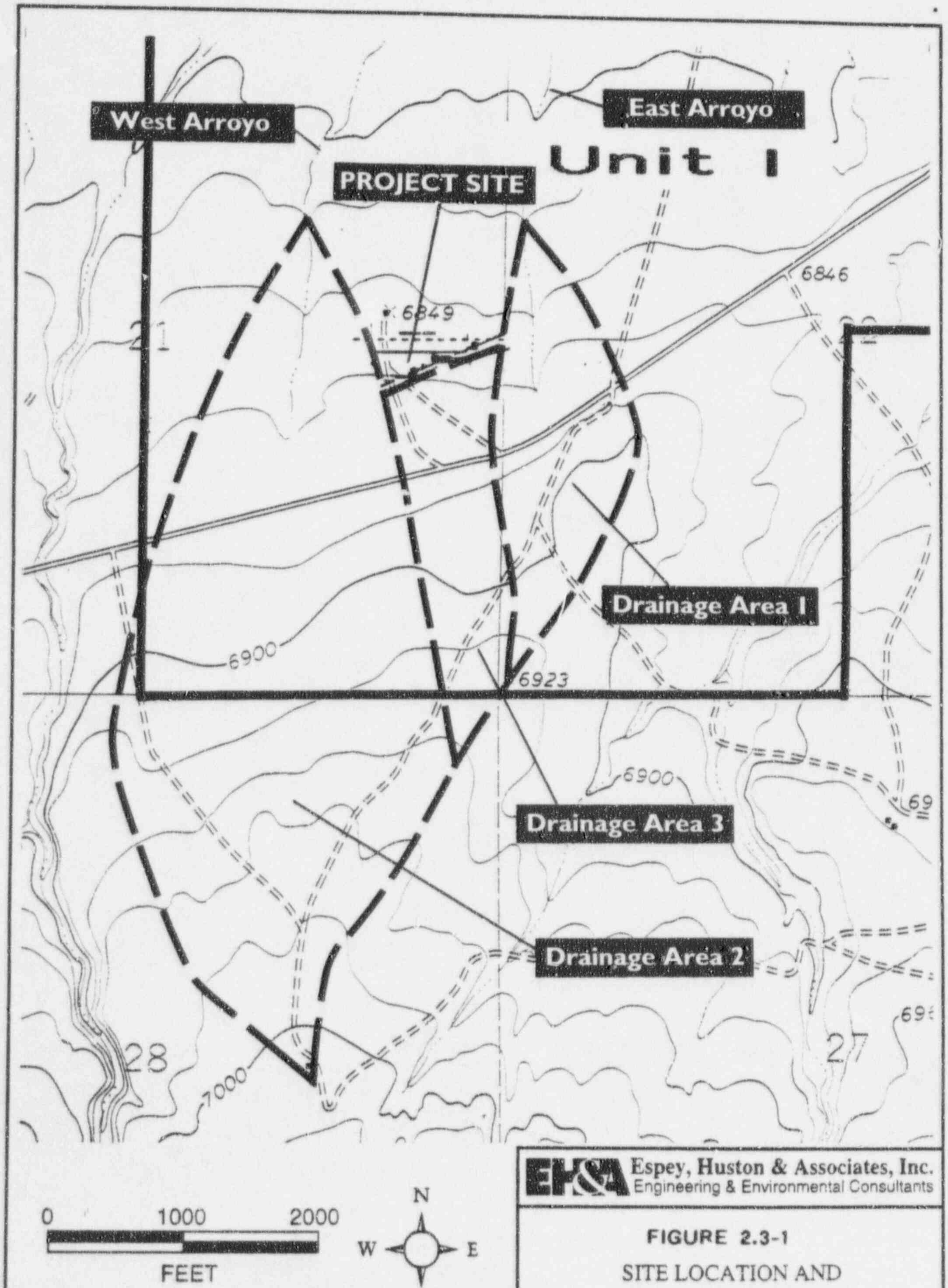
A Rational Method Calculation was performed to determine approximate flows reaching the arroyos in the vicinity of the project site during the Probable Maximum Precipitation (PMP) event. A full (100%) 1hr-1mi^2 PMP rainfall, adjusted for elevation, is approximately 8.9 inches. The rainfall depth is dependent on the rainfall duration for each drainage area. It was calculated by determining times of concentration (T_c) for the two small drainage areas leading to the arroyos, and using T_c as an approximate rainfall duration. The rainfall duration, and depth were then used to determine rainfall intensity for each drainage area.

A possible solution to route Drainage Area 3 away from the proposed site is a diversion channel that directs flows toward the Eas+ Arroyo. Table 2.3-2 shows a breakdown of existing, and proposed hydrologic characteristics of the Drainage Areas based on their delineations shown on Figure 2.3-1.

Table 2.3-2 HYDROLOGIC (RATIONAL METHOD) SUMMARY TABLE

	Drainage Area (A) (ac)	Time of Concentration (T_c) (min)	Intensity (I=rainfall depth/duration) (in/hr)	Runoff Coefficient (C) (-)	Peak PMP Flow Rate (Q=CIA) (cfs)
East Arroyo, Existing Conditions (DA1)	55	27	17.2	1.0	946
Drainage Area 3, Existing Conditions	45	33	14.6	1.0	657
East Arroyo, Proposed Conditions (DA1+DA3)	100	35	13.9	1.0	1390
West Arroyo, Existing, and Proposed Conditions (DA2)	230	55	9.5	10.	2185

Using Manning's equation, routing Drainage Area 3 towards the East Arroyo could be handled by a trapezoidal channel 3' deep, 8'



SOURCE: USGS TOPOGRAPHIC QUAD., CROWNPOINT, N.M.

EH&A Espey, Huston & Associates, Inc.
Engineering & Environmental Consultants

FIGURE 2.3-1

SITE LOCATION AND DRAINAGE AREA MAP

8/30/96

wide, with 5:1 sideslopes, at an incline of 2%. The velocity in this proposed channel is about 10 feet per second (fps), but erosion should be of minor significance considering the horizontal separation from the proposed site. With both arroyos Figure 2.3-1 beginning near the site, there is not much opportunity to accumulate significant flows, or flooding elevations. With the flows listed above, overtopping of the arroyos will be likely to occur, but the 500 foot separation between the arroyos, and the site should be more than sufficient to avoid the Probable Maximum Flood (PMF) Floodplain. A more detailed look at arroyo flooding will be part of the license condition. Local on-site drainage, and diversion will also be handled at a later date through the site development plans, and part of the license condition. Local on-site drainage, and diversion will also be handled at a later date through the site development plans, and part of the license condition.

2.4 Tankage

2.4.1 Fiberglass Vessels

The standard utilized in the fabrication of fiberglass reinforced tanks conform to Voluntary Product Standard PS 15-69. This voluntary standard, initiated by the Society of Plastics Industry, Inc., developed under the Procedures for the Development of Voluntary Product Standards, published by the Department of Commerce. The purpose of this product standard is to establish a national basis for standard sizes, dimensions, and significant quality requirements for commercially available, glass-fiber-reinforced, chemical-resistant process equipment. Nomenclature used in the industry comes from American Society for Testing, and Materials (ASTM) Designation D883-69, Standard Nomenclature Relating to Plastics, and includes the following definitions:

a. Glass Content - Glass content will be determined in accordance of ASTM Designation D2584-67T, Tentative Method of Test for Ignition Loss of Cured Reinforced Resins.

b. Tensile Strength - Tensile strength will be determined in accordance with ASTM Designation D638-67T, Standard Method of Test for Tensile Properties of Plastics.

c. Flexural Strength - Flexural strength will be determined in accordance with Procedure A, and Table 1 of ASTM Designation D790-66, Standard Method of Test for Flexural Properties of Plastics.

d. Flexural Modulus - The tangent modulus of elasticity in flexure will be determined by ASTM Method D790-66.

e. Hardness - The hardness will be determined in accordance with ASTM Designation D2583-67, Standard Methods of Test for Indentation Hardness of Plastics by Means of a Barcol Impressor.

2.4.2 Vessel Design - Fiberglass

The design of vessel wall thickness is predicated on using a safety factor of 10 to 1; using mechanical property data for Glass Content, Tensile Strength, Flexural Strength, Flexural Modulus, and Hardness; utilizing a liquid specific gravity of 1.2; and temperatures of 180 degrees Farenheit. Glass content, tensile strength, flexural strength, flexural modulus, and hardness will be determined in accordance with the American Society for Testing Materials (ASTM).

2.4.3 Choice of Fiberglass

When bidding fiberglass vessels to commercial fabricators, HRI always requests conformity to Voluntary Product Standard PS 15-69. This standard addresses the criteria used in manufacturing fiberglass flanges, vents, elbows, tees, crosses, eccentric reducers, and the compounds. Finally, the resin of choice for most applications within the recovery operation is one that can stand up to acids, and bases over a broad pH spectrum.

2.4.4 Steel Vessels

Sand filters, and downflow ion exchange vessels will be fabricated from steel using the American Society of Metallurgical Engineers (ASME) guide of Section VIII, Division 1, for the design, and fabrication of pressure vessels. This design incorporates a safety factor of four times the design pressure at conditions specified by the end user. Pressure testing for at least one hour at 1.5 times maximum operating pressures is required to obtain ASME coding. HRI specifies all of its steel pressure vessels to be built to these standards.

2.4.5 Piping

Process piping within the plant facility will be made of steel, polyvinyl chloride (PVC), fiberglass, and high density polyethylene (HDPE) of varying diameters, and wall thickness which follow ASTM standards. Wherever applicable, the use of

PVC, and HDPE piping will be utilized because of their superior rating for chemical resistivity.

a. PVC Piping - ASTM standards for PVC pipe, and fittings are divided among five groups. These groups are: Group A, Plastic Pipe Specifications; Group B, Plastic Pipe Fittings Specifications; Group C, Plastic Piping Solvents, Cements, and Joints; Group D, Methods of Test; and Group E, Recommended Practices. In addition, Product Standards have been established for each grouping. Type I, and II PVC are defined by manufacturer's recommended standards, and these standards originated from Product, and ASTM Standards.

Processing solutions are normally transferred under load pressures (<150 psig) within the plant facility. According to PS 21-70, and ASTM 1785, the maximum working pressure at 73.4 degrees Fahrenheit for 8 inch, schedule 40 PVC is 160 psig. Most PVC piping within the extraction facility will range below 6 inches in diameter. Maximum working pressure for 6 inch diameter PVC is 180 psig. Schedule 80 PVC, which has a wall thickness slightly larger than schedule 40, can sustain maximum operating pressures at higher levels. For example, 6 inch diameter schedule 80 PVC pipe has a maximum operating pressure of 280 psig.

All process piping will be designed in accordance with generally accepted engineering standards according to the flowrate, required pressure, and the medium being processed. Process pumps will also be sized to minimize required discharge pressures to achieve transfer requirements as specified.

b. Steel Piping - The use of steel piping will be minimized within the water treatment facility. However, if steel pipe is specified for a particular application, then the rated operating pressure for that pipe will be used in the design specifications. The construction of line steel pipe conforms to ASME A53 for standard plain end pipe. For example, Grade A pipe of dimensions 8 inches, 10 inches, and 12 inches have maximum operating pressures of 1,300, 1,200, and 1,400 psig respectively. These safe operating pressures far exceed any that will be employed at either the central plant, or satellite facilities.

HRI will employ all safety, and design features that have been successfully employed at its twin operations in Texas. The use of generally accepted engineering design will be utilized in the specification, and selection of piping, and tankage.

2.5 Yellowcake Dryer at Crownpoint

Yellow-cake slurry at Crownpoint will be dried by a batch-type rotary vacuum dryer system. The drying, and packaging will occur in the same area. Yellowcake drums awaiting shipment will be stored on a curbed concrete pad inside the restricted area.

a. a drying chamber, approximately 4 ft. by 12 ft., equipped with an internal mixing auger, and a mechanism for directly discharging the dried product into 55 gallon drums;

b. a bag filter to capture, and return to the drying chamber the entrained solid particles present in the exiting vapor stream;

c. a water-cooled condensing unit to cool, and liquefy water evaporated from the yellowcake slurry;

d. a vacuum pump, and;

e. a recirculating closed-loop hot oil heating system that uses a propane, or natural gas-fired, or electric boiler to heat the oil.

2.5.1 Operation of the Vacuum Dryer

A feed slurry, containing approximately 50% water by volume, is pumped into the drying chamber. Slurry transfer is made by hydraulic transport through a pumping loop. A complete batch (approximately 2500 kg of yellow-cake) obtained from the filter press is transferred to the dryer, and a record of the production inventory is kept by weighing the yellow-cake drums. Drying is achieved at about 100 degrees Celsius in a vacuum of 18 to 26 inches of mercury, with the hot oil recirculating around the drying chamber at about 230 degrees C. Drying progress is monitored by the rise in level of condensed water in the condenser column. Drying time is typically 9-14 hours per batch. Total cycle time including cooling, drum packaging, and refilling is about 16 to 24 hours.

HRI will, during all periods of yellowcake drying operations, ensure that the manufacturer recommended vacuum pressure is maintained in the drying chamber. This will be accomplished by continuously monitoring differential pressure, and installing instrumentation which will signal an audible alarm if air pressure differential falls below the manufacturers recommended levels. Yellowcake drying operations will be immediately suspended if any emission control equipment for the yellowcake drying, or packaging areas is not operating within the specifications for design performance.

2.5.2 Dryer Control of Particulates Emissions

The bag filter is designed to recover 99.5% of the solids entrained in the water vapor, and any solids escaping this filter are captured by the circulating sealant water within the vacuum pump. This water, which is kept cool by passage through a cooling tower, is periodically diverted to the production circuit to recover collected yellowcake particles, or is diverted to the wastewater circuit. The vapor discharge line from the vacuum pump is vented to the atmosphere.

2.5.3 Packaging

Dried yellowcake will be packaged in appropriately labeled, USDOT-approved, 55 gallon drums. Each drum in turn will be placed on a vibrating platform beneath the drying chamber, raised hydraulically, and secured at the rim to the dryer discharge chute. Drums will contain 650-1000 pounds of yellowcake. Filled drums will be lowered, covered, sealed, weighed, labeled, and moved to storage by means of forklift trucks, or dollies specifically designed for this purpose.

2.5.4 Transportation of Chemicals, and Reagents

HRI uses a number of reagents in the production of yellowcake. The primary reagents that will be transported are HCl, NaOH, $NaHCO_3$, H_2O_2, compressed liquid CO_2, liquid O_2, and NaCl. All transportation will be on paved roads except for a 9200 foot segment of unpaved, maintained road between Unit 1, and Navajo Highway #9, and a 1500 foot maintained segment of Church Road between Navajo #9, and the CCP.

2.5.5 Transportation To/From CCP

Yellowcake, and 11e(2) by-product waste material, other than samples for research, will not be transferred from the site without specific approval of the NRC in the form of a license amendment. HRI will a maintain permanent record of all transfers made under the provisions of this condition. Transfers of samples for research will comply with provisions of 10 CFR 40.22.

Because resin, or slurry will be transported from Churchrock, and UNIT I, and dried product will be transported from CCP, transportation safety must be addressed. At the maximum production rate of 1 million lbs. per year for each satellite it is anticipated that either 100 shipments of yellowcake, or 1000 shipments of resin will be transported from each satellite facility to the CCP per year. All transportation will be on paved roads except for a 9200 foot segment of unpaved, maintained road between the Unit 1 satellite, and Navajo Highway #9, and a 1500 foot maintained segment of Church Road between Navajo 9, and the CCP. Additionally, HRI will utilize the by-pass route so shipments of material will not pass through the town of Crownpoint. All delivery trucks used to transport project materials (resin, uranium slurry, yellowcake, etc.) will carry the appropriate certificates of safety inspections, and all delivery truck drivers will hold appropriate licenses. The transportation route is shown on Figure 2.5-1.

2.5.6 Transportation of Yellowcake to Conversion Plant

Following drying, and packaging of the yellowcake product, the product is sold to utilities. Yellowcake is sold, and transported from the CCP with the same precautions defined in 2.5.5 except that the yellowcake will be shipped south on Highway 371 to Interstate 40 near Thoreau. Depending on production levels, twenty to sixty shipments a year are anticipated.

2.6 Wellfields

2.6.1 Churchrock

Wellfields at the Churchrock satellite facility will be confined to T16N, R16W, Sections 8 & 17 as described in Section 1.1.2. The Churchrock satellite will consist of one mine unit which will be developed in two phases: the Section 8 phase, and the Section 17 phase. The mine area (the area completely contained within the monitor well ring) will consist of approximately 200 acres.

The layout of the wellfield is shown on Figure 1.4-8. It is in the floor of the valley, and will not be affected by the nearby escarpments. Fully developed, it will consist of multiple injection, and production wells which will feed into approximately 19 metering houses. All distribution lines from the individual wells to the meter house will be buried below frost depth. Main trunklines will be on the surface,

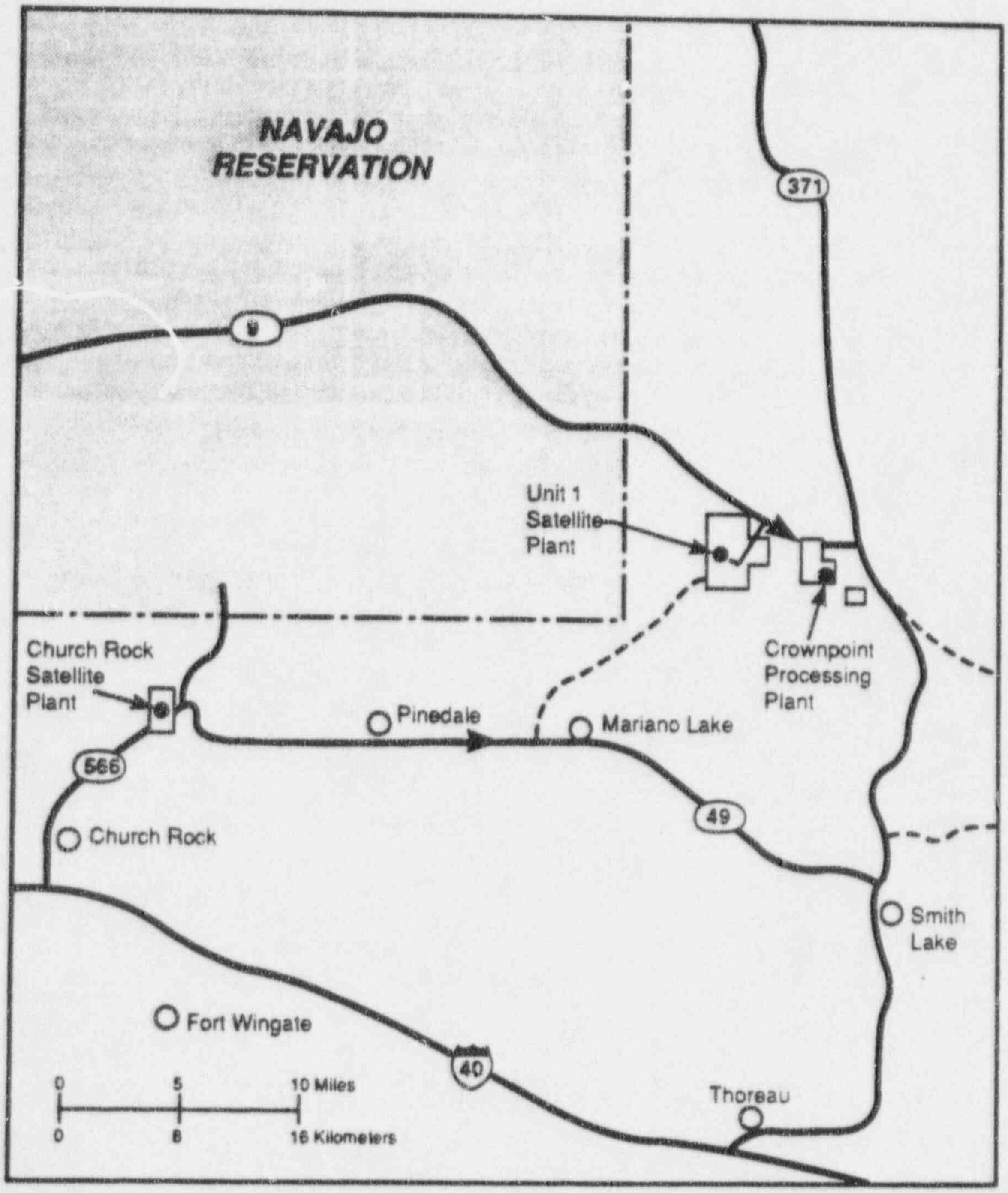


FIGURE 2.5-1 Haul routes for yellowcake slurry from satellite plants to the Crownpoint plant.

or buried, and will lead from the meter houses to the Satellite plant on Section 8.

2.6.2 Crownpoint

Wellfields at the CCP will be confined to T17N, R12W, & R13W as described in Section 1.1.1. The initial operating area will consist of one mine unit on the south 1/2 of Section 24. The mine area (the area complet .y contained within the monitor well ring) will consist of approximately 355 acres. The layout of the initial wellfield is shown on Figure 1.4-3. The wellfield will be located on flat terrain. Fully developed it will consist of multiple injection, and production wells which will feed into approximately 25 metering houses. All distribution lines from the individual wells to the meter house will be buried below frost depth. Main trunklines will be on the surface, or buried, and will lead from the meter house to the adjacent CCP.

2.6.3 Unit 1

Wellfields at the Unit 1 satellite will be confined to T17N, R13W as described in Section 1.1.3. The initial operating area will consist of one mine unit centered in the land block. The mine area (the area completely contained within the monitor well ring) will consist of 750 acres when fully developed.

The layout of the initial wellfield is shown on Figure 1.4-5. It will consist multiple injection, and production wells which will feed into approximately 14 metering houses. All distribution lines from the individual wells to the meter house will be buried below frost depth. Main trunklines will be on the surface, or buried, and will lead from the meter house to the Satellite plant on Section 21.

2.7 Land Application of Approved Waste Water

Depending on restoration strategy, process waste water during restoration may be used for land application. This waste water will undergo appropriate treatment to remove uranium, and radium, and will have acceptable quality standards.

2.7.1 Churchrock

HRI has identified one property for possible acquisition for the purpose of licensed land application of approved waste water. Additionally, HRI has rights to a number of blocks of property topographically suitable for land application.

Section 16 - T16N, R16W - is property which is owned by the state of New Mexico. The property consists of 640 acres, of which most is pasture, and will be suitable for land application. Its proximity to the Churchrock satellite makes it an attractive location for land application. This will be the largest potential parcel that will be considered for land application. For the purpose of cumulative impact, the maximum affected area will be 640 acres.

HRI also has surface rights on additional properties:

a. The land south of Highway 566 in the NE/4 of Section 17, T16N, R16W, comprises approximately 80 acres of pasture which will be suitable for land application. HRI holds a surface lease on this property;

b. HRI owns federal mining claims on the NE/4, and W/2 of Section 8, T16N, R16W, which consists of 480 gross acres. Approximately 206 acres of this land consist of flat mesa which will be suitable for land application, and;

c. HRI owns federal mining claims on Section 12, T16N, R17W, which consists of 640 gross acres. Approximately 270 acres of this land consists of flat mesa which will be suitable for land application.

The Section 16 property is the preferable location for land application of approved waste water because of the following three reasons:

- it is the largest block of relatively flat property,
- it is reasonably near to the Churchrock satellite facility,
- it is at approximately the same elevation as the satellite.

HRI will commit to filing an application with the NRC at the time irrigation plans have been finalized. Such an application will contain information on the environmental conditions of the parcel of land to be used.

2.7.2 Crownpoint/Unit 1

The land application area for the CUP CCP mine, and Unit 1 Satellite is land owned by HRI on T17N, R13W, Section 12 (Figure 1.1-2). This land comprises 640 acres which are suitable for land application.

3.0 OPERATIONAL PROCESSES

3.1 Introduction

At the CUP, the lixiviant will consist of native ground water to which gaseous oxygen, and gaseous carbon dioxide, and/or sodium bicarbonate have been added. After the lixiviant is injected into injection wells, and recovered from production wells, the mine fluids are pumped to the processing plant where the uranium is removed by passing the pregnant (uranium rich) lixiviant across ion exchange resin.

Loaded ion exchange resin, or wet yellowcake is periodically trucked to the CCP for processing into yellowcake. Yellowcake is dryed, and then stored in drums for shipment to a purchaser at a UF_6 conversion, or other nuclear fuel cycle facility. Process flow sheets for the CCP, and satellites are shown on Figures 3.1-1, and 3.1-2 respectively.

3.2 Lixiviant Injection/Recovery

Uranium, present in the host ore in a reduced insoluble form, will be oxidized by the lixiviant solution injected into the ore zone. Once uranium is oxidized, it complexes with bicarbonate anions in the groundwater, and becomes mobile. Mining will proceed with the continuous recirculation of fortified groundwater leaching solution through the uranium ore from the injection to the production wells. Uranium in the ore will react with the lixiviant to form a soluble uranyl dicarbonate complex.

$$2UO_2 + O_2 \rightarrow 2UO_3$$
$$UO_3 + 2NaHCO_3 \rightarrow NA_2UO_2(CO_3)_2 + H_2O$$

3.2.1 Lixiviant

The lixiviant, which is comprised of native ground water fortified with sodium bicarbonate, and/or gaseous carbon dioxide, and oxygen, is injected into injection wells. After passing through the ore zone, the pregnant lixiviant is pumped from production wells to the processing facility where the uranium is extracted by ion exchange onto resin. The resulting uranium depleted (barren) water will then be refortified with an oxidant such as O_2, or H_2O_2, and reinjected into the wellfield to repeat the leaching cycle. The lixiviant typically consists of the parameter concentrations shown in Table 3.2-1.

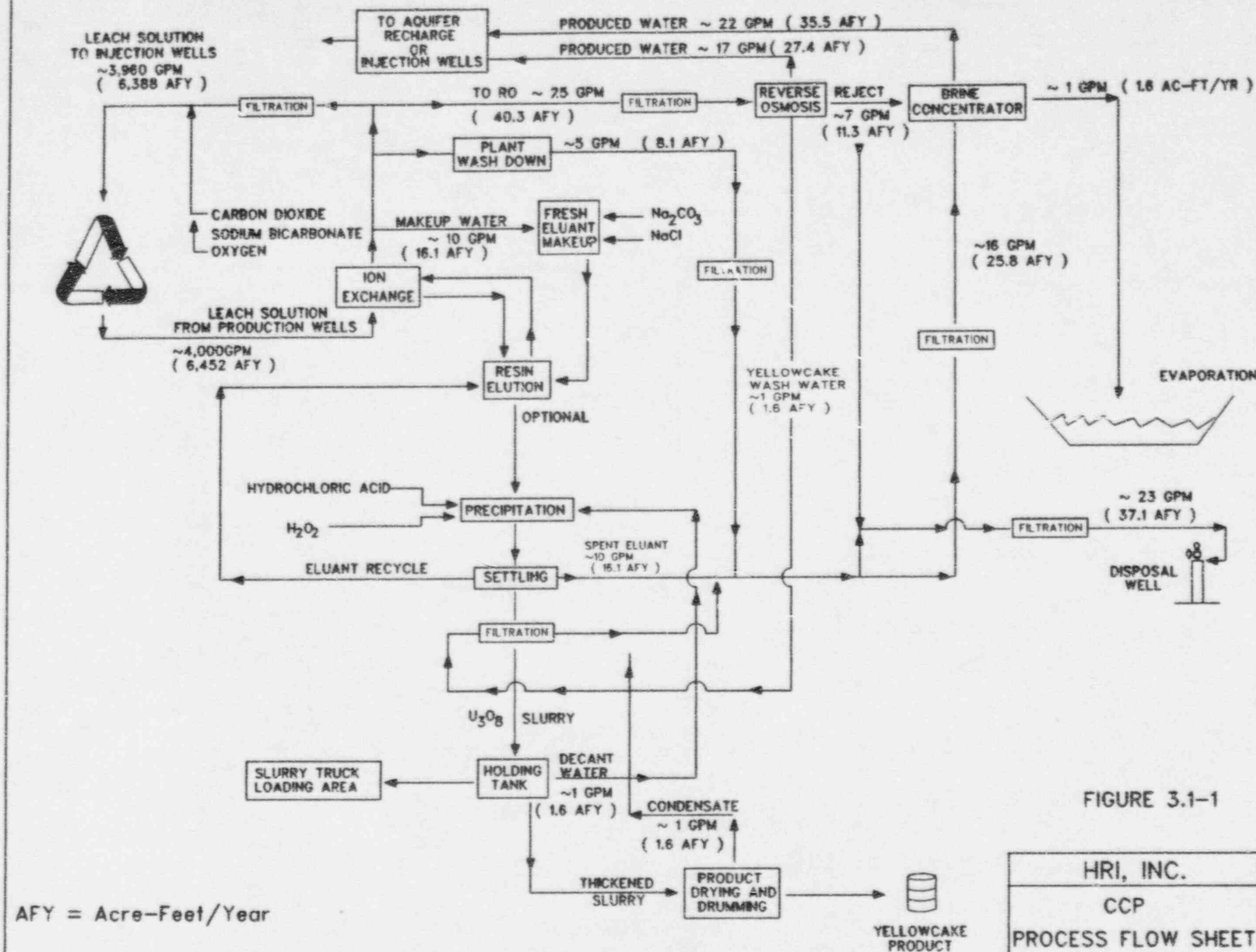


FIGURE 3.1-1

AFY = Acre-Feet/Year

HRI, INC.

CCP

PROCESS FLOW SHEET

REVISED MAY 8, 1997

CCP-PL4

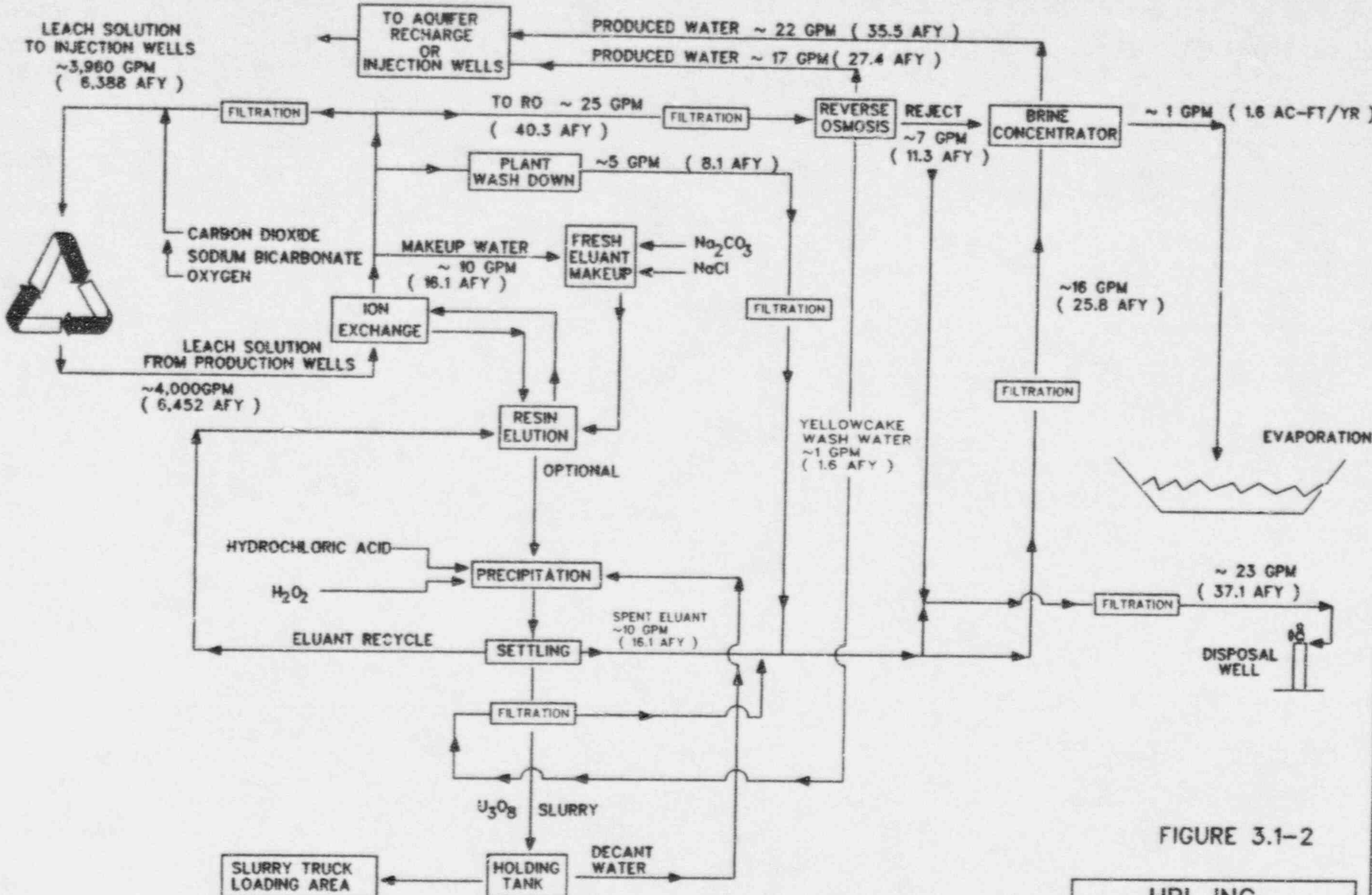


FIGURE 3.1-2

HRI, INC.

SATELLITE PROCESS FLOW SHEET

AFY = Acre-Feet/Year

REVISED MAY 8, 1997

SATELIT2

Table 3.2-1 Projected Lixiviant Chemistry

Calcium	100 - 500
Magnesium	10 - 50
Sodium	500 - 1600
Potassium	25 - 250
Carbonate	0 - 500
Bicarbonate	800 - 1500
Sulfate	100 - 1700
Chloride	250 - 1800
Silica	25 - 50
Total Dissolved Solids	1500 - 5500
Uranium	50 - 250
226-Radium	100 or greater pCi/L
Conductivity	2500 - 7500 uS/cm
pH	6 - 9 standard units

3.2.2 Production Well Circulation

Injection, and production well operations are described in Section 6.5.

Injection well, and production well flow rates are monitored to assess operational conditions, and mineral royalties. The flow rate of each production, and injection well is determined by monitoring individual flow meters in each wellfield metering house.

The pressure of the injection trunk line is determined daily in each wellfield metering house. The surface injection pressures will not exceed the maximum surface pressures posted in each metering house.

Data records for these monitoring activities are maintained on-site.

3.3 Ion Exchange (IX)

The pregnant leaching solution containing the uranyl dicarbonate complex will be received at the processing plant through a network of wellfield piping, collection headers, and trunk pipelines, and will be pumped through the ion exchange columns, operated in series in a downflow mode. The entire system will be pressurized, precluding the elevation of gasses including radon in the process building, and the environment. Uranium will be exchanged on the reacting sites of the resin for chloride ion (if the resin is in chloride form) according to the following reaction:

$$Na_2UO_2(CO_3)_2 + 2RCl \rightarrow R_2\, UO_2(CO_3)_2 + 2NaCl,$$

where R is a reacting site of the ion exchange resin.

When the ion exchange resin in a column has captured uranium to its optimum loading capacity, uranium breakthrough will occur. That is, uranium concentration in the barren leach water exiting the IX column will begin to rise. At this point, the column will be taken out of the operating circuit, and another column with fresh ion exchange resin will be placed on-line.

After the uranium is removed by the ion exchange columns the process bleed is removed from the lixiviant stream. The bleed may be treated by R.O., and if it is, the "product", or cleaned water is returned to the lixiviant injection, or to the formation outside the wellfield pattern, or disposed of by a approved method. The process bleed insures that more water is withdrawn than is injected, thereby keeping the lixiviant laterally within the production zone.

The only factor which could threaten a continued process bleed is loss of power. Since natural groundwater flow near the wellfield is on the order of only a few feet per year (even when considering the pumping affects of Crownpoint town waterwells), the flow outward from the wellfield during the period of short term power outage (2-3 days for example) will not be significant, or measurable because of the exceedingly slow natural groundwater migration rate. Although it may not be necessary, HRI will have diesel generating capacity to maintain a cone of depression, and lighting in the event of power outage.

HRI will continue a bleed at the CUP properties until the well fields have been declared fully restored to the required permit/regulatory limits.

After the bleed is removed from the lixiviant stream exiting the IX columns, the uranium-depleted (barren) water will flow through the sand filters to remove any particulates, be refortified with requisite chemicals, and piped back to the wellfields for reinjection.

Sodium bicarbonate, and/or gaseous carbon dioxide is added as needed to the lixiviant, while oxidant is dissolved into the barren water prior to injection into the injection wells. The entire injection, production, ion exchange, and reinjection process is effectively a closed system. This allows retention of residual carbon dioxide, and oxygen during recirculation of the lixiviant.

3.4 Elution and Precipitation

Once loaded with complexed uranyl dicarbonate, resin is eluted in place within the IX column. A brine, and soda ash solution is used to remove the uranium from the resin. The following chemical reaction occurs:

$$R_2UO_2(CO_3)_2 + 2NaCl + Na_2CO_3 \rightarrow Na_4UO_2(CO_3)_3 + 2RCl$$

In the first elution step, partially enriched eluant (from the second step of the previous elution) will be sent through the fully loaded ion exchange bed to yield a uranium-rich (pregnant) eluant, and will be stored separately in a tank. In the second step of the process, barren eluant will be passed through the partially denuded resin bed to remove the majority of the residual uranium present on the resin. The resulting partially enriched eluant will be stored in a recycle tank, and used in the first step of the next elution cycle.

Uranium oxide is then precipitated from the pregnant eluant. Carbon dioxide gas (CO_2) generated during acidification of the pregnant eluant with hydrochloric acid will be vented to the atmosphere. This breaks the carbonate complex from the uranium. Peroxide is then added to further oxidize the uranium, and cause uranium oxide crystals to form, and precipitate. The precipitate will be allowed to settle. The supernatant liquid (barren eluant) will be decanted, and stored in two storage tanks, reconcentrated with salt (NaCl), and sodium carbonate, and reused in the uranium stripping circuit. A part of this stream will be discarded to the lined retention ponds periodically to keep accumulated impurities within limits.

3.5 Yellowcake Processing

As described in Section 3.4, pregnant eluant which contains uranyl di, and tricarbonate will be acidified using hydrochloric acid (HCl) to destroy the uranyl carbonate complex as shown below.

$$Na_4UO_2(CO_3)_3 + 6HCl \rightarrow UO_2Cl_2 + 4NaCl + 3CO_2 + 3H_2O$$
$$Na_2UO_2(CO_3)_2 + 4HCl \rightarrow UO_2Cl_2 + 2NaCl + 2CO_2 + 2H_2O$$

In the next step hydrogen peroxide will be added to the solution to oxidize the uranium even further, and cause it to precipitate according to the following reaction:

$$UO_2Cl_2 + H_2O_2 + xH_2O \rightarrow UO_4 \cdot xH_2O + 2HCl$$

The crystalline uranyl peroxide slurry (UO_4 or yellowcake) may require pH adjustment, and then will be allowed to settle. The yellowcake will be further dewatered using a filter press. Finally, the yellowcake will be washed with a clean water to remove impurities such as sorbed chloride, and then dried at the CCP. Water left over from the dewatering, and drying will either be reused in the elution circuit, or sent to the waste pond. HRI's proposed operations at the CUP will result in a yearly production rate of approximately 3 million pounds of yellowcake.

3.6 Resin or Yellowcake Transport to the Central Plant

At the satellite plants, the resin may be eluted, and the uranium precipitated, and filtered. The resulting uranium slurry will be transported to the CCP for drying. HRI's proposal indicates yellowcake will be transported to the main processing plant in sole-use semi-trailer tankers designed, and placarded for this purpose, in accordance with the U.S. Department of Transportation requirements. The transportation route is described in Section 2.5.6.

4.0 WASTE MATERIAL DISPOSAL

4.1 General

There are three specific types of wastes which will be generated at the CUP sites. These include domestic sewage, non-radioactive contaminated solid wastes, and radioactive byproduct wastes. All solid, or liquid waste will be properly disposed, or treated to meet acceptable NRC, or other appropriate regulatory release standards.

HRI will return to the process circuit, maintain in wastewater retention ponds, or discharge as approved all liquid effluents from process waste streams, with the exception of domestic sewage as described in Section 4.2. HRI will demonstrate that any disposal method selected meets NRC's release limits for radionuclides (10 CFR Part 20) as well as standards from any other required permits. All changes to the liquid effluent disposal plan will have to be approved by license amendment.

4.2 Domestic Sewage

Domestic sewage from the CCP, and satellite office area will be serviced by a conventional septic tank/leach field system. This system will only receive waste water from restrooms, shower facilities, and miscellaneous sinks located throughout the office, and change rooms.

4.3 Non-Radioactive Wastes

Non-radioactive solid wastes generated at the project include office trash, boxes, miscellaneous wood packaging, and products, steel, and pipes. These materials will be stored in commercial sized dumpsters, and will be periodically disposed by a commercial waste disposal operation.

Waste oil from vehicle oil changes, and hydraulic equipment is stored in above ground tanks, or drums, and is periodically collected by a commercial used oil vendor for recycling.

4.4 Radioactive By-Product Wastes

4.4.1 Pre-Operational Wastes

Pre-operational wastes generated during wellfield development will include the cuttings obtained during well drilling, and the liquid wastes generated from water use in the drilling program, and in well development, and cleaning. They will both be confined to drilling mud pits. Both the solid, and liquid wastes will be generated as small, one-time, intermittent streams. The overall concentration of radionuclides in the drill muds will be below regulatory concern.

4.4.2 Process Plant

The major continuous stream of process waste will be the process bleed, amounting to about 1 percent of plant flowrate. The process bleed may be diverted to a waste treatment pond by a pipeline for treatment, and reduction in volume. The bleed may also be managed by an alternate process such as deep well disposal. The purified portion may be reinjected as aquifer recharge, and the concentrate will be evaporated. A small part of the purified portion may be withdrawn to meet process water needs. The entire concentrate may be further reduced by brine concentration.

Discontinuous liquid waste streams produced at the CCP, or satellites will include depleted eluant, and dilute process streams after uranium precipitation, filter wash water, and plant washdown waters. These wastes will be piped by pipeline to a waste retention pond, and managed in the same way as process bleed.

Normally, small quantities of solid radioactive waste such as spilled ion exchange resin will be produced at the plant. These materials will be collected, and held on the curbed storage area adjacent to the waste retention pond for subsequent disposal at a licensed byproduct waste disposal facility. Spilled yellowcake, if any, will be recovered.

4.4.3 Post-Operational Wastes

Post-operational wastes will be generated during the ground water restoration phase, and in connection with project decommissioning, and decontamination. Restoration of certain wellfields will proceed concurrently with production from other wellfields. The method of restoration to be employed will affect both quantity, and chemical composition of restoration waste streams.

According to the criteria set forth in Section 9, solid wastes will be characterized by scintillation probe, or µrem meter surveys, and separated into radioactive, and nonradioactive categories. Radioactive wastes will be appropriately packaged, and stored separately until their ultimate disposal at a licensed byproduct waste disposal facility. Other solid wastes will be disposed of at a suitable site, such as a landfill. The CUP will not generate any hazardous waste as defined by the Federal Resource Conservation, and Recovery Act.

Liquid wastes will be generated during the restoration phase at the rate of approximately 150-250 gpm. These wastes will be disposed of according to several options as described in Section 4.5.

4.5 Liquid Waste Management

The NRC regulations found in 10 CFR Part 20 limit radionuclide concentrations in effluents associated with solution mining process wastes. The limits are based upon radiological dose assessments. To ensure that all liquid wastes are accounted for, HRI will return all liquid effluents to the process circuit, or approved disposal systems. The solution mining industry has used various disposal methods for liquid waste streams, including evaporation ponds, deep-well injection, land application, and surface discharge under a National Pollution Discharge Elimination System (NPDES) permit. Each of these disposal methods is used to varying degrees in the industry for defined waste streams.

Guidance issued recently by NRC specifies that restoration wastewater from ISL operations is not considered to be byproduct material for purposes of section 11e.(2). In its Staff Technical Position entitled "Effluent Disposal At Licensed Uranium Recovery Facilities," DWM-95-01 (April 1995)(hereafter, the "STP"), NRC notes that there are two categories of effluent discharges from ISL operations: process wastewater, and mine wastewater (which is what is referred to in this Section as restoration wastewater). As the NRC notes, restoration wastewater (or mine wastewater) is subject to effluent limits for uranium that are established by EPA pursuant to the Clean Water act. According to the STP, these limits are set under the Clean Water Act because restoration water is not covered by NRC's regulations in 10 C.F.R. Part 20 (which sets out disposal requirements, and exposure limits for licensed materials). Therefore, restoration wastewater is not considered to be byproduct material, since if it were considered to be byproduct material, it will be subject to regulation under NRC's Part 20 regulations. By contrast, uranium levels in process wastewater are not regulated under EPA's Clean Water Act regulations. Instead, as indicated in the STP, discharges of process wastewater are required to comply with NRC's Part 20 regulations which is consistent with the understanding that process wastewater qualifies as 11e.(2) byproduct material.

HRI will treat all of its waste water streams, releasing only treated water that meets 10 CFR 20, or 40 CFR 440 release limits for radionuclides, and other parameters as is applicable. The State of New Mexico requires that any waste released in land application system meet State standards for irrigation. Authorization to use surface discharges, or deep well disposal will require separate permits.

4.5.1 Production

Liquid waste produced during production activities is described in 4.4.2 above. These wastes may be reduced in volume by reverse osmosis, and/or brine concentration. The purified, or product fraction of the reduced waste will meet 10CFR20 release criteria, and may be reinjected into the Westwater formation as aquifer recharge. The rejected portion of the reduced waste will be evaporated, or disposed by deep well injection.

4.5.2 Ground Water Restoration

Ground water produced during restoration (mine water drainage) will be generated at the CCP, and each satellite facility. The ground water restoration fluids will be generated during ground water sweep, and reverse osmosis activities. A detailed description of ground water restoration plans is included in Section 11.

The ground water sweep fluids will be treated for both uranium, and radium removal. (With respect to uranium, and radium, the quality of the treated ground water sweep fluids will be very similar to the quality of the barren leach solution.) The treated ground water sweep restoration water will contain less overall dissolved constituents than the barren leach solution due to the influx of natural, unaffected ground water, and as restoration proceeds, will resemble native formation water.

During the reverse osmosis stage of ground water restoration, the reject, or salt water stream from the RO, will constitute approximately one-quarter to one-third of the particular reverse osmosis equipment capacity. It is expected that the major inorganic constituents, represented by the TDS, will increase approximately two to four times that of the feed fluids.

4.5.2.1 Land Application and Surface Discharge

In order to acquire an EPA permit to surface discharge waste water a company must first be able to demonstrate that waste water quality, including Total Dissolved Solids (TDS), and radionuclides (uranium and radium) will comply with established NPDES standards. The treatment process for radionuclides is described below.

Land application is a disposal technique that uses agricultural irrigation equipment to broadcast waste water on a relatively large area of land. Land application has been used successfully by several solution mines. Water released in this fashion will require uranium, and radium removal as described below. At each site, irrigation will be regulated by irrigation standards adopted by the State of New Mexico, Environmental Department.

Contaminant concentrations will be determined during operations by monthly sampling of the parameters listed in NMWQCC 3.103.C. If a parameter is elevated above NMWQCC irrigation levels, it will be treated to reduce the contaminant below the standard, or as required by the NMED.

NMED will require that land application areas be properly permitted by an approved Discharge Plan prior to irrigation.

4.5.2.1.1 Uranium Treatment

Once the waste stream is pumped to the surface, the first step in treatment will be uranium removal. The uranium will be removed using the same process that was described in Section 3.3 - 3.6. HRI will maintain separate process circuits when treating restoration, and process water for uranium removal.

4.5.2.1.2 Radium Treatment

Following treatment for uranium removal, the solution will then be processed for the removal of Ra-226. Radium will be removed from discharge streams at the project by barium chloride precipitation. Currently accepted technology for radium reduction of mine waste streams involves the addition of approximately 10 to 20 mg/l of barium chloride to water. The barium chloride will form barium sulfate which in time will co-precipitate with soluble radium. Barium, and radium will form an insoluble salt with sulfate already found in the processing solution. If the concentration of sulfate is too low to efficiently cause precipitation, ammonium sulfate will be added to the waste stream prior to the barium chloride addition. Flocculates also may be added to enhance precipitation, and settling. This technology is well established.

4.5.3 Production and Restoration

4.5.3.1 Reverse Osmosis

Reverse osmosis is a water treatment process whereby the majority of dissolved "ions" are separated from the waste water, and concentrated into a smaller concentrated brine volume. The resulting product water typically meets, or exceeds drinking water standards, and during restoration activities, is reinjected back into the wellfield further diluting the underground mining solutions toward baseline quality. The concentrated brine system, representing 25-35% of the feed volume, must be disposed by either deep well disposal, surface evaporation, or further reduced in volume by brine concentration (a form of distillation).

Osmosis is a natural process that occurs in all living cells. With an appropriate semi-permeable membrane as a barrier to solutions of differing concentrations, naturally occurring osmotic pressure forces pure water from the dilute solution to pass through the membrane, and dilute the more concentrated solution. This process will continue until an equilibrium exists between the two solutions.

Reverse osmosis (R.O.) is a reversal of the natural osmotic process. By confining a concentrated solution against a semi permeable membrane, and applying a reverse pressure on the concentrate greater than the naturally occurring osmotic pressure, water will move across the membrane ("product water"), and out of the original concentrate, resulting in an even more concentrated solution ("brine"). The membrane rejects the passage of the majority of the dissolved solids while permitting the passage of water.

HRI, Inc. will likely utilize spiral wound, polyamide, thin film composite membranes, or equivalent for the CUP. These membranes were selected primarily for their inherent rejection characteristics across the range of dissolved solids likely found at the CCP. Spiral wound membranes have a greater ability to flush particulates through to brine (i.e. non-fouling), unlike their predecessor hollow filament membranes which were easily plugged by precipitates, and other micron-size debris.

The polyamide membrane composition can withstand a broad range of operating pH (1-12), whereas the cellulose diacetate membranes require a much narrower range of pH, near 5.5. This advantage translates into smoother, and less troublesome operating control of the reverse osmosis unit because of its tolerance to pH changes occurring within the feed solution. Another benefit of the polyamide membranes is the elimination of needed pH adjustment of the product water. This condition occurs because the hydrogen ion (H) passes more readily through the membrane wall than its reciprocal hydroxyl ion, causing a lowering of the pH in the product water when compared to the feed solution. However, one disadvantage of the polyamide membranes is their low tolerance of strong oxidants such as dissolved oxygen, or residual chlorine (disinfectant) As a result an oxygen scavenger such as sodium bisulfite might be added to R.O. feed water. The final product water will then be slightly on the reduced side electrochemically, thus aiding in the restoration of any oxidized ionic species.

Post-mining solutions from a depleted mine area will be directed to a surge tank in the plant area. Sodium bisulfite, and an anti-scalent will be added at this point, which is the only chemical pretreatment required. The solution may next be bulk-filtered across sand filters to remove all solids greater than 30 microns. Bag filters will then filter out the remaining solids greater than 3 microns. The solution at this point is ready for the reverse osmosis process.

To achieve reverse osmotic purification, the pretreated solution is pressurized to approximately 235 pounds per square inch (psi) by a centrifugal pump. The pressurized solution is directed to the first step of a two-stage reverse osmosis process. Approximately 50 percent of the total feed volume will be converted to product water in the first stage. The brine water of the first stage will then act as the feed for the second stage, which yields a overall product to brine ratio of 2-3:1. The brine generated will be disposed of by evaporation, and/or brine concentration, and evaporation. The quality of the product water will be vastly superior to that of the Westwater Formation. It is expected that the product water will be mixed with post-mining fluids before reinjection.

4.5.3.2 Deep Disposal Well

The most cost-effective method for disposal of waste water, and brines from in situ leach mining is the use of a deep disposal well. Injection of waste water, and brines into a deep geologic formation is used at URI's mining facility in south Texas, and is the preferred means of liquid waste disposal where technically feasible. Preferred geologic formations are repositories containing total dissolved solids (TDS) in excess of 10,000 ppm. Additionally, confinement from overlying fresh water aquifers must be demonstrated.

Wastes must be relatively neutral in the acid-base spectrum before being deep well injected. Calcium, and iron scaling inhibitors are often added prior to injection of the water which is continuously monitored for pressures, flowrates, and temperatures.

Mobil/TVA drilled a test well at Crownpoint to establish the availability of deep seated confined aquifers containing water in excess of 10,000 ppm TDS, which also met the confinement criteria. Two zones meeting these criteria were determined: the Abo, and Yeso Formations. If HRI plans to use deep well injection, it will require a permit from the New Mexico Environmental Department of Environment (NMED), or US EPA.

4.5.3.3 Brine Concentrator

A brine concentrator may be used for disposal of liquid waste. Costs related to a brine concentrator make it less advantageous than a deep disposal well. Before brine concentration of wastewater will be employed, water will be pretreated by ion exchange for uranium removal. Then, the effluent will be processed by reverse osmosis to produce a product water that can be reinjected in a Class V well outside the production pattern, or back into the wellfield during the restoration cycle. The RO reject stream will be treated with brine concentrator, and the resulting brine stream will be discharged to double-lined ponds for evaporation.

Brine concentration is a process that can literally process a waste stream into deionized water, and a solids slurry. Many electrical utilities in the Four Corners area, and paper ,and pulp companies have employed this technology for decades to handle their waste streams. The principle behind the process is based on the ideal Carnot cycle. More simply explained, an initial fixed volume of concentrated brine is heated to boiling temperature. The steam vapor created is mechanically compressed, resulting in a secondary steam vapor whose temperature is elevated (15-20 degrees) by the work consumed during compression. Distilled water is condensed from the secondary steam vapor onto internal heat exchangers. The heat loss during condensation is transferred to the circulating brine on the opposite side of the heat exchanger. The brine's temperature is raised, maintaining the internal boiling environment. This source of heat sustains the creation of primary steam used to feed the compressor. The cycle is continuous so long as energy is added at the compressor stage. The electrical power consumed in compressing, and elevating the temperature of the primary steam vapor produces a distilled product water. The resultant hyper-concentrated brine allows solid precipitate in the form of common salts as determined by the solution's limits for solubility. Systematic blowdown of the solid slurry is directed to a waste disposal pond. Typically, for each 100 gallons of waste brine treated, 99 gallons of distilled water, and 1 gallon of slurry solids are formed.

This technology provide a system which utilizes no more than 1-2 gallons per minute of groundwater during mining, and restoration, and which will generate a solid waste stream in the form of precipitated sludge. The sludge will be disposed as byproduct material.

4.5.3.4 Evaporation Ponds

The most costly method for disposal of waste water, and brines from in situ leach mining is the use of evaporation ponds. This system is similar to brine concentration in that liquid wastes are evaporated but unlike brine concentration the waters are not recondensed Since the vapor pressures of high TDS solutions are low, resulting from the additional attractive ionic forces in the waters, the solar evaporation rates will be lower than for ordinary fresh water (2.5 gpm per acre). Therefore, to dispose of the 150 to 250 gpm which will be produced during restoration at a given location:

a. approximately 100 acres of double-lined ponds will be required;

b. if a spraying system was installed in the ponds, the aerial evaporative extent required will be approximately 45 acres;

c. at the conclusion of mining, and restoration, the evaporative solids formed, and those solids blown into the ponds from the surrounding land will be disposed appropriately.

Volume reduction by solar evaporation from ponds will generally be used for all waste streams.

4.6 Contaminated Equipment

All contaminated equipment will be surveyed before the determination of its final disposition. The record of the survey will be completed on a form according to standard operating procedures. All equipment that does not meet the release requirements will be cleaned, and resurveyed, or be disposed only in an NRC-licensed disposal facility, such as a licensed tailings impoundment.

Any contaminated material accumulated at the site during operations, or reclamation may be disposed as byproduct material. Alternatively, contaminated equipment can be sold, or transferred to another source material license. This method will involve minimal decontamination, and all shipments will be subject to U.S. Department of Transportation requirements. Contaminated equipment having no salvage value will be stored in a restricted area until it can be shipped to a licensed waste disposal facility.

5.0 AIRBORNE EFFLUENT CONTROL SYSTEMS

5.1 Non-Radioactive Airborne Effluents

Non-radioactive airborne effluents are limited to fugitive dust from well field access roads. Due to the lack of significant fugitive dust from well field access roads, dust suppression of these areas is not required.

5.2 Radioactive Airborne Effluents

Radioactive airborne effluents are regulated by the Nuclear Regulatory Commission (NRC), and regulatory limits are specified in Appendix B of Code of Federal Regulations Chapter 10 Part 20 (10 CFR 20). One of the most significant potential airborne radioactive effluent is the release of 222-Rn gas which is present in the ore zone, and carried to the surface in the lixiviant. The second most significant potential airborne hazard is yellow cake which is natural uranium, and primarily a heavy metal toxic hazard as explicitly stated in 10 CFR 20.1201(e). Airborne hazard of uranium is primarily focused during the time of packaging yellowcake into drums in the dryer area, and is further restricted to personnel, packaging in the closed dryer building, who will wear the required respiratory protection equipment.

5.2.1 Radon Gas

At various points in the uranium production process, radon gas may be vented to the atmosphere. These points of discharge will depend on the technology used at the plant, and the need to minimize the doses received by workers, and the public. The use of alternate technologies introduce different sources of possible exposure by radon. Examples of these possible points of discharge include: 1) Periodic radon release from downflow ion-exchange columns; 2) Radon release in waste water, and; 3) Limited accidental release of radon, and lixiviant from a leak in the pressurized system. HRI will vent the radon gas in such a way as to conform with the standards imposed by MILDOS calculations, and will take appropriate measures to monitor, and abate radon exposure as required to protect both workers in the plant, and the public at large. HRI will use downflow IX columns, and a pressurized system to abate radon exposure to ALARA limits based on the best available technology.

Minor release from the plant will occur when individual IX columns are opened for resin transfer, or elution. At this stage of the process, the contents of one IX column will be transferred to open eluant, or precipitation vessels. Radon released will be limited to the fixed quantity of radon found dissolved in the water contained in one IX column. Radon escaping from the solution will be vented from the vessels through the ventilation system of processing buildings. In-plant monitoring will verify safe radon working levels are maintained in the plant.

The largest potential source of radon emissions from the proposed facilities is waste water. Typically, radon dissolved in waste water will equilibrate with atmospheric pressure upon discharge into a retention pond. Enhanced with the turbulence caused by the pond discharge outlet, radon gas will come out of solution, and escape to the atmosphere. HRI proposes to reduce this radon source by partially removing it in intermediate holding tanks using a vacuum pump, compressing the gas, and dissolving it in the lixiviant injection system.

5.2.2 Airborne Yellowcake

HRI will use the vacuum dryer described in Section 2.5 in its yellowcake drying, and packaging system. The proposed vacuum dryer is designed to be a zero-emission device. Therefore, yellowcake emissions to the environment which may be of concern with open hearth type dryers will not be a concern at the CUP.

6.0 WELL DRILLING, INSTALLATION, COMPLETION, OPERATION

6.1 General

Several types of wells will be installed at the project site to facilitate the in situ mining process. Injection wells will be installed to allow the injection of the lixiviant. Production wells will be installed to allow the recovery (pumping) of the pregnant lixiviant (production fluid). Wells will be installed within the production zone to determine baseline water quality conditions, as well as monitor wells around the outside of the production zone (monitor well ring), to document the lateral control of the lixiviant. Monitor wells will be also installed in the first aquifer above the production zone to ensure that the lixiviant does not migrate vertically from the production zone.

Production, and injection wells will be constructed to assure that the well annulus is sufficiently cemented to prevent communication from the production zone to overlying aquifers penetrated by the well.

6.2 Production and Injection Wells

In the wellfield, injection wells will be arranged around production wells in patterns designed for optimum uranium recovery. The physical configuration of the mineralized ore zone, which is inferred from exploration geophysical logs, will determine production, and injection well depths, and the intervals from which uranium will be leached. Typically, well patterns used for uranium in situ mining will include, but will not be limited to, alternating single line drive, staggered line drive, and five spot. Each well field area consists of groups of these patterns which will be installed to correspond with the irregular geometry of the ore bodies as determined from geological interpretation.

6.3 Monitor Wells

An extensive ground water monitoring program will be required for in situ mining, and will be installed at the CUP for environmental monitoring. Selected wells will be monitored for water level, and sampled for certain water quality parameters on a regular basis to ensure that the injected lixiviant stays within the defined production zone. Locations of monitor wells will be chosen to maximize detection of potential excursions of leachate migration outside the production zone. Thus, with routine water quality determinations from monitor wells, early detection of this migration will be possible, allowing prompt remedial action, and excursion prevention.

6.3.1 Production Zone Monitor Wells Spacing and Depth

Production zone monitor wells will be completed in the ore-bearing aquifer, encircling each wellfield at a distance of no more than 400 feet from the peripheral production, or injection wells, and at spacing of not more than 400 feet apart. The angle formed by lines drawn from any production well to the two nearest monitor wells will not be greater than 75 degrees. The 400 foot spacing convention is widely used by the in situ industry throughout the United States. This spacing was originally determined through practical experience to locate monitor wells near enough to the operational areas to prevent broad areas of potential solution contamination, yet beyond the normal extent of the radially transported lixiviant.

At the Churchrock site, monitor wells will be located by treating production mine workings like they were injection, or production wells. Therefore, monitor wells will encircle each wellfield at a distance of 400 feet from the edge of the production, injection wells, and mine workings, and will be 400 feet apart. The angle formed by lines drawn from any production, injection well, or mine working to the two nearest monitor wells will not be greater than 75 degrees. This means that the detection of horizontal excursion will not be influenced by the presence of the mine workings.

6.3.2 Non-Production Zone Monitor Wells Spacing and Depth

Shallow monitor wells, or non-production zone monitor wells, will be completed in the aquifers overlying the ore zone. These wells will be located in the first overlying aquifer at a minimum of one well per every four acres of production wells. If a second overlying aquifer is identified, and evaluation of the thickness, and integrity of the intervening aquitard will conservatively require its monitoring, then wells will be spaced in the second overlying aquifer at one well per eight acres of production wells.

6.4 Well Construction

All holes will be rotary-drilled with rigs typically used to drill water wells, and capable of circulating drilling fluids to the surface. Casings for injection, production, and monitor wells will be either of steel, fiberglass, or PVC, and perforated, underreamed, or integral screened. A combination of fiberglass in the lower section of the hole, and PVC, or steel in the upper hole is also an option that may be used.

In addition to HRI's proposed construction specifications described herein, consistent with regulatory requirements, all CUP wells will also be completed to meet the following specifications.

a. Minimum design factors for tension (1.6 dry or 1.8 buoyant), collapse (1.125), and burst (1.0) that are incorporated into casing design.

b. Casing collars will have a minimum clearance of 0.4222 inches on all sides in the hole/casing annulus.

c. All waiting on cement times will be adequate to achieve a minimum of 500 psi compressive strength at the casing shoe prior to drill out.

d. All casing will be new, and reconditioned, and tested used casing that meets, or exceeds API standards for new casing.

e. Casing will be cemented back to the surface (150% calculated volume needed will be available on-site during cementing operations.)

f. Casing will have centralizers on every fourth joint (about every 120 to 150 feet) of casing, starting with the shoe joint, and up to the bottom of the collar.

g. Top plugs will be used to reduce contamination of cement by displacement fluid. A bottom plug of other acceptable technique will be utilized to help isolate the cement from contamination by the mud fluid being displaced ahead of the cement slurry.

h. All casing strings will be pressure tested to 125% of actual wellfield operating pressure, not to exceed 70 percent of the minimum burst strength (measured on surface usually using water, and the rig pump). If pressure declines more than 10 percent in 30 minutes, corrective action will be taken.

6.4.1 Installation Technique

As mentioned above, the production, injection, and monitor wells will be cased using various casing types, and techniques, which are generally dependent on the depth of the particular wellfield, and completion horizon. General well construction, and casing specifications were tabulated in Section 6.4 above. All holes will be rotary-drilled with rigs which are capable of circulating drilling fluids to the surface. The drill holes will be straight-drilled, or directionally drilled depending upon the surface locations of obstacles such as buildings, cliffs, roads, and archeological sites. The production, injection, and monitor wells will be cased using one of the following techniques:

a. single string of casing through the completion interval to be undreamed, or perforated;

b. single string of casing with cement basket, and plug assembly, and with integral screen across the completion interval;

c. dual size casing with the shallow larger casing set at pumping depth to accommodate large submersible pumps, and smaller diameter casing set through the completion interval (to be underreamed or perforated);

d. dual size steel casing (as above), except that a crossover is to be made to fiberglass through the completion interval to facilitate perforating, or underreaming;

e. Single string (or dual size as above) set to the top of completion interval. Below the casing, the hole will be drilled out (underreaming is optional), and screen is set below the casing across the completion zone. A k-packer will be set inside the casing at the top of the screen. Gravel pack sand ouside of the screen is optional.

Perforations, and underreaming will be used to open wells which have casing placed across the target completion interval. The perforated casing completion utilizes the typical shaped charge explosives used extensively in the oil industry, to place holes through the casing, cement, and into the formation. The underreamed casing completion uses a mechanical downhole tool to cut away casing, cement, and the filter cake on the sandface. Both techniques are effective ways to open the wellbore to the completion horizon. These completions provide good vertical isolation of the interval due to cement remaining above, and below the production-interval.

6.4.1.1 Churchrock

Wells will be constructed at the Churchrock satellite to perform at depths averaging approximately 825 foot depths. At this depth the maximum injection pressure will be 137 psig (825 ft. x 0.167 psi/ft = 137 psig --- see Section 6.5.3). The maximum allowable wellhead injection pressure (MAWHIP) will be determined as in Section 6.5.3, and posted, and monitored as described in section 6.6 to ensure that the formation fracture pressure is not exceeded.

The casing will be constructed of either threaded fiberglass casing, solvent-welded PVC casing, or steel. The minimum casing design factors tabulated in Section 6.4 will be used for determining casing specifications.

6.4.1.2 Crownpoint/Unit 1

Wells will be constructed at the CCP, and Unit 1 satellite to perform at depths of approximately 2200 feet. At this depth the maximum injection pressure will be 367 psig (2200 ft. x 0.167 psi/ft. = 367 psig --- see Section 6.5.3). The MAWHIP will be determined as in Section 6.5.3, and posted, and monitored as described in section 6.6 to ensure that the formation fracture pressure is not exceeded.

The casing for the upper wellbore will be constructed of either steel, or threaded fiberglass casing, or a combination of each. The minimum casing design factors tabulated in Section 6.4 will be used for determining casing specifications.

6.4.1.3 Cementing Program

As described in Section 6.4, all waiting on cement (WOC) times will be adequate to achieve a minimum of 500 psi compressive strength at the casing shoe prior to drill out, or further completion. When the casing is placed into the drill hole it will include centralizers spaced between 150 to 200 feet along the total casing length. The casing that is to be cemented through the completion interval will include a cap at the bottom with a large hole in its center to allow cement to circulate out, and upward through the casing borehole annulus. Casing that is set to the top of the completion interval will have a similar cap.

Once the casing is run into a well, it is cemented from bottom to top. The cement is pumped downward through the casing, through the weepholes in the cap, or basket, and up the annular volume between the casing, and borehole to the surface. The slurry volume will be sufficient to fill the annular volume, a portion of the lower casing volume, and to provide enough excess volume to fill any potential washouts with returns to the surface. After the entire slurry volume is pumped down the well, it is displaced in the casing with water to a depth considered sufficient to ensure that enough cement remains in the casing to properly seal the bottom weepholes. The well is sealed with a surface valve to prevent backflow of the displacement fluid, and cement slurry. The cement is allowed to cure undisturbed for at lease 48 hours to develop compressive strength prior to final well completion, and cleanup procedures.

6.4.1.4 Logging and Mechanical Integrity Testing

Subsequent to the well completion, certain cased-hole geophysical logs (single point, resistivity, gamma ray) may be used to survey the open interval, and length of the casing. The open interval, and possible casing leaks may be detected by the logs.

After the interval has been opened, and cleaned (through air jetting, cross jetting, pumping, etc.), and the well casing has been logged, a mechanical integrity test (MIT) is performed to further test the casing for possible leaks. An inflatable packer is run into the well to a depth directly above the open interval. The packer is inflated, and the casing is filled with water. The casing test pressure will vary with the maximum allowed injection pressure as described below. HRI will periodically retest the integrity of injection, and production wells at an interval of every five years.

In all cases, the well will be sealed, filled with water, and pressured up with air to at least 125% of the maximum allowable wellhead injection pressure (MAWHIP). The MAWHIP will be determined as in Section 6.5.3, and posted, and monitored as described in section 6.6 to ensure that the formation fracture pressure is not exceeded. For example, at an average depth of 825 feet at Churchrock, the MAWHIP will equal 137 psig (825 ft. x 0.167 psi/ft), and for 2200 feet at Crownpoint, MAWHIP will equal 367 psig (2200 ft. x 0.167 psi/ft). Operating pressure will vary with the depth of the well, and will be less than formation fracture pressure with a safety margin. After the test pressure is reached, the well is sealed to hold pressure, and allowed to stand for 30 minutes. After 30 minutes, the well is passed if less than 10% of the starting pressure is lost over the course of the test. If the pressure loss is greater than 10%, and the well fails the test, then action might be taken to locate, and repair the leak, and the MIT re-run. The subsequent MIT will be passed before the well is considered operational.

By determining MAWHIP by depth as described section 6.5.3, "in-line" injection pumps can be used at the wellhead (if desired) in order to increase the flowrate for selected wells where high rates are necessary to "balance" to their extractors.

Records of mechanical integrity, and construction details of the well will be recorded on a well completion report.

6.5 Well Operation

6.5.1 Production Flow Rates and Bleed

Each production well is operated at the maximum continuous flowrate achievable for that pattern area. The primary consideration in determining maximum continuous flowrate is to assure the wellfield is collectively balanced.

Generally, the overall injection flowrates into the wellfields will be less than the total extraction flowrate by an amount known as "process bleed", resulting in a hydraulic pressure sink which causes native groundwater outside of the ore zone to migrate into the wellfield. This process bleed is used to help protect the monitor wells against lixiviant excursion, and varies according ore geometry, well pattern, and magnitude, and direction of the natural groundwater velocity. Since the process lixiviant is simply the natural groundwater recirculated continuously from the extraction wells through the surface IX facilities, into the injection wells, through the ore zone, and back to the extraction wells, the system can never be over injected, even with no process bleed. Groundwater velocity studies for the proposed CUP ISL sites, indicate low natural groundwater velocities of 10 - 20 feet per year, which varies according to the natural hydraulic gradient, and is site specific. As a result, the amount of process bleed used in any portion of HRI's wellfields will also be site specific, incorporating affects of actual ore geometry, and overall wellfield pattern, and operation. Since groundwater issues are strongly debated, and process bleed is considered a consumptive use of groundwater, process bleed will be minimized in all cases, yet will be sufficient to protect the monitor wells against excursion.

The process bleed, or excess water production from the wellfield, is taken after uranium recovery, and will form the primary liquid waste stream from the wellfield.

The net extraction of minewater, or bleed will substantiate the 1/4 mile area of review as specified in NMWQCC 5-202.B.2, and 40CFR146.6.

6.5.2 Injection

The MAWHIP will be determined as described in Sections 6.5.3, 6.4.1.1, and 6.4.1.2. However, because the well casing is cemented into the bore hole, downhole pressures could substantially exceed the pressure rating of the well casing without adversely affecting the integrity of the well casing.

6.5.3 Formation Fracture Pressure

The terms "formation fracture pressure" as used throughout this COP, has the same definition, and could be use interchangeably with the term "parting pressure". HRI will maintain downhole injection pressures less than the formation fracture pressure. To ensure that the formation fracture pressure is not exceeded, the maximum wellhead surface injection pressure will be determined for each meterhouse, and posted near the injection trunk line pressure gauge nearest to the injection wellhead, and used to monitor injection pressure.

The fracture pressure must be sufficient to lift the rock, and water overlying the point of fracture, as well as, overcome the adhesive property of the rock which resists "tearing". Rock Mechanics, as a field of study, has shown that hydraulically induced fractures will be formed approximately perpendicular to the least principal stress of the rock unit. Typically, this means that horizontal fractures will be formed for depths from surface to 1000 - 2000 feet, and vertical fractures below 1000 - 2000 feet.

The Oil & Gas industry has considerable experience in estimating formation fracturing gradient through the thousands of wells that have been cemented, and/or purposefully fractured to enhance hydrocarbon production. Mathematical discussions of the fracture gradient have been presented (e.g., Hubbert and Willis in Underground Waste Management, and Environmental Implications, AAPG Memoir 18, 1972), as well as, empirical correlations developed by many of the Oil & Gas service companies (Halliburton, Dowell, EMCO). One such correlation, EMCO Services' Fracture Gradient Chart 13 (EMCO 133-0778) for New Mexico, Oklahoma, and West Texas indicates a fracture gradient of 0.645 psi per foot of depth (psi/ft) at 1,800 ft, and 0.655 psi/ft at 2,300 ft. Using Hubbert and Willis, the fracture gradient in northwestern New Mexico is estimated at 0.64 to 0.70 psi/ft. To include a safety factor, a more conservative fracture gradient of 0.60 psi/ft was assumed for the fracture calculations shown here.

The hydraulic pressure at any point in the wellbore is the sum of the surface pressure plus the pressure caused by the weight of the fluids contained in the wellbore. This in turn equals the surface pressure plus the pressure gradient of the wellbore fluids times depth:

downhole psig = surface psig + (fluid gradient, psi/ft) (depth, ft)

Since ISL lixiviant essentially has a specific gravity of one, the wellbore fluid gradient equals that of water: 0.433 psi per foot depth (psi/ft). Thus, the estimated maximum allowable wellhead pressure (Max WHP) in northwestern New Mexico which will not exceed the formation parting pressure equals:

Max WHP = (fracture gradient - wellbore fluid gradient) x depth to open interval

Max WHP, psig = (0.60 psi/ft - 0.433 psi/ft) x (open interval depth, ft)

Max WHP, psig = (0.167 psi/ft) x (depth to open interval, feet)

This is conservative in that the New Mexico Oil Conservation Division (NMOCD) generally uses 0.2 psi/ft (approximately 20% higher than 0.167) for the parting pressure for the Cretaceous geologic system in the San Juan Basin absent any fracture tests. Using 0.167 psi/ft, the maximum allowable wellhead injection pressure (MAWHIP) can be determined as a function of the average depth to the open interval: MAWHIP at Churchrock for a depth of 825 feet will equal 137 psig, and for Crownpoint at 2200 feet, equals 367 psig.

Considering the fracture pressures in the Crownpoint area, a considerable safety margin is included in the MAWHIP. As noted above, EMCO Services' Fracture Gradient Chart 13 (EMCO 133-0778) for New Mexico, Oklahoma, and West Texas indicates a fracture gradient of 0.645 psi/ft. at 1,800 ft., and 0.655 at 2,300 ft. This translates into a 381 psig surface fracture pressure if the production zone were at 1,800 ft., and a 511 psig fracture pressure if the production zone were at 2,300 ft. Using HRI's proposed method of determining MAWHIP, injection pressure for the 1800 foot well will be 301 psig, and for the 2300 foot well will be 384 psig. A safety factor of 27%, and 33% at 1,800 ft., and 2,300 ft. respectively.

Consistent with regulatory requirements, prior to the injection of lixiviant, HRI will conduct a Westwater Canyon aquifer step-rate injection test (fracture test)or acceptable equivalent within project site boundaries, but outside future wellfield areas at each of the three CUP sites. The parting pressure determined from these tests will be decreased by 25%, and used to determine the maximum allowable pressure gradient, and MAWHIP. They will be used in lieu of the estimates made above.

6.6 Wellfield Instrumentation

Injection, and production flow rates will be monitored in order that injection can be balanced with production across the entire wellfield, with the injection flow smaller than the production flow by the amount of the bleed rate. This information is also used for assessing operational conditions, and for determining mineral royalties.

A combination of meters will be used in the wellfield, and the plant, with differing accuracy's dependent on their use. Because hundreds of flow meters will be in use at any particular time, and because no meter is 100% accurate, the overall summation of injection flows seldom ever exactly equals that of extraction. Yet, by the very nature of the closed ISL system, injection flow actually does exactly equal that of extraction, minus the bleed rate. As a result, injection flows will be prorated to that of extraction (or vice versa) after the bleed rate is subtracted. In addition, since ISL is a continuous operation across 24 hours a day for every day of the year, some meters will require repair, and will give faulty readings until problems are identified, and corrected. A major portion of operational maintenance is spent in identifying, and repairing faulty flow meters. Thus, the procedure for determining final total flowrates will vary from time to time. Again, it is important to note that total injection flowrates can never actually be higher than total extraction in ISL because of the closed system.

Because elevations of the individual wells, depths to the open intervals, and distances from meterhouse to well (the frictional pressure loss) may vary considerably between injection wells, monitoring of MAWHIP will proceed in one of two ways:

a. The maximum allowable wellhead injection pressure (MAWHIP) will be determined for each injection well, and posted in the meterhouse. For these injection wells, a pressure gauge will be placed on the wellheads, or in the meterhouse, and pressure readings taken daily to ensure that the MAWHIP will not be exceeded.

b. A single maximum allowable injection pressure will be determined for the total meterhouse, and posted in the meterhouse. The injection trunkline in the meterhouse will be fitted with a pressure gauge, and pressure readings will be taken of that gauge daily to ensure that maximum allowable trunkline injection pressure will not be exceeded.

Data records for these monitoring activities will be maintained on-site.

7.0 PIPELINE SPECIFICATIONS AND CONSTRUCTION

The fluids handling system in New Mexico encompasses various pumps, meters, pipelines, fittings, and connections, and will generally consist of polyethylene, PVC, fiberglass, steel, and stainless steel materials, which are used universally in ISL. In materials technology, the ISL setting is considered both low pressure, and low temperature, allowing use of "off the shelf" items, and materials which are easily available. In all cases, the components of this fluid handling system will be rated to withstand ambient temperatures, and pressures of their environment, and the pressures, and temperatures of the fluids with which they will be in contact, using published, generally accepted ratings. The materials will be chemically resistant, over their useful life, to the fluids, and solids with which they are in contact. Specifications will be determined to maintain structural integrity throughout anticipated life of the component. As new materials become available, these same criteria will be used in determining their suitability. All wellfield piping systems, and equipment will either be housed in containment buildings, placed on the surface, or buried.

All piping, including fittings, will be static pressure tested to 100% of its designed working pressure for 20 minutes. The pressure testing method will consist of filling the piping to be tested with water, pressured by an external pressure source, to the designed working pressure. The piping to be tested will then be isolated from the external pressure source with positive shut-off valves, and held under pressure for twenty minutes. Piping that retains 90% of the original shut-in pressure after 20 minutes will be considered to be competent, and pressure leakage in excess of 10% will constitute a failure of test. The 10% leakage factor is to allow for material expansion under pressure with time, and thermal expansion, if applicable. Any visible leakage of fluids within the test section of piping will constitute a failure of the pressure test. Any pipe that fails its pressure test will be replaced, or repaired, and retested.

Pressure testing at 100% of the designed working pressure will make allowances for injection wellheads, and associated piping on the occasional injection wells that require higher than normal injection pressures to maintain the designed injection rate. It will also account for changes in elevation along the path of the piping, since piping that changes elevation over distance will be tested to the maximum pressure that will be induced at the point of testing (the location where test pressures will be recorded) during operations. It follows, since the pressure at that point will be the maximum encountered at that point during operations, the pressure at every other point in the piping will be at the maximum to be encountered during operations, regardless of that point's elevation.

8.0 HYDROGEOLOGICAL ASSESSMENT OF WELLFIELDS

Prior to wellfield development, it will be necessary to collect, and assemble detailed information on geologic, and hydrologic conditions, in order that ore zones can be defined, geologic, and hydrologic parameters quantified, well fields planned, hydrologic monitoring programs developed, and baseline ground water quality sufficiently determined. To accomplish the above, HRI will conduct an intensive multi-step program. The following subsections contain a detailed description of the types of data which have been, and will be, collected for proposed wellfields.

8.1 Overlying Zones

8.1.1 Churchrock

At the Churchrock property, the Brushy Basin member of the Morrison Formation, and the overlying Dakota Formation are water-bearing. Above the Dakota Formation is continuous Mancos Shale to the surface. The Brushy Basin "B" Sand as well as the Dakota Sandstone aquifer will be monitored. Above the Dakota Sandstone, there are no additional aquifers, because it is continuous Mancos Shale to the surface. Upper monitor wells completed in the Brushy Basin "B" Sand will be located with at a minimum of one well per every four acres of production area. Upper monitor wells completed in the Dakota Sandstone aquifer will be located with a minimum of one well per every eight acres of production area.

While mineralization stratigraphically above the Westwater is known to exist, HRI has not delineated the extent of this mineralization at this time. Therefore, the feasibility of producing the Brushy Basin, or the Dakota ore is presently unknown. If HRI determines that production is feasible in either the Brushy Basin, or the Dakota, the permitting of these intervals, and environmental monitoring will proceed using the same program which has been described for mining in the Westwater Sand. Specifically, UIC permits, or amendments of existing UIC permits, will be obtained which will authorize this mining. This will include the New Mexico discharge plan, and federal EPA permit, and aquifer exemption, as necessary. Operationally, HRI will request that monitor wells will be established in the sand being mined (Brushy, Dakota) at a spacing of 400 feet apart, and 400 feet from the closest injection/production well. The first overlying sand will be monitored at a density of one well per four acres, unless mining is conducted in the Dakota, in which case there is no overlying zone.

HRI has conducted pump tests at the Churchrock property which demonstrated that the sands overlying the Westwater are hydraulically separated. Additional pre-mining water quality, and hydrologic testing of production zone monitor wells, and overlying monitor wells will be conducted after the operating monitor wells are installed as will be described in Sections 8.5, and 8.6.

8.1.2 Crownpoint/Unit 1

In the vicinity of Crownpoint, and Unit 1, the Brush Basin member of the Morrison Formation is shale. This thick, contiguous shale overlays the production zone throughout the vicinity of the Crownpoint property. This is a regional shale which physically provides the aquitard between the Westwater, and the Dakota.

Above the Brushy Basin is the Dakota Formation. Above the Dakota is 600-700 feet of Mancos Shale. Thereafter, to the surface are a number of sands form the Mesa Verde Group, the lowermost being the Gallup Sandstone.

As specified in Section 8.5 HRI will run hydrological tests prior to mining to confirm the previous mine area pump tests, and verify that additional drilling activities have not created any new avenues for leakage.

HRI proposes to monitor the Dakota Fm. as the first overlying aquifer at both the CCP, and Unit 1 satellite. Wells will be spaced at a density of one per four acres.

HRI does not propose to place monitor wells in sand of the Mesa Verde group for the following reasons:

a) These sands are separated from the production zone by the Dakota, which will be monitored.

b) The massive Mancos shale which separates the Dakota from the Mesa Verde group make interformational transfer impossible.

c) Mechanical integrity test will assure that casing does not leak into shallow sands of the Mesa Verde group.

d) Sands of the Mesa Verde group are not substantial aquifers.

8.2 Underlying Zones

Underlying the host sand at Churchrock, Crownpoint, and Unit One, is the Recapture member, and then the Cow Springs member of the Morrison Formation. There is little site specific data on the thickness of the Recapture shale. However, the information which is available on drilling through the Recapture shale provide strong evidence of the shales quality as an aquitard. Specifically, the Recapture shale is 250 feet thick, and is high quality shale. Given that the Recapture has been minimally penetrated, there is little potential for interformational transfer of mine fluids which will effect the any underlying sand. The primary risk to any underlying water bearing sand will be deep drilling through the confining shale section which, if not properly abandoned, could provide a conduit for fluid migration.

HRI does not propose to monitor the Cow Springs aquifer. Prior to the injection of lixiviant at any of the three project sites, HRI will collect sufficient water quality data to generally characterize the water quality of the Cow Springs aquifer beneath the project sites, and will conduct sufficient hydrological confinement tests to determine if the Cow Springs aquifer beneath the sites is hydraulically confined from the Westwater Canyon aquifer.

8.3 Effects of Old Mine Workings at Churchrock

The mine tunnels at the Old Churchrock underground mine site are opened into the Brushy Basin, and the Westwater Canyon sands, both part of the Morrison formation. To the best of HRI's knowledge, the workings themselves do not extend up into the Dakota sand. However, the shaft does appear to be opened slightly into the Dakota, one to two feet at the very bottom of the sand. As evidenced by the mine workings in Section 17 of the Churchrock area, uranium mineralization occurs in the Brushy Basin sandstone, as well as the Westwater Canyon. In addition, geologic evaluation of this area shows that significant ISL uranium reserves are contained in the Dakota formation. If HRI's ongoing evaluation of the Churchrock geology indicate that mining in the sands overlying the Westwater is economically, and technically feasible, applications for ISL mining in those zones will be made to all appropriate regulating entities, and proper authorizations will be received by HRI before such mining occurs. HRI will monitor the aquifer immediately overlying any host mining sands with monitor wells spaced at one well per four acres. Thus, if mining is taking place in the Brushy Basin sandstone, HRI will propose that the Dakota sand will have monitor wells placed at one well per four acres in the area above the ISL mining. Although no aquifer has been identified above the Dakota sand in the Churchrock satellite area, HRI will undertake such monitoring if a "first overlying sand" is determined at the time of actual ISL mining in that zone.

8.4 Exploration Holes

HRI, Inc. has exploration drill hole survey locations for every exploration hole at each of the three CUP properties. The status of plugging records will be detailed for each property below.

8.4.1 Churchrock Property

Hydrologic testing, simultaneous with wellfield development, will further confirm that the production zone is confined. If during operational testing individual holes become suspect, they can be found because their locations are surveyed, and mapped, and corrective action (plugging) will be performed.

In addition to routine hydrological testing, and corrective action, wellfield operations, and the physical characteristics of the old exploration holes themselves allow containment of the leaching solutions as follows.

8.4.1.1 Operational Controls

During operations, more water is withdrawn than is injected (wellfield bleed), which creates lower pressure within, and around the wellfield area. Additionally, water levels in the zones overlying the production horizon are monitored. Any movement of water out of the production zone, and into the overlying intervals will be signaled by a water level in those formations higher that the original fluid level. In addition, the periodic samples taken from the monitor wells are chemically tested for leachate.

8.4.1.2 Borehole Characteristics

The weight of the abandonment fluid used in an exploration well is considerably heavier than water, and by itself will contain substantial pressure. A weight of about 9.5 ppg could be reasonably expected for the mud, but decreasing this even further to 9.2 ppg in the pressure calculation provides an additional level of confidence. The average depth to the top of the production horizon using the four baseline wells completed into the Westwater Canyon is 666 feet. Thus, the weight of the hole abandonment fluid, by itself, will generate a pressure of 30.1 psi.

The gel strength of a fluid is a measure of the shearing stress required to overcome the tendency of the fluid to remain static. The gel strength of the drilling mud left in a borehole, then, requires that a certain pressure be reached before the mud will even move. This is in addition to total mud weight. The shear stress, in units of pressure, can be calculate from the following:

pressure, psi = 0.00333 x (GS) x h / D
Where GS = gel strength, $lb/100ft^2$.
h = length of fluid column, feet.
D = wellbore diameter, inches.

From: Davis, Ken. E., "Factors Effecting the Area of Review for Hazardous Waste Disposal Wells", PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON SUBSURFACE INJECTION OF LIQUID WASTES, New Orleans, LA; March, 1986.

Gel strength increases with time, and can range from about 20 $lb/100\ ft^2$ to hundreds after the mud has set in the borehole for years. Low gel strength muds are preferable in drilling but can be expensive to purchase, thus relatively high gel muds are common. A gel strength of 50 $lb/100\ ft^2$ is felt to be conservative, and was used in the pressure calculations. A wellbore diameter of 4.75 inches is typical of the size used for exploration wells. Using this with 660 feet as average height of the fluid column noted above, the mud in exploration holes will require 23.3 psi [0.00333 x 50 x 666/4.75] of pressure to overcome the fluid's gel strength.

The formations, especially clays, and shales, which have been penetrated by an exploration hole will slough into the well, and will also naturally squeeze across the wellbore closing it off. This trait is especially evident in drill holes left open for even a few days, when the borehold must be reamed again in order to get to the bottom. This plugging of the wellbore by pressing of clays into the borehole has been such a problem in the past in the Churchrock area, that, as early as the 1950's, additives were mixed into the drilling mud to minimize the effect, a very unusual practice for that time.

The physical characteristics of an exploration hole, drilled, and abandoned years ago, make leakage out of our production zone very unlikely. But nevertheless, the monitoring system is designed to alert the operator to a problem, including potential problems.

This is the same monitoring system which will be in place even under the best conditions in which there were no old holes, or in which cement/Shur-Gel had been used in their plugging. That is, unplugged holes will not affect our ability to detect, and clean up any leaching solution outside of our wellfield.

Pump tests directly measure the integrity of the shales separating the production horizon from the overlying, and underlying sands. By itself, a pump test provides the best indication as to the continuity of the confining shales, and therefore, leakage potential of an aquifer. For this reason, a hydrologic test is considered necessary, even at a substantial cost to the company.

Pump tests provide a means of determining leakage potential, whether from unplugged wells, or high permeability general to the confining layers. A more detailed , theoretic analysis of a leaky system with the high permeability of the isolating clays is presented in the attachment: Popielak, R.S., and Sigel, J.;"Economic, and environmental implications of leakage upon in-situ uranium mining", Mining Engineering. August 1987, pp. 800-804. Part of the results of that study are noted in the abstract to the paper: "The potential for environmental impacts appear to be minor".

8.4.2 Crownpoint Property

Drilling at Crownpoint property began in the late 1960's, and early 1970's. Therefore, all plugging at the site was in compliance with the New Mexico State Engineers Regulation NMSA Section 69-3-6, which was promulgated in 1968.

HRI, Inc. has all of the plugging records which are available for the Crownpoint project.

Hydrologic testing that has been conducted at the Crownpoint property to date provides strong evidence that the production zone is confined from overlying zones. HRI, Inc. will conduct additional testing simultaneous with wellfield development. If former exploration boreholes become suspect during hydrologic testing, their locations are surveyed, and mapped so they can be readily located, and corrective action (plugging) will be performed.

8.4.3 UNIT 1 Property

Drilling at the UNIT 1 property began in the early 1970's by Mobil Oil. Therefore, all plugging at the site was in compliance with the New Mexico State Engineers Regulations NMSA Section 69-3-6, which promulgated in 1968.

HRI, Inc. has purchased Mobil's records which contain, to the best of our knowledge, all plugging reports.

Hydrologic testing that has been conducted at the UNIT 1 property by Mobil Oil provides additional strong evidence that the production zone is confined from overlying zones. HRI, Inc. will conduct additional testing simultaneous with wellfield development. As with other HRI properties, if individual holes become suspect during additional testing, their location are surveyed, and mapped so they can be readily located, and corrective action (plugging) performed.

8.5 Hydrologic Testing Plan

HRI considers that the primary goal of pump testing in new mine areas for ISL is to determine the degree of communication between the mine zone, and (1) the overlying zones, and (2), the production zone monitor wells. This will reflect the effects of hydraulic pathways, such as unplugged holes, and other pathways, to the overlying zones, as well as ascertain the ability of production zone monitor wells to respond to changing flow conditions within the mining area. The degree of communication at the production zone monitor wells surrounding the mine zone will also directly indicate the magnitude of horizontal formation anisotropy. Of secondary importance, is the determination of the physical flow parameters (transmissivity, storage, permeability) of the producing horizon, since they are of only very general utility to the ISL operator.

8.5.1 Single Well Test

Once an area has been adequately assessed from a geologic, and mineability standpoint, and the limits of the mine area are determined, and it becomes a proposed mine unit. Monitor wells (both overlying, and production zone), and baseline mining wells are installed. A hydrologic test is then designed with the primary (hydraulic communication), and secondary goals in mind. Sufficient data preceding the pumping test will be collected for each of the monitor wells to assure that they are adequately reacting to barometric, and/or antecedent conditions.

Initially, a single well, relatively central to the proposed mining area, will be produced at a constant flowrate to allow for analysis of the formation flow parameters of transmissivity, storage, and permeability. Only a portion of the wells surrounding this first pumping well will be formally analyzed for these parameters, since they are of little value in the actual operation of a ISL wellfield. At least three wells, at appropriate angles to the pumping well, will be used to mathematically determine horizontal formation anisotropy. Isopleths, showing the piezometric surface near the time of maximum pressure drawdown across the area, will be drawn to graphically depict this same anisotropy. If other wellfields are active in the area, they will be kept at flowrates as reasonably constant as possible during this segment of the hydrologic testing.

8.5.2 Multiple Well Tests

The pressure drawdown (cone-of-depression) caused by water production creates stress in the formation, and any potential hydraulic boundaries, or barriers, such as the overlying confining clays, and possible non-sealing faults. If the proposed mine area is sufficiently small, then the stress induced by pumping from a single well will adequately test potential barriers. Although the pressure drawdown decreases logarithmically with distance from the pumping well, the cone-of-depressions developed by multiple pumping wells are additive across the mine area, and can significantly increase the stress developed at any particular point. Since the ultimate goal of the hydrologic testing is to determine the degree of communication of the mine zone with the overlying, and production zone monitor wells, the second phase of the investigation, if needed (as determined by the observed maximum drawdowns across the proposed mine area developed by the single produced well), will involve producing multiple wells concurrently across the area, and observing the composite effect of the resulting pressure drawdown on the various monitor wells. Plots of the water levels versus time of pumping will be made for the overlying monitor wells, and evaluated for pressure responses to pumping from the mine zone. Maximum drawdowns will be tabulated for each of the production zone monitor wells to ensure that adequate response was achieved for those wells.

8.5.3 Mine Unit Hydrological Test Document

Following completion of the field data collection, data reduction, and data interpretation in accordance with accepted scientific techniques, and principles, the Mine Unit Hydrologic Test Document will be assembled, and available for regulatory review. In accordance with NRC requirements, the Mine Unit Hydrologic Test Document will be reviewed by a Safety, and Environmental Review Panel (SERP) to ensure that the results of the hydrologic testing, and the planned mining activities are consistent with technical requirements, and do not conflict with any requirement stated in the NRC license. A written report will be prepared by the SERP which evaluates safety, and environmental concerns, and demonstrates compliance with applicable NRC license requirements. The written SERP report will be maintained at the site.

The Mine Unit Hydrologic Test Document contains the following:

a. a description of the proposed mine unit (location, extent, etc.);

b. a map(s) showing the locations of the baseline mining wells, and all monitor wells;

c. geologic cross-sections, and cross section location maps.

d. isopach map of the overlying confining unit.

e. discussion of how the hydrologic test was performed, including well completion reports;

f. discussion of the results, and conclusions of the hydrologic test including raw data for the pumping test(s), drawdown match curves, potentiometric surface maps, water level graphs, drawdown maps, and when appropriate, directional transmissivity data, and graphs;

g. sufficient information to show that wells in the monitor well ring will be in adequate communication with the production patterns;

h. any other information pertinent to the area tested will be included, and discussed;

After appropriate review of Mine Unit Hydrologic Test Document, and subsequent authorization by the SERP, injection of lixiviant will begin in the new mining unit.

8.6 Baseline Water Quality Determination

8.6.1 General

The collection of baseline water quality data, and determination of baseline water quality conditions is very important as the Upper Control Limits (UCL's), and ground water restoration objectives are based on this data.

Consistent with regulatory requirements, initially, HRI will collect three independent baseline water quality samples from each well. However, based on the consistent results of multiple samples from individual wells taken previously, HRI believes that multiple independent baseline water quality samples from each well will not be warranted. With the concurrence of NRC, HRI will sample each well once, and perform the requisite analysis to determine baseline water quality characteristics. It is with this presumed approval that the following portion of the Plan is drafted.

8.6.2 Data Collection

Baseline water quality will be determined from water samples collected from wells installed in the various aquifers present as follows:

a. Monitor wells will be installed per the Mine Unit Hydrologic Test Document which is reviewed, and approved by the SERP. At a minimum wells will be installed at the following density:

1. production zone baseline wells - one per four acres from select injection, and extraction wells which are completed as mining progresses;

2. mine area monitor wells - spaced 400 feet apart, 400 feet from the wellfield patterns completed in the ore zone aquifer;

3. first overlying monitor wells - one per four acres completed in the first overlying aquifer;

4. second overlying monitor wells - one per eight acres completed in the second overlying aquifer.

b. Water quality samples will be obtained, and analyzed from the monitor wells described in **a** above. The sample well will be pumped during completion until water is free of mud, and foreign material, and until conductivity, and pH are reasonably constant in a natural range. As samples are taken during baseline sampling, the sampled well will be pumped for a sufficient amount of time to assure that sampled water is formation water. Sampling, preservation, analysis, and analytical quality control methods will be as defined in the current issues of *Methods for Chemical Analysis of Water, and Wastes (EPA - Technology Transfer)*.

The number of samples collected, and the parameters analyzed will be as follows:

1. Production Zone (Production Pattern) - One sample, collected, and analyzed for the parameters listed in Table 8.6-1. Prior to sampling, regulatory authorities are contacted in order that they can, if desired, collect split samples from the field sampling for comparative purposes.

2. Mine Area (Monitor Well Ring) - One sample, collected, and analyzed for the parameters in Table 8.6-1. Prior to sampling, regulatory authorities are contacted in order that they can, if desired, collect split samples from the field sampling for comparative purposes.

3. Overlying Zones - One sample for the parameters in Table 8.6-1. Prior to sampling, regulatory authorities are contacted in order that they can, if desired, collect split samples from the field sampling for comparative purposes.

8.6.3 Assessment of Baseline Water Quality Data

Baseline water quality is determined by averaging the data collected for each parameter, from each well, for each zone that is monitored. This average is used to determine the "well field average" for determining restoration criteria, and UCL's. The variability of the data is also calculated. Outliers are determined using accepted methods such a eliminating all values which exceed five standard deviations from the mean of the gross data. Values determined to be outliers are not used in the baseline calculations.

Baseline conditions are determined as follows:

a. Production Zone (Production Pattern) Wells - Individual well data for each parameter are averaged. The resulting average is generally referred to as the production area average.

b. Mine Area (Monitor Well Ring) Wells - Individual monitor well data for each parameter are averaged. The

Table 8.6-1 Water Quality Parameters with Lower Levels of Detection (LLD) and Primary, and Secondary Restoration Goals.

	LLD[1]	Primary	Secondary[3]
Alkalinity	1	WF AVG.	WF AVG.
Ammonium	0.01	WF AVG.	10.0
Arsenic	0.001	WF AVG.	0.05
Barium	0.01	WF AVG.	1[2]
Bicarbonate	1	WF AVG.	WF AVG.
Boron	0.01	WF AVG.	WF AVG.
Cadmium	0.001	WF AVG.	0.01
Calcium	0.001	WF AVG.	WF AVG.
Carbonate	1	WF AVG.	WF AVG.
Chloride	1	WF AVG.	250
Chromium	0.001	WF AVG.	0.05
Copper	0.001	WF AVG.	1
Electrical Conductivity ~25 degrees C (micromho/cm)	1	WF AVG.	WF AVG.
Fluoride	0.1	WF AVG.	2[2]
Iron	0.01	WF AVG.	0.3
Lead	0.01	WF AVG.	0.05
Magnesium	0.001	WF AVG.	WF AVG.
Manganese	0.001	WF AVG.	0.05
Mercury	0.0001	WF AVG.	0.002
Molybdenum	0.01	WF AVG.	WF AVG.
Nickel	0.01	WF AVG.	0.1
Nitrate	0.01	WF AVG.	10
pH (s.u.)	°0-14	WF AVG.	6.5-8.5
Potassium	0.01	WF AVG.	WF AVG.
Radium-226 (pCi/l)	0.1	WF AVG.	5
Selenium	.001	WF AVG.	.05
Silica	.01	WF AVG.	WF AVG.
Silver	.001	WF AVG.	WF AVG.
Sodium	0.001	WF AVG.	WF AVG.
Sulfate	1	WF AVG.	250
TDS	1	WF AVG.	500
Uranium	0.001	WF AVG.	.44[4]
Vanadium	0.1	WF AVG.	WF AVG.
Zinc	.001	WF AVG.	5

[1] mg/l unless otherwise noted. LLD may vary depending upon the laboratory that is used.
[2] NMWQCC 3-103 Standard.
[3] 40CFR141.62 or 143.3 unless otherwise noted.
[4] 10CFR20, Appendix B, Table 2.

resulting average is generally referred to as the mine area average.

c. Overlying Zones - Individual monitor well data for each parameter are averaged. The resulting average is generally referred to as the non-production area average.

Consistent with the PBL format, HRI will develop a Standard Operating Procedure (SOP) which addresses the statistical assessment of baseline water quality data, and the treatment of outlier data.

8.6.4 Upper Control Limits (UCL's)

8.6.4.1 General

As part of the detailed hydrogeological assessment, UCL's are determined based on the baseline water quality data. The UCL parameters are chloride, bicarbonate, and conductivity.

8.6.4.2 Determination of Upper Control Limits

The UCL's are based on the average baseline water quality data (i.e. mine area average, or non-production area average), and determined as follows:

a. Chloride UCL - baseline average of all monitor wells in the horizon to be monitored plus five standard deviations.

b. Bicarbonate UCL - baseline average of all monitor wells in the horizon to be monitored plus five standard deviations.

c. Conductivity UCL - baseline average of all monitor wells in the horizon to be monitored plus five standard deviations.

To ensure that the UCL's determined from the baseline data are accurate, the monitoring data collected at the onset of the operational monitoring program (at least the first two samples) will be compared with the appropriate UCL's, and baseline data. In the event that the data collected at the onset of the operational monitoring program shows that the baseline water quality data, and UCL's are not consistent with previously determined baseline values, and UCL's, additional baseline water quality data will be collected, and alternative UCL's will be proposed to the regulatory agencies.

Consistent with the PBLC format, HRI will develop a Standard Operating Procedure (SOP) which addresses the determination of UCL's, including the treatment of outlier data.

8.7 Operational Groundwater Monitoring Program

8.7.1 General

During production operations a carefully planned groundwater monitoring program is utilized to ensure that production fluids are contained within the defined production zone. If production fluids exit the production zone, increases in concentration of the UCL parameters chloride, bicarbonate, and conductivity at the affected monitoring wells will occur. If this situation occurs, and the concentration of the UCL parameters meet the criteria defined in Section 8.6, an excursion is present, and certain regulatory, and operational procedures are followed.

8.7.1.1 Monitoring Frequency and Reporting

Monitor wells installed in the production zone monitor well ring, and those installed in the overlying, and underlying aquifers (where applicable) will be sampled, and analyzed for the UCL parameters every two weeks during production operations unless unable to do so because of uncontrollable events such as snowstorms, flooding.

Monitoring data for the UCL parameters will be retained on site for review by the NRC.

8.7.1.2 Water Quality Sampling and Analysis Procedures

Water quality samples will be obtained from the monitor wells with air lifts, or submersible pumps. To assure that water within the well casing has been adequately displaced, and formation water is sampled, wells will be pumped a certain amount of time, based on the particular well's performance. A minimum of one (1) casing volume of water will be removed from the well prior to sampling. Prior to sampling, the electrical conductivity, and pH will be measured at periodic intervals, and recorded on field data sheets to demonstrate that water quality conditions have stabilized, and ensure that formation water is sampled. All data for each well will be periodically reviewed to ensure that both sampling, and analytical procedures are adequate.

Water quality samples will be analyzed for conductivity, chloride, and bicarbonate, usually within 48 hours of sampling, at the on-site laboratory. All analyses will be performed in accordance with accepted methods.

8.7.2 Excursions

An excursion will be declared if any two excursion indicators in any monitor well exceed their respective upper control limits (UCLs), or a single excursion indicator exceeds its UCL by 20 percent. A verification sample will be taken within 24 hours after results of the first analyses are received. If the second sample does not indicate UCLs are exceeded, a third sample will be taken within 48 hours after the second sampling data is acquired. If neither the second nor third sample indicate UCLs are exceeded, the first sample will be considered in error. If the second, or third sample contains the indicators above UCLs, an excursion will be confirmed.

Upon verification of an excursion, the EPA, or NMED, and NRC will be verbally notified within 24 hours, and notified in writing within seven days. Corrective actions, such as changes in pumping, or injection rates will be implemented as soon as possible. Corrective actions will continue until the excursion is mitigated. When excursion status is confirmed, corrective action will be required to return the water quality to the applicable upper control limit. During corrective action, sample frequency will be increased to weekly for the excursion indicators until the excursion is concluded.

In the event of a vertical excursion at the Crownpoint, and Unit 1 properties, HRI will explore any significant aquifer above the Dakota sandstone aquifer for vertical excursions, as opposed to just the deepest saturated sand of the Mesa Verde Group. The specific aquifers to be monitored in the event of a vertical excursion will be identified in HRI's 60-day excursion report as described in **a** below.

If an excursion has been confirmed, the following procedures will be applicable:

a. A written report describing the excursion event, corrective actions taken, and the corrective action results will be submitted to the NRC within 60 days of the excursion confirmation. The report will describe the excursion event, correction actions taken, and the results obtained. If wells are still on excursion at the time the report is submitted, the report will also contain a schedule for submittal of future reports to the NRC describing the excursion event, corrective actions taken, and the results obtained. In the case of a vertical excursion, the report will also contain a projected completion date when characterization of the extent of this vertical excursion will be completed.

b. In the event an excursion is not corrected within 60 days of confirmation, the HRI will terminate injection of lixiviant the vicinity of the monitor well within the wellfield on excursion until such time that aquifer cleanup is complete, or will provide an increase to the reclamation bond, in an amount that is agreeable to NRC, which will cover the full cost of correcting, and cleanup of the excursion. The bond increase will remain in force until the excursion has been corrected. The written 60-day excursion report will state, and justify which course of action will be followed.

An excursion is corrected, when all control parameters have been reduced to their upper control limit, or below. After the excursion is corrected, normal operations will be resumed.

Consistent with PBLC format, HRI will develop a standard Operating Procedure (SOP) which addresses regulatory agency reporting, and corrective actions to be taken in the event of an excursion.

8.7.3 Wellfield Development Documentation

Documentation of wellfield development will be maintained by the RSO, and approved by the SERP.

8.7.3.1 Previous Mining

Planning for previous mining activities is required only at the Churchrock Section 17 property.

As stated in Section 8.3, HRI has full knowledge of the locations of all previously mined workings. These workings were developed in the area of uranium mineralization, as will be all production patterns. Therefore, the mine area monitor wells will be placed outside the physical location of mine workings. HRI will verify that the mine area monitor wells are outside the locations of workings by superimposing their surveyed locations on existing surveyed maps which illustrate the working locations.

The location of non production zone monitor wells is discussed in Section 8.3.4. HRI will verify that non production monitor wells are placed proximal to raises by superimposing their exact locations on existing surveyed maps which illustrate the raise locations.

Documents, and maps showing the location of monitor wells will be maintained on sight for inspection.

8.7.3.2 Geologic Data

The geology of an individual mine area is evaluated in conjunction with wellfield development to assure proper placement of monitor, and production wells. The project geologist, and hydrologists will work together to compile the geologic/hydrologic data into a report. Included in this report will be:

a. a description of the proposed mine unit (location, extent, etc.);

b. a map(s) showing the locations of the baseline mining wells, and all monitor wells;

c. geologic cross-sections, and cross section location maps.

d. isopach map of the overlying confining unit.

e. discussion of how the hydrologic test was performed, including well completion reports;

f. discussion of the results, and conclusions of the hydrologic test including raw data for the pumping test(s), drawdown match curves, potentiometric surface maps, water level graphs;

g. sufficient information to show that wells in the monitor well ring will be in adequate communication with the production patterns;

h. any other information pertinent to the area tested will be included, and discussed.

This information will be maintained on sight for inspection.

8.7.3.3 Well Field Location

The license area location is described in Section 1.1.1 for the Crownpoint wellfields, Section 1.1.2 for the Churchrock wellfields, and Section 1.1.3 for the Unit 1 wellfields. Property boundaries are generally well marked, and HRI can not legally encroach these boundaries. Additionally, all wells will be surveyed. These mapped locations will also contain boundaries, and cultural features.

These maps will be maintained on sight for inspection.

8.7.3.4 Well Completion

Well location, and completion will be performed as described in Section 6.0. Monitor well functionality will be verified through hydrological testing, and reported as described in Section 8.5.

Details of the construction, completion, and testing of each well is maintained within a file for that well. This file will contain all geophysical logs associated with the well, field information, and the completion reports.

This information will be maintained on sight for inspection.

8.7.3.5 Well Integrity Testing

Only wells that pass the mechanical integrity testing (MIT) requirements specified in Section 6.4.1.4 will be used at the CUP. MIT results will be recorded on the completion reports.

This information will be maintained on sight for inspection.

8.7.3.6 Baseline Water Quality Data

Baseline water quality will be collected, analyzed, and evaluated according to the discussion set forth in Section 8.6. Statistical analysis, will be reviewed by the SERP, and the results documented, and filed.

This information will be maintained on sight for inspection.

8.7.3.7 Upper Control Limits

Baseline water quality will be collected, analyzed, and evaluated according to the discussion set forth in Section 8.6 Upper Control Limits (UCL's) analysis will be conducted according to the statistical procedures set out in Section 8.6.4. UCL results will be reviewed by the SERP, and the results documented, and filed.

This information will be maintained on sight for inspection.

8.7.3.8 Define Restoration Target Values

Baseline water quality will be collected, analyzed, and evaluated according to the discussion set forth in Section 8.6. Restoration Target analysis, will be conducted according to the statistical procedures set out in Section 8.6.3, and will be reviewed by the SERP, and the results documented, and filed.

This information will be maintained on sight for inspection.

8.7.3.9 Location of Monitor Wells

Monitor wells will be located according to the discussion set forth in Sections 6.3.1, 6.3.2, and 8.6.2. Baseline water quality will be collected, analyzed, and evaluated according to the discussion set forth in Section 6.3.1, 6.3.2, and 8.6.2. Details of the construction, completion, and testing of each well is maintained within a file for that well. This file will contain all geophysical logs associated with the well, field information, and the completion reports. Additionally, all well will be surveyed, and mapped. These maps will also contain boundaries, and cultural features. Monitor well completion reports and location maps will be reviewed by the SERP.

Monitor well completion reports, and location maps will be maintained on sight for inspection.

8.7.3.10 Hydrological Tests of Confinement

Mine unit pumping tests will be performed, and reported according to the methods, and procedures set forth in Section 8.5. The Mine Unit Hydrologic Test Document will be reviewed by a Safety, and Environmental Review Panel (SERP) to ensure that the results of the hydrologic testing, and the planned mining activities are consistent with technical requirements.

The Mine Unit Hydrologic Test Document will be maintained on sight for inspection.

8.7.3.11 Injection Pressures

Injection pressures of either individual wells, or trunk lines is determined daily at the injection well, or in each wellfield metering house. The surface wellhead pressures will not exceed the maximum surface pressures posted in each metering house.

Data records for these monitoring activities are maintained on-site.

8.7.3.12 Pump Test Confirmation of Monitor Well Locations

Mine unit pump testing will be performed, and reported according to the methods, and procedures set forth in Section 8.5. The primary goal of the mine unit pump test is to determine the degree of communication of the mine zone with the overlying, and production zone monitor wells. The primary results of the mine unit pump test will be recorded in the Mine Unit Hydrologic Test Document. The Mine Unit Hydrologic Test Document will be reviewed by a Safety, and Environmental Review Panel (SERP) to ensure that the results of the hydrologic testing, and the planned mining activities are consistent with technical requirements.

The Mine Unit Hydrologic Test Document will be maintained on sight for inspection.

8.7.3.13 Hydrologic Parameters

Of secondary importance, is the determination of the physical flow parameters (transmissivity, storage, permeability) of the producing horizon, since they are of only very general utility to the ISL operator. Physical flow parameters will be calculated from the data that is obtained during the mine unit pump test. Physical flow parameters will be recorded in the Mine Unit Hydrologic Test Document. The Mine Unit Hydrologic Test Document will be reviewed by a Safety, and Environmental Review Panel (SERP) to ensure that the results of the hydrologic testing, and the planned mining activities are consistent with technical requirements.

The Mine Unit Hydrologic Test Document will be maintained on sight for inspection.

9.0 RADIATION SAFETY

In accordance with 10 CFR 20.1101(b), and Regulatory Guides 8.10, and 8.31, HRI is committed to maintaining personnel occupational exposures to radioactive materials "as low as reasonably achievable", or ALARA. The following Radiation Safety Program is developed from operating experience at URI facilities gained from 1978 to the present. This program is designed to comply with the "new" Part 20 regulations which became mandatory January 1, 1994.

9.1 Uranium Production Facilities

9.1.1 Conventional Mining

Underground mines pose significant inhalation hazards from airborne uranium, and uranium decay progeny suspended in the mine air due to blasting, or other mining operations. Additionally, the buildup of 222-Rn, and its progeny can yield significant doses to the bronchial tissues of the lung, resulting in the most significant radiological doses in mining operations. The buildup of radon progeny in mining environments can result in air concentrations on the order of tens to hundreds of working levels, depending on emanation, ventilation, and other factors. The average exposure of all underground uranium miners in the U.S. in 1979 had an average exposure, for radon only, of about 3000 mrem per year, or 2.9 WLM (Working Level Months) [Cooper, W.E., 1981,, O'Riordan, M.C., et.al., 1981, Johnson, J.R. et.al, 1981].

9.1.2 Solution Mining

In situ mineral extraction applies engineering controls, and processes to insure the health, and safety of personnel, the public, and the protection of the environment. Mine solutions contain extracted soluble uranium circulated in a closed loop system through the processing plant, and back to the ore zone, and thus there is no overall airborne hazard of uranium, or uranium progeny. Unlike conventional mining which can use copious amount of water, solution mining conserves consumption of water by continually circulating mining fluids back to the mine zone. In situ mining extracts uranium while allowing the ore body to remain intact. This leaves the surrounding landscape open for grazing, or raising crops (URI's La Rosita and Kingsville Dome sites respectively). The final product is yellowcake, dried in a vacuum hopper with near zero emissions prior to shipment to an enrichment facility.

9.2 Product Material - Yellowcake

9.2.1 Chemical Form

Uranium in the ore body becomes soluble in the oxidized phase, and once oxidized, is mobilized by the bicarbonate (HCO_3^-) anion as a uranyl dicarbonate ($UO_2(CO_3)_2^{-2}$) anion. The mine leach solution is then pumped to the surface from the ore zone. The ion-exchange (IX) resin columns in the processing plant acts in a manner very similar to a domestic water softener. Uranyl dicarbonate anions are exchanged onto the surface of the IX resin, and displace two chloride ions (Cl^-). When fully charged, an NaCl brine solution is used to release the uranyl dicarbonate into an eluant, and to regenerate the IX resins. The eluant is then acidified with HCl, breaking the dicarbonate complex, and forming UO_2Cl_2. This is precipitated with hydrogen peroxide (H_2O_2) forming hydrated UO_4 as described in section 3.7. The uranium peroxide is then dried, and the product "yellowcake" packaged for transport.

9.2.2 Uranium - Naturally Occurring Radioactive Material

Uranium is widely distributed around the world with an average concentration in the earth's crust of 4 PPM. Uranium is a heavy metal, and is naturally radioactive. Natural uranium contains three isotopes 238-U (99.3%), 235-U (0.7%), and 234-U (0.006%). 238-U constitutes one of the main primordial radioactive decay series, and has a long radioactive decay half-life of 4.5 billion years.

238-U decays to 234-Th by alpha emission. Since 238-U has a long half-life, and its immediate decay progeny (234-Th, 234-Pa, and 234-U) have relatively much shorter half-lives, these isotopes are in secular equilibrium with the 238-U decay. Because of 238-U's long half-life, the specific activity of natural uranium is unusually low (0.68 µCi/g 10 CFR 20 App. B Footnote 3). With a half-life of a quarter of a million years, 234-U will not decay to produce significant progeny for several thousand years with a half-life of a quarter of a million years.

In the decay from 238-U to 234-U, alpha, beta, and gamma radiations are emitted. Radioactive emission include two alphas of about 4 MeV of energy each, five different betas with E_{max} ranging from 0.1 to 2.3 MeV, and seven gamma rays all of either rare frequency, or low energy of about 63 to 92 keV. A 55 gallon drum of yellowcake comes into secular equilibrium with 234-Th, and 234 Pa within several months of production. Measurement at

30 cm from the surface of the drum will yield an external exposure rate of 2 mrem/hr.

9.2.3 Metabolism and Toxicity

Natural uranium is primarily an internal hazard, and the chemical toxicity far exceeds the radiological hazard as explicitly stated in 10 CFR 20.1201(e). Uranium metabolically behaves somewhat like calcium, and will deposit on the bone surfaces. The three major organs which will receive the largest radiological dose from intake of uranium are the lung, bone, and kidney.

Table 9.2-1. Organ Dose Conversion Factors for Inhalation of Natural Uranium (Federal Guidance Report No.11 EPA-520/1-88-020 1988; secular equilibrium of 234-U with 238-U; class W)

Organ	Dose Conversion Factor (Sv/Bq)
gonad	7.11×10^{-9}
breast	7.13×10^{-9}
lung	1.51×10^{-5}
red marrow	2.04×10^{-7}
bone surface	3.12×10^{-6}
thyroid	7.12×10^{-9}
remainder	2.70×10^{-7}
Total:	1.87×10^{-5}

Most of the uranium is excreted out of the body, mostly contained in the feces, and a smaller fraction in the urine. The urinary clearance can vary widely depending on the solubility of the chemical form, and whether the intake pathway is ingestion, or inhalation. Soluble uranium will rapidly be eliminated while insoluble uranium will slowly convert to a soluble form in the body. Nephrons in the kidneys work hard to eliminate the heavy metal from the blood stream. Sufficient acute intakes of uranium will cause the kidneys to swell, with the risk of infection, and slightly higher intakes will cause permanent damage in the kidneys.

9.3 Uranium Work Area

Any area in which employees potentially have access to yellowcake, i.e. product material, will be defined as a Uranium Work Area. The Uranium Work Area is within the Restricted Area. Offices, eating, drinking, and smoking areas will not be Uranium Work Areas, will not contain product material, nor will the employee(s) in these areas have access to yellowcake, and are also in the Restricted Area.

Areas which potentially contain yellowcake, and are candidates for designation as Uranium Work Areas are: the Filter Press Area, Elution Area, IX, and Sandfilters, RO Unit Area, Dryer Area, and YC Drum Storage. Engineering controls, and surveys will help monitor, and maintain airborne yellowcake within these designated areas. Additionally, employees will be required to survey for alpha contamination before leaving the Uranium Work Area.

Consistent with PBLC format, HRI will develop an SOP which describes the details of the areas which are designated Uranium Work Areas.

9.4 Instrumentation, Calibration, and Surveys

9.4.1 Instruments

Table 9.4-1 summarizes the types of radiation detection instruments which will be used at the CUP. All radiation monitoring, sampling, and detection equipment will be calibrated at least annually, and after each repair. The calibration records will be maintained on site.

Detector which will be used by HRI include ZnS scintillators, GM pancake probes, and NaI scintillators. Scintillation probes incorporate a photo multiplier tube (PMT). Filter air samples, and surface material swipes will be counted for alpha using a ZnS scintillator filter sample counter, and for alpha, and beta using an end window GM detector. External exposure will be monitored using a NaI-PMT detector which has a high efficiency for detecting gamma.

In addition, passive detectors such as TLD's, or electrolyte radon cups will be used in conjuction with the instruments below to monitor for maximum potential exposures. A few instruments most commonly used are listed in Table 9.4-1.

Table 9.4-1. Radiation Instrumentation Types, and General Specifications

1. Alpha Filter Sample Counter

·Scintillator: ZnS (Ag)
·Operating Voltage: 0.5-1.2 kV
·Weight: 1.9 kg
·Window: 0.4 mg/cm2
·Sample Holder: O-ring sealed stainless steel slide
·Sample Size: 2.54 cm diameter, 1.5 mm thick
·Tube Assembly: 3.8 cm diameter magnetically shielded photomultiplier tube
·Dynode String Resistance: 100 MW
·Compatibility: Model 177.

2. Pancake G-M Detector

·Window: 1.7 mg/cm2 mica, 15 cm2 active, 12 cm2 open
·Operating voltage: 0.9 kV
·Halogen quenched G-M
·Dead Time: 80 us
·Construction: Al housing, optional Pb shield
·Weight: 0.5 kg
·Compatibility: Models 3 and 177.

3. End Window G-M Detector

·Window: 1.7 mg/cm2 mica, 6 cm2 active, 5 cm2 open
·Operating voltage: 0.9 kV
·Halogen quenched G-M
·Dead Time: 200 us
·Construction: Al housing
·Weight: 0.5 kg
·Models 3 and 177.

4. Alpha Scintillator

·Scintillator: ZnS (Ag)
·Window: 0.8 mg/cm2 aluminized mylar, 76 cm2 active, 50 cm2 open
·Tube Assembly: 3.8 cm diameter magnetically shielded photomultiplier
·Dynode String Resistance: 100 MW
·Operating Voltage: 0.5-1.2 kV
·Weight: 0.9 kg
·Compatibility: Model 177.

5. General Purpose Survey Meter - Model 3

·Compatible Detectors: G-M, scintillation
·Threshold: 30 mV
·Weight: 1.6 kg
·Meter Dial: 0-2 mR/hr or 0-5k cpm
·Multipliers: x0.1, x1, x10, x100
·High Voltage: Adjustable 0.2-1.5 kV

6. Alarm Ratemeter - Model 177

·Compatible Detectors: G-M, scintillation
·Alarm Set: front panel with lock
·Reset: push-button to reset alarm
·Power: 120 VAC, 60 Hz single phase, <100 mA
·Battery: 6 V Pb-acid rechargeable, life of 50 hours in non-alarm condition
·Weight: 1.9 kg
·Meter Dial: 0-500 cpm, 0-1.5 kV
·Multipliers: x1, x10, x100, x1k
·Threshold: Adjustable 10-100 mV
·High Voltage: 0.2-1.5 kV
·Response: Fast - 4 seconds, Slow - 22 seconds for 10% to 90% of final reading

***Instrument Manufacturer**

Ludlum Measurement
P.O. Box 810 - 501 Oak Street
Sweetwater, TX 79556

9.4.2 In Plant Surveys

The process areas described in Table 9.4-2 are subjected to the surveys listed in Table 9.4-3. These surveys are described in more detail throughout this Section.

9.5 Environmental Monitoring

Environmental monitoring will generally follow the schedule shown on Table 9.5-1. All environmental monitoring will begin at each station, for each media being sampled, three months before operations begin.

All effluent releases will be subject to release limits specified in 10 CFR Part 20. HRI will not inject lixiviant prior to NRC'c review, and approval of a SOP level detail environmental monitoring plan. The plan will indicate SOPs such as sampling methods, and equipment, analytical procedures, and lower limits of detection. The plan will also indicate proposed environmental monitoring locations based on "as built" construction, and provide the rational for their selection. The approved NRC monitoring plan will form the basis for HRI's operational SOP which will describe the details of the environmental monitoring program.

9.6 External Radiation Exposure Monitoring Program

9.6.1 External Radiation Monitoring Plan

All personnel are issued dosimeters for at least the first year of operations. TLD personnel badges measure the external exposure to the individual on site. On at least a quarterly basis, the badges are read by the vendor, and reported on NRC Form 5, or equivalent. Issued TLDs are of a design for measuring mixed beta, and photon mixtures to accurately characterize the deep, eye, and shallow dose equivalents.

After the first year of operations, the monitoring data collected from these badges will be recorded, and reviewed to determine if exposures exceed the 500 mrem administrative action limit. If it is documented that after the first year of production operations that the annual dose to workers at assigned project locations is less than 10 percent of the 5 rem annual limit contained in 10 CFR 20.1201(a) then personnel TLD monitoring may be reduced, or eliminated at those locations at the descretion of the RSO.

Table 9.4-2. Process Area Radioactivity Monitoring Location.

All Process Facilities

1. Filter Press Area and YC Slurry Storage
Gamma - (TLDs)one on each yellowcake storage tank and one next to the filter press
Radon Progeny - one

2. Elution Area
Gamma - (TLDs) one at the base of barren eluant vessels and one between the eluant columns
Radon Progeny - one between the sand filters and the IX columns

3. IX and Sandfilters
Gamma - (TLDs) one between IX columns and sand filters
Radon Progeny - two at the IX and one at the sand filter.

4. RO Unit Area
Gamma - (TLDs) one between IX columns, one on the filter platform, one between the RO water storage tanks, one RO unit, and one between the cleaner tanks
Radon Progeny - one located by the IX columns

5. Chemical Storage Pad
Gamma - (TLDs) one located on the chemical storage pad

6. Exit Points
Alpha - thin window scintillator with an alarm rate meter

Areas only Concerning the Crownpoint Central Plant

7. Dryer Area
Gamma - (TLDs) one in the office, the shower, and the dryer room
Uranium - (low volume pump) continuous particulate filter sampling
Radon Progeny - one

8. YC Drum Storage
Gamma - (TLDs) one located central to the storage
Radon Progeny - one

**Additional monitoring are conducted or eliminated at the RSO's discretion.*

TABLE 9.4-3

SUMMARY OF SURVEY FREQUENCIES

Type of Survey	Type of Area	Survey Frequency	Lower Limit of Detection
1. Yellowcake	Filter press Special maintenance involving high air-borne concentrations of yellowcake.	Monthly grab samples Extra breathing zone grab samples.	1×10^{-11} uCi/ml
	Dryer Building downwind of Dryer Building	Continuous	
2. Radon Daughters	Scaffolding	Monthly radon daughter grab samples.	0.03 WL
	Tanks	As needed.	
3. External Radiation: Gamma	Throughout process facility	Quarterly	.1 mrem/hr.
4. Surface Contamination	Yellowcake areas	Daily	Visual
	Eating rooms, change rooms, control rooms, offices	Monthly	5,000 dpm alpha per 100 cm^2
5. Skin and Personal Clothing	Yellowcake workers who shower	Each day before leaving	1,000 dpm alpha per 100 cm^2
	do not shower		
6. Equipment to be released.	Equipment to be released that may be contaminated	Once before release	5,000 dpm alpha per 100 cm^2

Table 9.5-1
Environmental Monitoring
for Churchrock, Crownpoint and UNIT I Facilities

Type of Sample	Number	Location	Method	Frequency	Frequency	Type of Analysis
Air	3 (1 from each location)	Upwind and downwind of the plant site and at the nearest residence or occupied structure within 10 km of the plant site.	Continuous Track Etch	One sample per calendar year.	Each sample	RN-222
Process Fluids	1 from each lixiviant intake. 1 from lixiviant outlet.	Lixiviant trunk lines in amount of process	Grab	Quarterly	Each sample	RN-222
Water Groundwater	1 from each well	Potable, livestock, and irrigation water supply wells within a 2-1/2 mile license area.	Grab	Quarterly	Each sample	Natural U, RA-226, gross alpha, gross beta, pH
Water Monitor Wells	1 from each well	As designated in ED discharge plan.	Grab	2 samples per month	Each sample	Conductivity Cl, U, HCO3
Water Surface Water	1 from each impoundment and a minimum of two from each stream	Permanent impoundments and upstream and downstream in surface waters passing through the license area; also adjacent impoundments subject to drainage from the license area.	Grab	Quarterly	Each sample	Natural U and total and soluable RA-226
Sediment, Soil and Sludge Sediment	1 from each impoundment and a minimum of 2 from each stream	At surface water sampling locations	Grab	Annually	Each sample	Natural U and RA-226
Soil	1	Septic system drain field	Grab	Prior to requesting termination of license	Each sample	Natural U and RA-226
Sludge	1	Septic tank	Grab	Prior to sludge removal from tank and prior to requesting termination of the license.	Each sample	Natural U and RA-226

Consistent with the PBL format, HRI will develop a Standard Operating Procedure (SOP) which addresses the methods which will be used to establish, and record all doses to each employee from internal, and external sources received at the CUP.

9.6.2 External Radiation Monitoring Surveys

Quarterly surveys will be performed at specified locations throughout the Satellite buildings, and CP to assure that areas requiring posting as "Radiation Areas" are identified, posted, and monitored to assess external radiation conditions. "Radiation Areas" will be those areas exhibiting 5 to 100 mrem per hour at a distance of 30 cm from the source.

9.7 Airborne Radiation Monitoring Program

9.7.1 Airborne Uranium Particulate Monitoring

There is no potential for exposure to ore dust at the Crownpoint Uranium Project since the facility is an *in situ* uranium mine. However, there is the potential for exposure to yellowcake dust in certain areas of the CUP. All areas, including the filter press, drying, and packaging areas, have a potential for exposure to yellowcake dust.

There will be a continuous monitoring of airborne uranium particulates at the drying, and packaging areas. During periods of drying, and packaging activity, the filters of the continuous air monitors will be changed, and analyzed every several days as a decrease in airflow through the filter necessitates. At times when the dryer is operated discontinuously, the airborne monitor will be operated, and the filter analyzed for only the period of batch operation. During periods that drying, and packaging activities are not occurring, the filters will be changed, and analyzed on a weekly basis.

When non-routine work activities are performed in an area, or manner that could result in exposure to uranium particulates, area air samples, or breathing zone samples will be utilized to determine airborne uranium particulate levels.

Areas of the CUP, outside the drying, and packaging areas, and Satellite facilities will be monitored on a quarterly basis for airborne uranium. For all potential exposures, in the event that bioassay data is unavailable to quantify actual intakes, time studies, and/or actual occupancy times will be used to estimate the employees' exposure.

Consistent with the PBL format, HRI will develop a Standard Operating Procedure (SOP) which addresses the methods which will be used to monitor air particulates in the dryer at the CUP.

9.7.2 Radon Daughter Monitoring

Radon progeny will be routinely monitored on a monthly basis at the satellites, and the CCP.

Routine exposures to radon daughters will only be determined within the processing plant. The method of analysis is the modified Kusnetz method, or other commonly accepted method of measurement. Measurements are made in locations, and at times when there is a potential for the release of radon, or radon progeny.

Consistent with the PBL format, HRI will develop a Standard Operating Procedure (SOP) which addresses the details of radon monitoring at the CUP.

9.7.3 Airborne Effluent Environmental Monitoring

To ensure compliance with 10 CFR 20.1301, 20.1302, and 20.1501, HRI will maintain a continuous air monitoring program at three separate locations: upwind of the CPP, or satellite facility, downwind from the CPP, or satellite facility at the restricted area boundary, and downwind at the nearest residence. These sampling locations contain passive gamma, and radon monitoring devices that are changed out on a quarterly basis.

In addition to the monitoring described above, continuous passive monitoring for gamma, and radon will be performed at two locations (one upwind and one downwind) at the satellite facilities. These monitoring devices will be exchanged quarterly, and the results documented, and maintained on site.

9.8 Employee Exposure Records

Employee exposures at the CUP are monitored in accordance with USNRC Regulatory Guide 8.34, "Monitoring Criteria and Methods to Calculate Occupational Radiation Doses." The employees will be monitored for internal exposure to yellowcake dust, see Section 9.9 "Bioassay Program", patterned after NUREG 8.22 "Bioassay at Uranium Mills". A bioassay program will be utilized as a means of ensuring the adequacy of the monitoring, and respiratory protection programs for protection from airborne uranium dust, and from 222-Rn, and its decay progeny. HRI will advise each worker of their annual dose pursuant to the provisions of 10CFR20.2106. A quarterly tabulation of annual dosage for all employees will be posted on a bulletin board in the central offices of the CCP, and the Satellites along with all other regulatory postings. The table will contain all the provisions of NRC Form 5, or equivalent for each employee.

Declared pregnant women will have additional materials tabulated, and posted stating the annual dose to the embryo-fetus.

9.8.1 Time Period Airborne Exposure

In the event that bioassay data is unavailable to estimate actual intakes of yellowcake, employee exposure to airborne soluble uranium will be estimated for routine activities. The exposure estimates will be based on exposure times, and the concentrations of airborne uranium as determined from routine air monitoring, or non-routine air monitoring (i.e. breathing zone monitoring, or specific area air monitoring).

Routine exposures to uranium, and radon daughters will be only determined only for workers routinely exposed to airborne radionuclides in concentrations which are likely to result in annual exposures in excess of 10% of the ALI without respiratory protection. Routine exposures will be estimated using exposure times generated from semiannual time studies.

Non-routine exposures to uranium will result from performing non-routine operational, or maintenance tasks that have the potential for creating a significant exposure to airborne uranium. These types of exposures will be monitored utilizing a Radiation Work Permit (RWP). The RWP will specify the types of radiological monitoring required for the task, and the protective equipment, and clothing employees must wear while performing the task. The sampling results will be evaluated, and documented. This data, together with the employee's time in the area, will be used to estimate the non-routine exposure. Each employee's routine, and non-routine exposure to airborne uranium will be recorded weekly, and summarized annually.

Routine employee exposure to radon daughters will be determined by measured working levels. Similar to non-routine uranium exposures, non-routine radon daughter exposures will be monitored utilizing an RWP. Routine exposure times will be determined by semi-annual time studies, or actual occupancy times. Each employee's routine, and non-routine exposure to radon daughters will be recorded weekly, and summarized annually.

9.8.2 Airborne Uranium Exposure Calculation

The intake of uranium of soluble class W during the weekly, or annual period being evaluated is estimated using the following equation:

$$I_u = (\Sigma (\chi_i)(\Delta t_i)/(DAC)) * (PF)$$

from i=1 to n

Where:

I_u - uranium intake (DAC-hours)

Δt_i - time worker is exposed to concentration (hours)

χ_i - average concentration of uranium in the air (μCi/ml)

DAC - the derived air concentration value for soluble class W uranium from Appendix B of 10 CFR 20 (3E-10 μCi/ml per DAC)

PF - respirator protection factor from Appendix A of 10 CFR 20

n - number of exposures during the period of evaluation

9.8.3 Radon Progeny Exposure Calculation

As was discussed in Section 9.7.4, the modified Kusnetz, or commonly acceptable method for determining exposure to radon daughters will be utilized at the URI's Crownpoint *in situ* uranium project, and satellite facilities. From the monitoring data collected, the employees intake of radon progeny will be calculated using the following equation:

$$I_r = (\Sigma (WL_i)(\Delta t_i)/(DAC)) * (PF)$$

from i=1 to n

Where:

I_r - radon daughter intake (DAC-hours)

Δt_i - time of exposure to concentration WL_i (hours)

WL_i - average number of working levels in the air

DAC - the derived air concentration value for radon daughters from Appendix B of 10 CFR 20 (0.33 WL per DAC)

PF - respirator protection factor

n - number of exposure periods during the year

9.8.4 Bioassay Intake Calculation

When urine bioassay data is available, and the bioassay indicates significant uranium intake, worker airborne uranium intakes are calculated by using an intake conversion factor (ICF) similar to NUREG 8.22, and standards in HPS ANSI "Bioassay Programs for Uranium". All uranium intake calculations are of soluble class W. Calculations of chronic vs. acute intake will be determined at the descretion of the RSO. Subsequent bioassays may be necessary to confirm an intake, and will supersede an unconfirmed previous bioassay.

$$I_{u\ acute} = \Sigma\ C_{u,i}\ /ICF_{acute,i}\ \text{and}$$

$$I_{u\ chronic} = \Sigma\ C_{u,i}\ \Delta t_i\ /ICF_{chronic,i}\ ,$$

$$\text{from } i=1 \text{ to } n$$

Where:

$C_{u,i}$ - urine bioassay concentration (μg/L)

$I_{u\ acute}$ - uranium acute intake (μg)

$I_{u\ chronic}$ - uranium chronic intake (μg)

Δt_i- time duration of worker chronic for bioassay i (days)

$ICF_{acute,i}$ - acute intake conversion factor for bioassay i (/L)

$ICF_{chronic,i}$- chronic intake conversion factor for bioassay i (days/L)

n - number of intakes or bioassays during the period of evaluation

9.8.5 Action Levels Requiring Notification

Section 20.2203 of 10 CFR requires that overexposure reports be made to the appropriate NRC Regional Office if the intake of uranium, and/or radon exceeds the quantities specified in 10 CFR 20.1201. If the following exposure limits will be exceeded at the CUP, HRI will notify NRC.

a. Soluble Uranium - if an employee has an intake of more than 10 mg of soluble uranium in one week. This intake is in consideration of chemical toxicity.

b. Total Effective Dose Equivalent (TEDE) - if an employee exceeds the TEDE annual limit of 5 rem.

c. If an employee exceeds 4 WLM ^{222}Rn Progeny.

9.8.6 Administrative Action Levels

An administrative action level will be set at 3 mg of soluble uranium for a calendar week. An administrative action level will be set at 130 DAC-hours for exposure to insoluble uranium, and/or radon daughters for any calendar quarter. If the action level is exceeded, the RSO will initiate an investigation into the cause of the occurrence, determine any corrective actions that will reduce future exposures, and document the corrective actions taken. Results of the investigation will be reported to management.

The results of the TLD badges will be evaluated on a quarterly basis, and an administrative action level will be set at 300 mrem per quarter. If an employee's exposure exceeds this level, the RSO will investigate the reason for the exposure, and initiate corrective measures to prevent a recurrence.

The results of the bioassay program also will be used to evaluate the adequacy of the respiratory protection program at the facility. An abnormally high urinalysis will be investigated both to determine the cause of the high result, and determine if the exposure records adequately reflected that such an exposure may have actually occurred.

9.8.7 Airborne Radioactivity Areas

Any area, room, or enclosure will be designated "Airborne Radioactivity Area" as defined in 10 CFR 20.1003, if at any time the uranium concentration exceeds 1 DAC (3E-10 μCi/ml). It is anticipated that only the yellowcake dryer area will be posted as Airborne Radioactivity Areas as concentrations of soluble uranium may at times exceed 3E-10 μCi/ml. Because the predominant form of airborne uranium in these areas is comprised of yellowcake dried at 100 degrees Celsius, the uranium DAC for solubility class W is used (3E-10 μCi/ml).
Additionally, areas will be posted as "Airborne Radioactivity Areas" in the case that an individual present in the area without respiratory protection could exceed, during the hours an individual is present in a week, an intake of 10 percent of the ALI. Airborne radioactivity areas will be posted in accordance with 10 CFR 20.1902. HRI will avoid posting radiation hazard signs in areas that do not require them.

9.9 Bioassay Program

9.9.1 Persons to Be Monitored

Bioassays will be performed for all workers who are routinely exposed to airborne yellowcake, or excessive levels of yellowcake, such as may occur when maintenance work is performed in yellowcake areas.

9.9.2 Type of Bioassay

Bioassays will be by means of urinalysis capable of detecting the uranium content of the urine with a sensitivity of at least 1 μg/L of urine. Results will be obtained within 20 days of the collection, and corrected to standard urine specific gravity of 1.02.

$$C_{u\ corrected} = C_{u\ measured}\ (1.02 - 1)/(S_g - 1)$$

Where:

$C_{u\ corrected}$ - uranium concentration in urine corrected to standard specific gravity of 1.02 (µg/L)
$C_{u\ measured}$ - measured uranium concentration (µg/L)
S_g - measured specific gravity of the urine bioassay specimen

If an outside laboratory is used, results exceeding corrected concentration of 30 µg/L will be reported by telephone.

9.9.3 Frequency of Bioassay

Bioassays are conducted at least once each month for workers routinely exposed to yellowcake. This generally applies to individuals who are assigned to the Uranium Work Area. Individuals who work within the restricted area but not in the Uranium Work Area are not subject to routine bioassay.

Declared pregnant workers will have bioassay conducted at a minimum of once per month regardless of job assignment.

9.9.4 Actions Based on Bioassay Results

A corrected value of 30 µg/L under equilibrium conditions is considered the limiting value a worker may have for chemical toxicity. A value of 130 µg/L obtained within two weeks following a single intake of yellowcake indicates a value significantly large to cause kidney damage, according to the U.S. Nuclear Regulatory Commission. In view of this, the following actions will be taken:

a. **Less than 15 µg/L** - none

b. **15 to 30 µg/L** -

   1. Confirm results (repeat urinalysis).
   2. Attempt to identify cause of high exposure.
   3. Take corrective measures, and/or limit worker exposure.

c. **Greater than 30 µg/L** -

1. Take actions as given above for 15-30 µg/L.
2. Notify the NRC in writing.
3. Determine whether other workers could have been exposed, and perform additional bioassay measurements on them.
4. Consider work restrictions to assure the worker does not exceed a uranium concentration of 30 µg/L in urine.

d. Greater than 30 µg/L for four consecutive bioassays or greater than 130 µg/L for any 1 test -

1. Take actions given in c.
2. Have additional urine samples tested for albumin.

9.9.5 Prevention of Specimen Contamination

Specimens are normally collected at the beginning of the work day before contamination in the workplace is possible. Clean, disposable containers are used, and the worker must wash his/her hands carefully prior to voiding, and then clearly print first, and last name, date of specimen donation, and Social Security Number.

9.9.6 Quality Control

The bioassays will be processed along with known control specimens of 15, 30 mg/L, and one blank to provide a means of assuring accuracy of the tests. New employees will be required to donate a baseline urine specimen for analysis. A program which tests for proteins using a dip-stick indicator will be established under the RSO's discretion in the RSO's lab by a designee soon after receiving the specimen. Then, an appropriate method of preservation will be employed for specimens which are stored for longer than one week according to ANSI standards of urine uranium bioassay sample preservation (such as refrigeration, or the addition of a small amount of HCl). The RSO has discretion in requesting a 24 hour urine specimen collection (1-2 L) for confirmatory analysis.

URI maintains a Standard Operating Procedure (SOP) which addresses current procedures for the bioassay program.

9.10 Contamination Control Program

The primary sources of potential surface contamination at the Crownpoint Uranium Project will be associated with precipitation, drying, and packaging activities. The recovery, and elution portions of the process will not present a significant surface contamination problem except for dried spills, or when special equipment maintenance is required. The primary method for control of surface contamination will be instruction in, and enforcement of, good housekeeping, and personal hygiene practices. Any visible yellowcake, or production fluid spills will be cleaned up as soon as possible to prevent drying, and possible suspension into the air which could pose an inhalation hazard. Plant operators will be instructed in the proper use of equipment, and the prevention of spills, and solution leaks at various stages of the process. Inadvertent contamination of designated clean areas will be controlled by instructing employees not to enter such areas with clothing, or equipment contaminated with radioactive materials. If yellowcake is detected in a designated clean area, the RSO will be notified immediately, the area will be promptly cleaned, and an investigation into the source of the contamination will be performed.

To ensure these administrative controls will be effective in controlling surface contamination, alpha contamination surveys will be performed monthly in process areas, and in designated clean areas.

Table 9.10-1 provides the limits for surface contamination.

Table 9.10-1 Limits for Release to Uncontrolled Areas

Nuclide	Average[a]	Maximum[b]	Removable[c]
U-nat	5,000 dpm/100 cm2	15,000 dpm/100 cm2	1,000 dpm/100 cm^2
226-Ra	100 dpm/100 cm2	300 dpm/100 cm^2	20 dpm/100 cm^2

a. Averaged over no more than 1 m^2.

b. Applies to an area of not more than 100 cm^2.

c. Determined by smearing with dry filter, or soft absorbent paper, applying moderate pressure and assessing the amount of radioactive material on the smear.

Source: Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors," and "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use, or Termination of License for Byproduct, Source, or Special Nuclear Material."

9.10.1 Surface Contamination Control

Routine surveys in the Central Processing, and Satellite Facilities will consist of both a visual inspection for obvious signs of contamination, and instrument surveys to determine total alpha contamination. If the total alpha survey indicates total contamination greater than 1000 dpm/100 cm^2, a smear survey will be performed to determine the removable contamination. Results will be documented on the survey data sheet.

In non-Uranium Work Areas such as lunch rooms, offices, and change rooms, if the total alpha survey indicates contamination in excess of 1000 dpm/100 cm^2 (i.e. 20% of Table 9.10-1 removable limits; a smear test will be performed to assess the level of removable alpha activity. If smear test results indicate removable contamination greater than 1000 dpm/100 cm^2, the area will be cleaned promptly, and resurveyed. The RSO will investigate the cause of the contamination, and implement corrective action to minimize the potential for a recurrence.

Uranium processing equipment that must be removed for maintenance, or repair will be thoroughly decontaminated to prevent the possibility of contamination in the maintenance shop. Any materials, or equipment being released from the project site to an unrestricted area will be surveyed for contamination prior to release. Should the survey indicate contamination in excess of the Table 9.10-1 limits, the equipment/material will be decontaminated, and surveyed again. The survey results will be documented, and maintained on site.

9.10.2 Personnel Contamination Control

Employees will maintain change rooms, showers, and lockers for clean clothing. An operable, and appropriately calibrated alpha survey meter will be made available for employee use at the exit of the change room.

Employees will be instructed in the use of the survey meter, techniques for minimizing contamination, for maintaining good industrial hygiene, and in basic decontamination methods. Also, employees will be instructed on methods, and procedures for good housekeeping practices within process areas to minimize the potential for contamination of personnel, and equipment. The RSO, or designee will perform unannounced spot check surveys for alpha contamination on workers leaving the Uranium Work Areas. These unannounced spot check surveys will be conducted on at least a quarterly basis.

Employees working in the precipitation, drying, and packaging areas, as well as those involved in process equipment maintenance, or repair, will maintain appropriate protective clothing, and equipment. Protective clothing will be laundered on site, or if a disposable type, will be disposed in a facility licensed to accept such wastes.

All employees with potential exposure to yellowcake, or yellowcake dust may shower, and change clothes each day prior to leaving the site. An employee who showers, and changes clothes will be considered to be free of significant contamination. In lieu of showering, employees who work in the Uranium Work Area are required to survey their clothing, shoes, hands, face, and hair with an "frisk", alpha survey instrument prior to leaving the site. These surveys, and/or showers will be documented, and maintained on site. Additionally, prior to entering a designated clean area (e.g. lunchroom) from processing areas, employees will be required to wash their face, and hands to ensure complete removal of possible contamination.

9.10.3 Transports and Shipments

Transport surveys demonstrate that the exposure levels are below the regulatory limits, and the truck surfaces are free of radioactive material.

9.10.3.1 Yellowcake Drum Transport Survey

Packaged drums filled with dry yellowcake located on the storage pad will be smear surveyed using filter paper before shipment. The truck, and trailer loaded with yellowcake drums will be surveyed for external exposure rate. The surface swipes, and external exposure surveys will be recorded, and included as part of the YC drum shipment papers. Shipment papers will include measured contents of each drum, drivers agreement, bill of lading, and instructions in case of accident, or spill.

Limits for Yellowcake Drum Transport

• removable alpha[1]	2,200 dpm/100 cm^2
• removable gamma/beta[1]	22,000 dpm/100 cm^2
• external exposure rate[2] at skin of trailer	2 mrem/hr

[1] 49CFR173.443
[2] 49CFR173.400

9.10.3.2 Yellowcake Drum Transport Labeling

Yellowcake is classified by the Department of Transportation as radioactive material of Low Specific Activity (LSA) according to 49 CFR 172-178. Each drum will be labeled on two sides with the drum number, net yellowcake weight, and radioactivity stickers including LSA, and Caution - Radioactive Material. Radioactive Material sticker is magenta against yellow background, and contains the following information:

Caution
Radioactive Material

Handle Carefully
No person will remain within 3 feet of this container unnecessarily
Principle radioactive contents: Natural Uranium (Oxide)
Activity of contents: 50 mCi (maximum)
Estimated radiation level at package surface
when packaged: 3.0 mrem/hr

HRI, Inc.
2929 Coors Rd., Suite 101
Albuquerque, NM 87120-2929

9.10.3.3 Slurry Transports

Yellowcake slurry will be transported in DOT approved slurry trailers which are placarded according to DOT specifications. Slurry transports will be surveyed before, and after positioning on the processing pad. Slurry transports will be surveyed in a manner similar to the drum transport survey using a portable external exposure rate meters. Filter swipe(s) will be taken, and counted for alpha.

Limits for Slurry Transports

·	removable alpha	1,000 dpm/100 cm^2
·	external exposure rate	200 mrem/hr

9.10.3.4 Shipping and Receiving Packages

All packages will be surveyed as soon as practicable after receipt, and prior to commercial ground carrier shipment. The RSO will be notified of any anticipated package shipments, and upon their receipt. The package will be surveyed for external exposure rate, surface alpha, and beta, and swipe survey for removable alpha, and beta. All packages will be required to have the DOT labeling for packages containing radioactive material with the correct UN number, and a Radioactive White I, Yellow II, or Yellow III label which includes the radionuclide(s), and quantity. For packages containing yellowcake samples for an independent laboratory analysis, they will also be labeled Low Specific Activity (LSA). Packages received will be assessed for degradation, or loss of containment integrity.

9.10.3.5 Trash Surveys

Office trash, and other materials which are free of process contamination are disposed of in a municipal land fill. Loads of trash are surveyed for gamma activity before leaving the site. No survey will exceed two times background at the surface of the trash trailer. Records are maintained on site.

9.11 Respiratory Protection

9.11.1 Introduction and Policy Statement

In accordance with Subpart H, "Respiratory Protection and Controls to Restrict Internal Exposure in Restricted Areas" of 10 CFR Part 20, "Standards for Protection Against Radiation" which permits licensees to make allowance for the use of respiratory protection in estimating exposures of individuals to airborne radioactive material, HRI will initiate a Respiratory Protection Program for the purpose of using the allowance similar to the U.S. Nuclear Regulatory Commission Regulatory Guide 8.15.

Whenever practicable, HRI will utilize engineering controls, such as ventilation, or process enclosure to preclude the use of respirators. However, when it is impracticable to apply process, or other engineering controls to limit concentrations of radioactive materials below those that define an airborne radioactivity area, other precautionary procedures, including increased surveillance, and air sampling, limitation of work times in the area(s), and respiratory protective equipment, will be used to maintain the intake of radioactive materials ALARA.

Respirators will be routinely used for certain operations within the dryer, and packaging areas, as well as for certain maintenance activities in these areas. Radiation work permits for non-routine jobs, and emergency situations may also require respirator usage. Employees will not enter areas where radioactive materials may exceed acceptable standards nor perform maintenance activities which may involve airborne releases until the RSO, or designee has evaluated the potential exposure, and selected the proper respiratory equipment, and other radiological protection controls.

9.11.2 Respiratory Protection Policies and Responsibilities

a. Respirators will be used only for operations where it is not feasible to prevent atmospheric contamination by effective engineering controls such as process enclosure, or ventilation. However, respirator use is no substitute for practicable engineering controls. Therefore, respirators will be used only while engineering controls are being evaluated/instituted, and during maintenance in tanks, or other enclosures that routinely contain radioactive materials, and/or other toxic materials. Only approved, or certified respiratory equipment will be used.

b. Respirators will be used routinely for operations within the drying, and packaging areas, and for certain other maintenance activities. Radiation work permits for special jobs, and emergency situations may also require respirator use. Employees will not be allowed to enter areas where radioactive contaminants may exceed acceptable standards nor perform maintenance activities which may involve airborne releases until the Radiation Safety Officer (RSO), or designee has evaluated the potential exposure, selected the proper respiratory equipment, and implemented other health physics controls as may be appropriate for the situation.

c. Employees will leave an area where respiratory protection is required at anytime for relief from respirator use in the event of equipment malfunction, physical, or psychological distress, procedural, or communication failure, significant deterioration of operating conditions, or any other condition that may require such relief.

d. Any individual required to wear a respirator to perform routine, or nonroutine tasks is also required to have a shaven face where nothing interferes with the seal of tight-fitting face pieces against the skin.

9.11.3 Employees Responsibilities

a. Using the respirator in accordance with instruction, and training provided by the RSO, or designee. For some types of respirators providing protection for individuals wearing corrective glasses is a serious problem. A proper seal cannot be established if the temple bars of the eye glasses extend through the sealing edge of the full facepieces. When a worker must wear corrective glasses as part of a facepiece, the facepiece, and lenses will be fitted by a qualified individual to provide both good vision, comfort, and a gas-tight fit.

b. Informing his Supervisor of any personal health problem that could be aggravated by the use of respiratory protection equipment.

c. Not modifying, or in any way altering the manufacturers design of the respirator.

d. Pre-use inspection, and reporting any observed, or suspected malfunctioning respirator to the RSO, or designee.

e. Using only those brands, and types of equipment for which he has been trained to use, and can obtain a satisfactory fit.

f. Checking the seal of the respirator by appropriate means prior to entering a harmful atmosphere.

g. Notifying his supervisor, the RSO, or designee whenever it is necessary to enter an area in which airborne radioactive contaminants may exceed acceptable standards, for the purpose of performing non-routine maintenance, or activities for which a standard operating procedure does not exist.

9.11.4 Supervisors Responsibilities

a. Notifying the RSO, or designee whenever it is necessary for an employee to enter an area in which airborne radioactive contaminants may exceed acceptable standards for the purpose of performing non-routine maintenance, or activities for which a standard operating procedure does not exist.

b. Enforcing the use of respirators in situations that require respiratory protection.

c. Consulting with the RSO, or designee for evaluation of exposure hazards whenever it is suspected that airborne radioactive or, toxic contaminants could exceed acceptable standards.

d. Notifying the RSO, or designee of any employee known to have an active medical work restriction, and obtain RSO clearance for such employee prior to assignment of any job requiring the use of respiratory protection.

9.11.5 The RSO or Designee Responsibilities

a. Providing necessary respiratory equipment to protect the health of the employee.

b. Maintaining equipment in serviceable condition.

c. The selection, and fitting of employees with the proper respirator, as well as instructing them in the correct use, and maintenance of the respirator.

d. Random inspections of respirator use.

e. Evaluating employee exposures, and work conditions, including monitoring of airborne radioactive contaminant concentrations during the time the employees are working, and determining when a urinalysis is required similar to NRC Regulatory Guide 8.22.

f. Establishing, and keeping records as required.

9.11.6 Respiratory Protective Equipment Selection

Several types of respiratory protection equipment are available, and have been chosen to offer protection against potential airborne radioactive hazards to be encountered. The function of respirator type selection is assigned to the RSO, designee, or the Director of Safety.

a. Several factors govern equipment selection. These include:

1. Nature, and extent of the hazard.
2. Work requirements, and conditions.
3. Respiratory equipment limitation.

b. The types of respirators that may be used at the Crownpoint Uranium Project are those specified in Appendix A of 10CFR20.

c. Protection Factors. The overall protection given by a certain respirator is defined in terms of its protection factor (PF). These are outlined in Table I, US NRC Regulatory Guide 8.15, and 10 CFR 20 Appendix A.

The PF is a measure of degree of protection afforded by a respirator defined as the ratio of the concentration of contaminants outside the face mask, or hood to that inside the equipment under conditions of use. For example, an air purifying half-mask may be used for protection in atmospheres with a contaminant concentration up to 10 times the permissible exposure limit. In the case of employee-measured intake of airborne radioactive contaminants, the ambient concentration in the air is divided by the protection factor to determine actual intake. The PFs are based on laboratory tests which show how much leakage can occur between face piece seal, and the face on a cross-section of different facial types, and sizes after each wearer was properly fitted with various types of equipment. Therefore, the PFs may only be used on those people who are found to have a satisfactory fit with the device they are wearing. (See NRC Regulatory Guide 8.15, or 10CFR20 App. A for appropriate protection factors.)

d. Air-Purifying Respirators. Air-purifying respirators remove nonradioactive gases, and vapors, or any Particulates from the ambient air to make it suitable for breathing. Air-purifying media consist of fiber filters, or sorbents used individually, or in combination, and are contained in a suitable protective casing that is designed for attachment to the respirator facepiece, or breathing tube. A filter is a fibrous medium used for the removal of airborne solid, or liquid particulates from the air stream entering the respirator enclosure. They are designed for a single type of particulate, or for various combinations of particulates such as dust, fumes, and mists. The protection factors apply for air-purifying respirators only when high efficiency particulate filters [above 99.97% removal efficiency by thermally generated 0.3 ppm dioctyl phthalate (DOP) test] are used in atmospheres not deficient in oxygen, and not containing radioactive gas, or vapor respiratory hazards.

Sorbents are used for chemically removing toxic gases, and vapors from the airstream entering the respirator enclosure. The sorbents may be used singly, or in a mixture, and multiple layers to give protection against a single gaseous contaminant, a class of contaminants (e.g., organic vapor, or acid gases), or combination of gases, and vapors. They are not, of themselves, effective against particulates. They are not approved for use for protection against radioactive gases, or vapor unless their efficiency against the gas, or vapor of interest has been well established.

9.11.7 Respiratory Training

Persons administering the Respiratory Protection Program (i.e. training, respirator selection, respiratory integrity testing, etc.) will have at least one year of work experience relevant to applied health physics, radiation protection, industrial hygiene (or related work), and respiratory protection. This experience will involve working with respiratory protective equipment, cleaning, maintenance, and fit testing (not strictly administrative). Additionally, a thorough understanding of the facilities' process, and equipment, and the hazards generated will be required. The RSO, or designee will conduct respirator training. Every employee who needs to wear a respirator for health protection must be trained in the proper selection, maintenance, and use of the respirator, and its limitations. Respirator training will be documented on a respirator training completion form. Additionally, when respirators have been used in atmospheres containing airborne uranium, employees will participate in a bioassay program consisting of urinalyses similar to NRC Regulatory Guide 8.22.

Training consists of:

a. Fitting which will be done by the RSO, or trained designee.

b. Testing face piece-to-face seal under normal face/head movements that could cause leakage to ensure a proper fit. The face-to-facepiece seal will be tested using irritant smoke.

c. Learning how to wear, adjust, and test for proper fit before each wearing, including the positive, and negative pressure fit checks.

d. Identifying the locations, and times that respiratory protection is required.

e. Learning how to identify the various respirator cartridges, and types of contaminants that each cartridge is designed to protect against.

f. Learning the proper maintenance, inspection, and storage of respirator protection devices.

Any individual with an active work restriction (temporary or permanent) will consult with his supervisor, the RSO, or designee before using any respirator.

9.11.8 Medical Approval

Medical examination (approval) is required for anyone who needs, or may have the need to wear a respirator. The medical examination is required to determine that an individual is medically fit to use the respiratory equipment. The frequency of medical examinations will be determined by a physician prior to the initial fitting of respirators, and thereafter at a frequency determined by a physician. An examination will be given every 5 years up to age 35, every 2 years up to age 45, and annually thereafter. The approval will be documented by the tester on the respirator training.

9.11.9 Pre-Use Inspection Procedure

The respirator will be inspected before each use to ensure it is in good operating condition. Any damage, or defective parts will be replaced before use. The following inspection procedure will be performed:

a. The facepiece will be checked for cracks, tears, and dirt. The facepiece, especially the face seal area, will be checked for distortions. The face seal area material will be pliable - not stiff.

b. All valves will be examined for signs of distortion, cracking, or tearing. Valve seats will be inspected for dirt, or cracking.

b. The head straps will be intact, and have good elasticity.

d. All plastic parts will be examined for signs of cracking, or fatiguing. All the gaskets will be checked for proper seating.

e. The lens in the full face mask will be clear, and free from cracking, or crazing. It will be checked for embrittlement.

f. Full face respirators with gas mask type canister will require pre-inspection of the canister. The expiration date located on the side label will be checked. The respirator will not be used if the date has past. The respirator will not be used if the seal is missing over the bottom opening, or where it threads onto the face mask.

g. When using supplied air the air filtering system will be connected to the instrument air line. The filters in the air filtering system will be checked, and replaced if necessary. The air line hose will be inspected for cracks; the rubber will be pliable, not stiff. Additionally, the hose connecting fittings will be checked to insure they are in good working order.

9.11.10 Assembly Instructions

Appropriate cartridges (high efficiency, organic vapor, or, acid/gas or, combination) will be attached securely to the facepiece at the side inhalation openings.

9.11.11 Putting on the Full Face Respirator

The following will be performed for full face respirators in a non-contaminated area.

a. The head straps will be adjusted to their full extended position.

b. The facepiece will be donned by grasping the head strap harness with the thumbs through the bands, spread outward.

c. The harness top will be pushed up the forehead, brushing hair upward from the face seal area. The donner will continue pushing up, and over the head until the harness is centered at the rear of the head, and the chin is fitted into the chin cup.

d. The facepiece will be centered on the face, and the wearer will pull both lower (neck) head straps at the same time towards the rear.

e. The two upper (temple) head straps will be tightened.

f. The forehead head strap(s) will then be tightened.

9.11.12 Putting on the Half Mask Respirator

The following will be performed in a non-contaminated area.

a. The respirator will be placed over the mouth, and nose. Then the head harness will be pulled over the crown of the head.

b. The bottom straps will be placed in back of the neck, and hooked together.

c. Tightening will require pulling the ends of the head harness, and the neck straps.

9.11.13 Fit Check

Before entering an area containing a hazardous atmosphere, the respirator wearer will be required to test the tightness of the seal of the respirator facepiece to the face by performing a negative or, positive pressure fit check. At the CUP, an random smoke fit test will be used as a spot check. These fit checks will be as follows:

a. Positive Pressure Fit Check - Place palm of hand over exhalation valve cover, and exhale gently. If the facepiece bulges slightly, and no leaks between the face, and facepiece are detected, a proper fit will be obtained. If air leakage is detected, reposition the respirator on the face, and/or readjust the tension of the head-straps to eliminate the leakage. Repeat the above steps until a tight seal is obtained. If one cannot achieve a proper fit, do not enter the contaminated area.

b. Negative Pressure Fit Check - Place the palms of the hands (alternatively$_1$ either pieces of cardboard or, plastic) over the open area of the filter cartridge, inhale gently, and hold your breath for five to ten seconds. If the facepiece collapses slightly, a proper fit has been obtained. If air leakage is detected, reposition the respirator on the face, and/or readjust the tension of the head straps to eliminate the leakage. Repeat the above steps until a tight seal is obtained. If one cannot achieve a proper fit, do not enter the contaminated area. If a tight seal cannot be achieved contact the RSO or, designee. DO NOT ENTER THE AREA WHERE THE RESPIRATOR IS REQUIRED.

To check the full face respirator with supplied air, the air is closed off, and the wearer inhales gently. The wearer then holds their breath for 10 seconds. A good fit is indicated if the mask remains collapsed toward the face while holding ones breath.

Half mask respirators require fit testing EVERY time the respirator will be put on since it is more difficult to achieve, and maintain an adequate fit with half masks than with other face pieces. At Crownpoint, a smoke fit test will be used as a spot check.

9.11.14 Respirator Maintenance

a. The primary purpose of the maintenance program will be to ensure that respiratory protective equipment will be kept ready for use. This part of the program will be very important to insure the safety of the wearer. Respirators will be cleaned, and maintained under the direction of the RSO, or designee. Each employee will be responsible for maintenance, and cleaning of the respiratory equipment they are using. The maintenance program will include the following.

1. Employee training in the approved methods for maintenance, and cleaning of respiratory equipment.

2. The decontamination, cleaning, and disinfecting of respiratory protective equipment.

3. Inspection, and testing of the respirator components for integrity, and operability.

4. Replacement of defective components, when necessary.

5. Maintenance of auxiliary equipment.

6. Appropriate storage for respiratory protective equipment.

7. Spot checks by the RSO, or designee for respirator contamination, proper respirator usage, respirator component integrity, correct cleaning practices, and proper respirator storage.

b. Respiratory Protective Equipment Cleaning, Sanitizing, and Maintenance - Hygienic procedures will be required for respirators being issued for use in environments containing airborne radionuclides, or other air contaminants. When operating in the dryer, and packaging areas, the respirator will require frequent cleaning, thereby avoiding the potential for radioactive material contaminating the inside of the facepiece. The employee will be responsible for ensuring the respiratory equipment in use will be in good working order, and the inside of the facepiece will be contamination free. Emergency devices (SCBA) require cleaning after each use.

c. Placement of used respirators in a container designated for dirty/contaminated respirators, returning them to the Environmental Laboratory.

d. Removal of filter cartridges from respirators before washing.

e. Washing the respirator in a dish washer using liquid soap, such as LIQUI-NOX. Following the wash, all parts are allowed to air dry at room temperature.

f. Inspection of all components for wear or, deterioration, especially the inhalation, exhalation valves, and seats.

g. Replacement of any worn components. Replacement parts are kept in the Environmental/Radiation Safety Lab.

h. A random swipe survey to be performed by the RSO or, designee with the results recorded on the respirator survey form. If any respirator survey indicates an alpha activity greater than 100 dpm/100 cm fixed alpha, the respirator will require re-cleaning, and surveying again.

i. Storing of the respirator in a clean plastic bag. Bags are found in the warehouse or, the Environmental Radiation Safety Lab.

j. Random inspections by the RSO or, designee of both respirator fit, and conditions during periods of use by employees. Any employee found to have a poor fit, and/or a respirator that will be unserviceable will be removed from the area, the employee refitted, and/or the respirator repaired. No protection factor will be used for the period of time the employee had an improper fit or, unserviceable respirator.

Consistent with the PBLC format, HRI will develop a Standard Operating Procedure (SOP) which addresses updated procedures for the respiratory program.

9.12 Quality Assurance

HRI will establish a Quality Assurance Program for all radiological, and non-radiological effluent, and environmental (including ground water) monitoring programs at the CUP. This Quality Assurance Program will address elements discussed in USNRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams, and the Environment."

9.12.1 Program Objectives and Elements

Quality assurance comprises those planned, and systematic actions which will be necessary to provide adequate confidence in the results of a monitoring program. Quality control will include those quality assurance actions that provide a means to control, and measure the characteristics of measurement equipment, and processes to established requirements. Therefore, quality assurance will include quality control.

The overall objectives of a Quality Assurance program are:

a. To identification of deficiencies in the sampling, and measurement processes to those responsible for these operations so that corrective action can be taken.

b. To obtain a measure of confidence in the results of the monitoring programs to assure regulatory agencies, and the public that the results are valid.

To achieve these objectives, a Quality Assurance plan has been developed that includes elements recommended in USNRC Regulatory Guide 4.15.

9.12.2 Organizational Structure and Responsibilities

Figure 9.12-1 shows the Environmental, and Radiation Safety organization, and reporting responsibilities at the Crownpoint Uranium Project. The responsibilities of those personnel involved in Quality Assurance will be follows:

9.12.2.1 V.P. of Health, Safety and Environmental Affairs

The Vice President of Health, Safety, and Environmental Affairs (VPHSE)will have the ultimate responsibility, and authority for the radiation safety, environmental compliance, and Quality Assurance program at the Crownpoint Uranium Project in addition to off-site project development activities. The VPHSE will provide corporate audit input to the Environmental Manager, and Radiation Safety Officer to ensure that all radiation safety, environmental compliance, and permitting/licensing programs will be conducted in a responsible manner, and in compliance with all applicable regulations, and permit/license conditions. The VPHSE will report directly to the CEO of Uranium Resources, Inc.

9.12.2.2 V.P. Technology

The CUP Vice President of Technology (VPT) will be directly responsible for all operations, including, implementing industrial, and radiation safety, and environmental protection. This includes all operating procedures, radiation safety programs, industrial safety programs, environmental, and ground water monitoring programs, associated quality assurance programs, and routine, and non-routine maintenance activities. The VPT will be also responsible for compliance with all regulatory

HRI ORGANIZATIONAL STRUCTURE

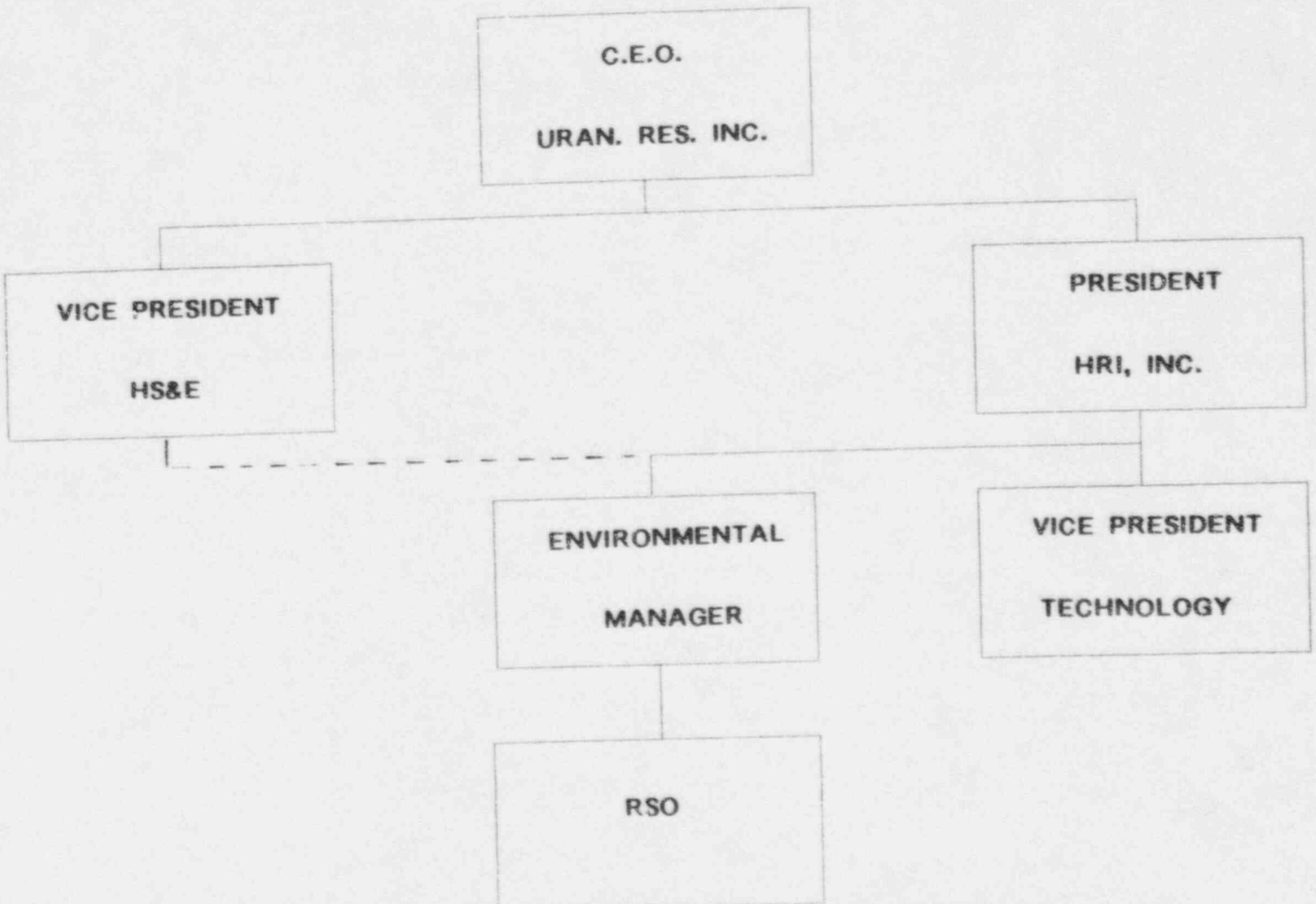


FIGURE 9.12-1

license conditions, and regulations, and reporting requirements. The VPT will have the responsibility, and authority to terminate immediately any activity that is determined to be a threat to employees, or public health, or the environment as indicated in reports from the Environmental Manager, or RSO. The VPT will be a member of the ALARA Committee, and the ALARA Audit Team, and will report directly to the President of HRI.

9.12.2.3 Environmental Manager

The Environmental Manager (EM) will be responsible for the development, administration, and enforcement of all radiation protection, environmental, and ground water monitoring programs at the CUP.

The EM will assist in the development, review, and approval of sampling, and analysis procedures used at the CUP, and aid in the technical evaluation of laboratory data, as required. The EM will be also responsible for routine auditing of sampling quality assurance/quality control programs developed, and used at the CUP.

The EM will develop, and administer radiation protection programs to ensure that (1) employees will be afforded the optimum practical protection against radiation hazards, (2) exposure of employees to radiation, and radioactive materials will be maintained "As Low As Reasonably Achievable", and (3) all applicable regulatory requirements will be met. The EM also will provide technical guidance, and assistance to site personnel in the matter of radiation protection. The EM will have the authority to terminate immediately any activity that will be determined to be a threat to the employees, or public health, or the environment as indicated in reports from the CUP RSO. The EM will chair the ALARA Committee, be a member of the ALARA Audit team, and report directly to the President of HRI.

9.12.2.4 Radiation Safety Officer

The CUP Radiation Safety Officer (RSO) will be responsible for the daily supervision of the radiation safety, and environmental programs at the CUP. Responsibilities will include the development, and implementation of all radiation safety, and environmental programs, ensuring that all records will be correctly maintained, and assist the VPT in ensuring compliance with NRC regulations, and license conditions. The RSO will be designated as the Site QA Coordinator. The RSO will conduct training programs for the supervisors, and employees with regard to the proper application of radiation protection, and environmental control procedures. The RSO will personally inspects facilities to verify compliance with all applicable radiological health, and safety requirements, and the Quality Assurance Program. The RSO will be a member of the ALARA Committee, assist management with the Annual ALARA Audit, and report directly to the EM.

9.12.2.5 Radiation Safety Technician

At least one RST will be present at each CUP location including the CCP, and the individual satellites. The Crownpoint RST will conduct environmental, and radiological surveys, collect air, water, soil, and vegetation samples, performs analyses, collects data for the radiation safety program; perform calculations of employee radiation exposures, keep records, and conduct various other activities associated with implementation of the environmental, and radiation protection programs. The RST will report all radiation protection data directly to the RSO prior to submittal to the EM. The RST will be a member of the ALARA Committee, assist management with the Annual ALARA Audit, and report directly to the RSO.

9.12.3 Qualifications and Training

Minimum technical qualifications, and experience required for personnel who will be responsible for developing, and administering the Crownpoint radiation, and environmental protection programs, and the Quality Assurance Program will be as follows:

9.12.3.1 VPHSE

The VPHSE will require a Bachelors degree in Engineering, or Science from an accredited college, or university, or equivalent work experience, plus a minimum of five years management experience in senior management of engineering, and operations functions. A Masters degree will qualify for two years work experience.

9.12.3.2 Vice President Technology

The position of VPT will require a Bachelors degree in Engineering, or Science from an accredited college, or university, or equivalent work experience, plus a minimum of five years supervisory experience. A Masters degree will qualify for two years work experience. Work experience will include industrial process/production experience, and industrial process/production management.

9.12.3.3 Environmental Manager

The position of EM will require a bachelor's degree in the physical, or biological sciences, mathematics, or engineering from an accredited college, or university, and at least three years of experience in applied health physics, and radiation protection. Experience will be industry related. A Masters degree will qualify for two years work experience.

9.12.3.4 Radiation Safety Officer

The position of RSO will require a Bachelor's degree in physical, or biological sciences, engineering, or related discipline from an accredited college, or university, and at least three years of appropriate experience in environmental compliance, permitting, radiation protection, and technical supervision. At least two of the three years experience will be at an operation, and in a position where knowledge of radiation protection programs has been obtained. A Masters degree in Health Physics will qualify for two years work experience. This position will also require 40 hours of formal radiation protection training.

9.12.3.5 Radiation Safety Technician

The position of RST will require a minimum of a high school diploma, or alternatively, an equivalent combination of experience, and training in uranium mill radiation protection. A Bachelor's degree in physical, or biological sciences, engineering, or related discipline from an accredited college, or university with no experience will also be acceptable.

9.12.3.6 QA Training

Personnel performing quality related activities, such as radiological sampling, water quality sampling, and analysis, and environmental monitoring, will be trained in the principles, and techniques of the activities performed. The majority of the personnel involved in these quality related activities will be experienced professionals. Training of the field personnel (e.g., RST, samplers) will be achieved by an on-the-job training (OJT) program that will be specific to the activities performed, and will be administered by experienced professionals. This OJT training will be documented, and maintained on site. The training period will continue until the employee demonstrates proficiency as determined by observation of his/her working techniques, and by obtaining acceptable sampling, and analytical results.

9.12.3.7 Training Evaluation

At least annually, each individual who performs quality related activities will undergo a performance review by his immediate supervisor which will include an evaluation of the person's performance, adherence to written procedures, and knowledge of the nature, and goals of the Quality Assurance Program. This evaluation will be documented, and maintained on site.

9.12.4 Operating Procedures

HRI will establish Standard Operating Procedures (SOP's) for operational, and non-operational activities involving radioactive materials including quality related activities. Prior to implementation of new, or revised SOP's, they will be reviewed, and approved by the SERP to ensure that proper safety, and radiation safety principles, and practices have been included. Additionally, the EM will perform a documented audit of all existing operating procedures that deal with radioactive materials on an annual basis.

9.12.5 Ground and Surface Water Quality Monitoring Program

Additionally consistent with PBL license requirements, HRI will develop specific SOP's detailing the procedures for collecting water samples, and analyzing for the excursion parameters. Baseline water quality samples will be filtered, and preserved on site, and transported to an EPA approved laboratory for analysis. All baseline samples are preserved, and analyzed in accordance with accepted methods. Ten percent of the baseline samples are duplicated, and the duplicate sample sent to a second EPA approved laboratory for the purpose of comparative analysis.

For every 20 excursion monitor well samples, a duplicate sample, and a spiked sample are analyzed. The duplication begins with original sample aliquots, and allows the analyst to determine the precision of the analytical result. Standard addition spikes consist of the addition of a known amount of analyze to a duplicate sample aliquot. These spiked samples are useful in estimating the accuracy of an analytical result as well as identifying potential interferences.

The quarterly environmental ground, and surface water samples described in Section 9.4.2 are preserved on-site ,and transported to an EPA certified laboratory for analysis. The samples are preserved, and analyzed in accordance with accepted methods.

9.12.6 Airborne Effluent and Environmental Sampling Program

The air filters collected from the environmental stations are composited quarterly, and sent to an EPA certified laboratory for analysis. The passive radon, and gamma detectors are analyzed by the manufacturer.

9.12.7 Radiological Monitoring Program

9.12.7.1 Monitoring Locations

Figures 2.1-1, and 2.1-2 of the Operations Plan illustrate the monitoring locations, and the type of sampling performed at each location within the process areas at the CUP is described in Table 9.4-2.

9.12.7.2 Monitoring Equipment

Table 9.4-1 lists the specifications of typical radiation monitoring instruments that are used at the Crownpoint Uranium Project. A sufficient number of back up instruments will be available to insure that there will be operable instrumentation during calibration downtime, and in the event of maintenance problems.

9.12.7.3 Quality of Samples

Provisions will be made to ensure that representative samples are obtained by the use of proper sampling equipment, locations of sampling points, and sampling procedures.

Air samples may be composited for analysis if they are collected at the same location, and if they represent a sampling period of one calendar quarter, or less. Air samples collected for analysis of 222-Rn, and/or radon progeny will be analyzed using appropriate methods to minimize activity loss due to decay.

9.12.7.4 Lower Limit of Detection

The lower limit of detection for radiological, and environmental samples is determined similar to NRC Regulatory Guide 4.14, "Radiological Effluent and Environmental Monitoring at Uranium Mills"; Regulatory Guide 8.30, "Health Physics Surveys in Uranium Mills"; and NUREG - 5849, "Manual for Conducting Radiological Surveys in Support of License Termination", Section 5.2 "Instrument Detection Sensitivity" In general for radiological detection of a mass sample when the gross, and background count times are equal, the Minimum Detectable Amount (MDA) is:

$$MDA = [2.71 + 4.65 (R_b)^{0.5}] / [2.22 E M (t_b)^{0.5}]$$

Where:

- MDA - minimum detectable amount (pCi/g)
- R_b - background count rate (cpm)
- t_b - background count time (min)= gross count time
- E - counter efficiency
- M - sample mass (g)
- 2.22 - activity conversion factor (dpm/pCi)

9.12.7.5 Error Estimates

Whenever possible, results reported from the contract laboratory include estimates of uncertainty. The magnitude of the random error of the analysis to the 90% uncertainty level is reported (2 standard deviations).

9.12.7.6 Calibration

Individual SOP's are used for calibrating all sampling, and measuring equipment (in conjunction with the use of qualified calibration services using appropriate procedures). Procedures, and calibration methods used ensure that the equipment will operate with adequate accuracy, and stability over the range of its intended use. Calibration procedures may be compilations of published standard practices, manufacturers' instructions, or procedures written in-house. To the extent possible, calibration of radiation measuring equipment is performed using radionuclide standards traceable to the National Institute of Standards and Technology (NIST).

Calibrations are performed on radiation detection instruments at annual intervals. Equipment is recalibrated, or replaced after any repairs, or whenever it is suspected of being out of adjustment, excessively worn, or otherwise damaged, and not operating properly. Functional tests, i.e., routine checks performed to demonstrate that a given instrument is in working condition, are performed using sources that are not traceable to the NIST. Radiation detection instruments are function tested with a radiation check source before each day's use to ensure that they are responding to within +/- 20% of the reference reading for the check source. These function tests are documented, and maintained on site.

9.12.7.7 Quality of Results

A continuous program has been implemented for ensuring the quality of results, and for keeping random, and systematic uncertainties to a minimum. The procedures ensure that samples, and measurements are obtained in a uniform manner, and that samples are not changed prior to analysis because of handling, or storage environment.

Procedures for computation of the concentration of radioactive materials include periodic independent verification of the results by a person other than the one performing the original calculation. The input data for computer calculations are verified by a knowledgeable individual. All computer programs are verified prior to initial use, and after each modification made by the manufacturer.

9.12.8 Field Sampling and Measurement Records

Field sampling, and measurement records are maintained at the Crownpoint Site. These records include:

a. Baseline Well Sampling Data Sheets;

b. Monitor Well Sampling Data Sheets;

c. Environmental Radiological Sampling Data Sheets;

d. Analytical Laboratory data sheets containing data on environmental samples, spikes, and duplicates;

e. Radiological measurement data sheets containing sampling, background measurement, and standardization data;

f. Instrument calibration records.

It will be the responsibility of the RSO to maintain all records pertaining to radiation measurement. The EM will be responsible for all records pertaining to baseline, and excursion monitor well water quality sample collection, and analysis.

A duplicate set of contract laboratories' analytical results will be maintained at an off site location.

One copy of each annual ALARA/QA/QC audit report as discussed in Section 9.12.12 will be kept at the site, and it will be the responsibility of the RSO to maintain this file. A second copy will be filed at the CCP.

All records will be maintained for five years, or until such time disposal is authorized by the USNRC if less than five years. All personnel radiation exposure files will be retained at the Corporate Office after CUP is closed.

9.12.9 Quality Assurance for Sampling

The quality assurance program for sampling can be broken down into the following areas:

a. Procedures used by the sampler which will define the details of sample location, sample frequency, number of samples, duration of sampling, sample volume, sample collection methods, and holding times, equipment used for sample collection, sample containers, pre-treatment of containers, type, and amount of preservative added, a replicate program, and chain of custody procedures.

b. SOP's will be prepared for calibration, and maintenance of equipment used for field measurement. These procedures will provide details for the standardization, use, and maintenance of the instruments

c. Random control checks are made by taking duplicate samples from specified points, and submitting these to the contract analytical laboratory. These checks will allow for the evaluation of the performance of the contract laboratory, and to some extent, the validity of sampling procedures. In the event that the results of the duplicate samples will not agree within acceptable tolerances, an audit will be performed to determine if the cause is due to sampling, preservation, and/or shipping methods, or the contract laboratory. Appropriate corrective action will be taken based on the results of the audit.

9.12.10 Quality Control in the Laboratory

9.12.10.1 Water Quality Laboratory

All baseline water quality samples will be sent to a contract EPA certified laboratory for analysis. HRI requires that the contract laboratory notify HRI should they no longer be EPA certified.

9.12.10.2 Radiochemical Laboratory

Environmental radio-chemical analysis will be conducted by an EPA certified contract laboratory. HRI will require that the contract lab notify HRI should they no longer be EPA certified.

9.12.10.3 Inter-Laboratory Analysis

As a further check on the Contract Laboratory, HRI will routinely submit duplicate samples to the laboratory, and a second EPA certified laboratory as described in Section 9.12.5. If the results of the duplicate analyses are not within acceptable tolerances, the laboratory will be advised, and must take the necessary corrective action to assure precise, and consistent data. The corrective action taken by the laboratory will be reported in writing to HRI.

9.12.10.4 On Site Laboratory

The goal of the Quality Assurance program of the on site laboratory will be to assure that data generated by the laboratory is scientifically valid, of known quality, and of sufficient quality to meet the regulatory agencies' requirements. The data must be reliable, defensible, and comparable to similar data generated by other laboratories. In order to meet this goal, the following plan will be implemented at the CUP laboratory:

a. All environmental samples received by the laboratory will be documented with the date received.

b. Records of field conductivity, and pH will be compared with the values obtained by the laboratory. Significant discrepancies will be investigated promptly to determine if the field, or laboratory measurements are in error. Appropriate corrective action will be taken based on the results of the investigation.

c. Checks will be made to ensure proper preservation, and storage techniques have been implemented where applicable.

d. Chemical analysis procedures will be documented, and maintained in the SOP manual.

e. Newly employed lab technicians will be fully trained, and their ability to accurately perform the analyses is documented.

f. Sample analysis information such as volume of sample, volume of titrant, absorbance, etc. will be permanently recorded as well as the initials of the technician performing the analysis.

g. One spike, and one duplicate analysis per 20 monitor well samples excursion will be performed, and the results evaluated.

h. Standards, and blanks, if necessary, will be run, and the results documented.

I. Results of the analyses will be entered on the proper forms, and copies of the forms will be distributed according to a prescribed distribution list. The original form will be maintained by the laboratory.

j All calibration, maintenance, and repair records of laboratory instrumentation will be documented, and maintained on site.

9.12.11 Review and Analysis of Data

The radiological, and water quality data received from the on-site and contract laboratories will be reviewed by the RSO, and/or the Environmental Manager, or designee, who will be responsible for technically evaluating the data, and distributing it to the appropriate files.

The criteria for the technical evaluation of the data will be discussed below.

9.12.11.1 Water Quality Data

Water quality data will be evaluated for reasonableness, and agreement with previous analyses by the analyst, and the Environmental Manager in accordance with the procedure outlined in Section 9.12.11.3.

Cation-anion balance will be between 0.95 and 1.05.

The ratio of the measured total dissolved solids (TDS) at 180 degrees with the calculated TDS corrected for bicarbonate decomposition will be between 0.9 and 1.10.

9.12.11.2 Radiological Data

Radiological data received from the on-site, or contract laboratories will be reviewed for reasonableness, and agreement with previous analyses by the RSO who will be responsible for technically evaluating the data, and distributing it to the appropriate files.

The criteria for the technical evaluation discussed below.

The reviewer will verify that the detection limits are lower than the measured concentrations, or are equivalent to the values given in USNRC Regulatory Guide 4.14, whichever is greater.

The reviewer will determine whether the data indicates exceedance of applicable limits, or are trending upwards toward a problem.

9.12.11.3 Data Comparison

The data on a given sample, or set of samples, and will be compared with the data from previous representative samples from the same population. If an individual result is within the precision, and accuracy range of the method being utilized, and agrees with results obtained on previous samples, the result will be considered acceptable. If the result is outside of this range, and does not agree with previous results, the data set will be evaluated for trends, other unusual distributions, or laboratory, and/or sampling error. The laboratory will then be notified, and asked to check calculations, and quality control checks. If no discrepancies are found, a new analysis will be requested on the sample provided that the maximum holding time for the sample has not been exceeded. If the maximum holding time has been exceeded, a resample will be requested. If the resample verifies that a significant change in water quality, or radiological conditions has occurred, the cause of this change will be determined. The results of this investigation will be documented, and reported to the Environmental Manager as soon as possible, and, if necessary, corrective action initiated. If the data indicates that exceedance of applicable limits has taken place, appropriate reporting, and documentation of corrective actions will be performed in accordance with NRC license, and permit requirements.

9.12.12 Quality Assurance/Quality Control Audits

An annual audit of the water quality sampling, and analysis program, radiological monitoring sampling, and Quality Assurance/Quality Control programs will be conducted in conjunction with the annual ALARA audit by the EM, and the VPHSE. The EM may designate individuals qualified in chemistry, and monitoring techniques who will not have direct responsibilities in the areas being audited to assist in the audit. Audit results will be reviewed with the RSO, the VPT, and the President of HRI. The results of the audit, and corrective actions to be taken, if required, will be documented, and maintained on site. An additional copy will be filed at the corporate office.

9.13 Security

HRI will minimize access, and provides accountability for all persons entering the CUP restricted area. Restricted areas will include the CCP, and individual satellites. The restricted area includes the facilities inside the fenced area of the CUP. This will include all buildings, and wellfield patterns, and associated equipment. Access to this area will be through the main gate which will be electronically controlled, and will only be opened by entering a combination into the key pad, or by contacting a HRI employee inside the property on the call box.

All non-employees entering the CUP will be required to log in at the main office after receiving visitor training or, as appropriate for the work they will be performing. The combination to the main gate will be changed at irregular intervals to ensure that the restricted area security is maintained.

9.14 Contingency Plan for Transportation Accidents

9.14.1 Purpose

This section identifies the procedures to be followed in the event of a highway transportation accident of uranium concentrate (yellowcake slurry or ion exchange resin) between the Unit 1 satellite, or Churchrock satellite, and CCP facility. Material shipped from Crownpoint will be dried, and packaged according to Department of Transportation (DOT) requirements. The shipper utilized by HRI will be licensed to transport the yellowcake product, in its dried form, and have an approved accident contingency plan, as part of the licensing process.

There are three major portions to the emergency response plan: immediate containment, accurate, and proper notification, and a conceptualized cleanup procedure with preplanned dedicated personnel, and equipment.

9.14.2 Shipments

To minimize the severity of an accident, the driver will be fully briefed on the nature of his load, and the necessary safety precautions. The special instructions for accidents will be verbally presented to him, and he will also carry written instructions with him accompanying the shipping papers. Additionally, a simple one page response letter will accompany the shipping papers detailing the nature of the problem. The letter will be used by persons encountering the accident, if the driver is unable to explain the nature of the material, and the preliminary containment procedures. An example of the emergency response letter, and the driver's manual accompanies this manual.

9.14.3 Initial Containment

The basic philosophy in spill containment will be to prevent the spread of the material, and to notify HRI personnel, and civil authorities.

a. Containment - each transporter will be equipped with the proper shipping papers, response letter of identification, and notification, driver's contingency manual, and the following equipment in a weatherproof box:

1. Polyethylene sheeting (2,000 square feet).
2. Shovels (2, short handle).
3. Disposable coveralls (3 pairs).
4. Rubber boots (3 pairs, mixed sizes).
5. Rubber gloves (4 pair).
6. Fiber tape (2 rolls).
7. Pocket knives (3).
8. Reflective warning signs, and polyethylene rope.
9. Respirators (3).

The drivers, or civil authorities immediately on the scene will cover any spilled material with the sheeting. Sufficient protective clothing will be available for the work. The equipment, and clothing will be wrapped in plastic after it is used (for future decontamination). The site will be secured from unauthorized personnel, and all civil authorities will be notified, and briefed on the situation. The initial notification, and precautions will be enumerated in the response letter, and the driver's manual.

The following are procedures, and containment:

1. Tank - not leaking

   a. Rope off area, and restrain people from tampering with any material. Request the police for assistance in keeping people about 50 feet from the accident.

b. Assure everyone professional assistance, and equipment are on the way, and there is no danger with a sealed tank.

2. Tank - Leaking

a. Rope off area, and caution everyone to stay away from the material. Use the police for assistance.

b. Assure the police that there is no radiation danger, but potential dusts from the material is poisonous, and should not be inhaled.

c. Request to the civil authorities that the traffic be routed in such a fashion as to prevent tracking.

d. If possible, prevent the material from running into streets, gutters, sewers, etc. A simple method is utilizing dirt ditches, or dikes.

e. Minimize dispersion, and wear supplied respirators.

3. Fire Involved with Accident

a. If necessary, isolate area from entry by using civil authorities.

b. The material will not explode; but, if possible, keep the fire away.

c. If the tank is ruptured, use respirators to preclude material inhalation

b. Initial Notification - Initial notification will be from the driver, or the civil authorities who find the response letter, and the driver's manual. The HRI slurry tractor will be equipped with a cellular telephone to provide for the telephone communications. The people to be notified (by collect calls) are as follows:

Craig Bartels	Alburqurque	505/883-1777 Off 505/792-1412 Home
Mark S. Pelizza	Dallas	214/387-7777 Off 214/618-5780 Home
Salvador Chavez	Grants	505/786-5845 Off.

505/287-4165 Home

As soon as one of these individuals is notified, a company notification system is activated which will consist of management, clean-up team, and civil/regulatory notification. There will be duplication of notification in key areas to insure that notification is given. The basic system will be as follows:

X	XX	XXX
V.P.Technology will notify all:	V.P.H.S.& E. will notify all:	Plant Superintendent will notify all:
V.P.H.S.& E	V.P.Technology	V.P.Technology
Plant Superintendent	Plant Superintendent	V.P.H.S.& E
State Police	State Police	Clean-Up Team
Navajo Police	Navajo Police	Hospital
Clean-Up Team Leader	Clean-Up Team Leader	NRC
NRC	Clean-Up Team	

X. V.P.Technology Notifications

V.P.H.S.& E -	Mark S. Pelizza	214/387-7777 Off. 214/618-5780 Home
Plant Super. -	Salvador Chavez	505/786-5845 Off. 505/287-4165 Home
State Police		505/827-9001
Navajo Police (if on Indian lands)		505/786-5397

(If not New Mexico, see civil/regulatory list for State Police) Clean-Up Team Leader (notifies clean-up crew) Hospital (if necessary).

XX. V.P.H.S.& E Notifications

V.P.Technology_-	Craig Bartels	505/883-1777 Off 505/792-1412 Home
Plant Super -	Salvador Chavez	505/786-5845 Off. 505/287-4165 Home
State Police		505/827-9001
Navajo Police		505/786-5397

(If not New Mexico, see civil/regulatory list for State Police)
Clean-up Team Assistant Leader (notifies clean-up team)
Regulatory Agencies (see list)

XXX. Plant Superintendent Notifications

V.P.Technology_-	Craig Bartels	505/883-1777 Off. 505/792-1412 Home
V.P.H.S.& E -	Mark S. Pelizza	214/387-7777 Off. 214/618-5780 Home

Clean-up Team Leader (notifies clean-up team)

Hospital (if necessary)

Regulatory Agencies

New Mexico Environmental Department	(505) 827-0219
Navajo Environmental Protection Agency	(520) 871-7812
U.S. Nuclear Regulatory Commission	(301) 816-5100

9.14.4 Clean-Up Team Equipment

In order to handle effectively a uranium spill, the following equipment will be assembled, and stored in transportable containers for use by the clean-up team:

- **a.** Coveralls - disposable (15 pair per size--medium large)
- **b.** Gloves - rubber - long cuff (15 pairs)
- **c.** Rubber boots - 15 pairs(3 size 9, 7 size 10, 5 size 12)
- **d.** Shovels - (3 std. long handle, 3-scoop blade)
- **e.** Plastic sheeting - 12 mil, 3200 square feet
- **f.** Solvent glue for sheeting (3 cans/jars)
- **g.** Hard hats (10)
- **h.** ~rooms (2) industrial floor
- **i.** gallon drum liners (50 bags)
- **j.** ortable water sprayer (misting down powder)
- **k.** Sample bottles (24)
- **l.** Urine bottles (24)
- **m.** Rope - 1-1/2 inch - 1000 feet
- **n.** Warning signs - radioactive materials
- **o.** Fiber tape - 6 rolls
- **p.** Sump pump - 110 volt
- **q.** Garden hose - 50 feet
- **r.** Highway flashers
- **s.** Respirators - 100 dust disposable

Additional Equipment from CCP:

- **a.** Calibrated beta, gamma, alpha survey meter
- **b.** Hydrochloric acid, 55 gallon drum w/dispensing pump

c. Product storage drums(25),55gallons w/lids, and bolts
d. Tools
e. Onan generator with fuel
f. Portable flood lights
g. Vacuum cleaner
h. Air compressor
i. Front end loader/back hoe
j. Radiotelephone, if possible
k. Camera with flash
l. Ore transport

9.14.5 Clean-Up Procedure

a. Set-up

1. Arrive at site, access situation, and assign team members to (1) collect/procure additional site specific equipment; (2) notify management of situation; and (3) brief civil authorities on procedures.

2. Issue protective clothing, and secure site from unauthorized entry.

3. Cover all spilled materials with plastic.

4. Set-up command post.

b. Protective Berming for Slurry spills

1. Cover exposed material with plastic sheeting.

2. Construct a protective berm completely around the whole area including the working, or clean-up area.

3. if possible, construct a berm around the spilled material.

4. Construct a lined diked area for drum reloading, and contaminated equipment.

5. If possible, construct a lined area for trailer decontamination.

c. Clean-up - Clean-up will proceed with the clean-up of the trailer cleaning, and removal of the product, and finally the spill site.

1. Trailer Clean-up

a. Remove spilled mate ial by shovels, and/or vacuum cleaner into lined 55 gallon drum, and move to pad.

b. Right trailer, if possible, and move off road surface to diked clean-up area.

c. Clean exterior, and interior, and remove to nearest fully controlled site (plant) for final decontamination.

d. Test for contamination.

2. Pavement Clean-up

a. If spill material has contacted the pavement, clean-up of this surface should be conducted next.

b. Using scoop shovels, load lined barrels.

c. Construct a two foot (2) wide plastic lined trench along the pavement edge.

d. Rinse the surface with an acid solution, and direct the solution to the lined ditch for pick up by the sump pump.

e. Continue until all signs of the materials are removed.

f. Neutralize surface with water, and collect final run-off for lab verification of clean-up.

3. Road Shoulder (soil) Clean-up

a. Using shovels, or loader, remove product to drum.

b. Remove six inches of top soil, and place in drums in area of direct spill.

c. After trailer is removed, and road is cleaned, begin to decontaminate plastic.

d. Place plastic in drums.

e. Place obviously contaminated soils in drums.

f. Remove trailer.

g. Remove majority of drums.

h. Begin final removal of all topsoil in affected area.

i. Conduct soil sampling in a grid fashion.

4. Final Clean-up

a. Do not remove outer protective berm if constructed.

b. Review grid soil samples with regulatory agencies, and get final clean-up approval.

c. Consult with highway department of reseeding program.

d. Remove protective berm after written verification from regulatory agencies.

e. Reseed area.

9.14.6 Personnel Protection

a. Identify everyone by name, and address who came in contact with the material.

b. Secure urine analysis from these individuals.

c. Report analysis to these individuals, and explain the results.

9.14.7 Response Letter

A letter containing the following information will be displayed in a prominent location within the cab of the transport vehicle in the event a outside individual discovers a accident.

This vehicle is transporting uranium yellowcake, or uranium ion exchange resin. The material is poisonous, and should not be inhaled, or injested. It is not a radiation hazard, or an explosive. You should try to keep the material off your clothing, and try not to track it about. The following steps will minimize spreading of the material.

a. Notify the Department of Public Safety, or County Sheriff, or Navajo Police, and request his assistance in guarding the site.

b. Find the plastic sheeting in the vehicle, and cover all spilled material.

c. The following people have the responsibility for handling the problem. CALL COLLECT as possible.

Craig Bartels	Alburqurque	505/883-1777 Off. 505/792-1412 Home
Mark S. Pelizza	Dallas	214/387-7777 Off.

214/618-5780 Home

Salvador Chavez	Grants	505/786-5845 Off. 505/287-4165 Home

d. Instruct one of the above on the situation. Please give him your name, and address. These people are trained in handling this problem.

e. Request assistance in preventing people from handling the material, or removing it, until Hydro Resources, Inc. (HRI) personnel are present.

f. Give this letter, and all other shipping papers, and the driver's spill instructions manual to civil authorities.

9.14.8 Instructions to Driver

This section outline the type of instruction which will be maintained in the glove compartment of the transport for use by the driver in the case of an accident.

The material you are transporting is uranium concentrate, or uranium product.

a. Is not a radiation hazard in exposure of less than a few days;

b. Is poisonous, and should not be breathed, swallowed, or put in the mouth;

c. Should be kept to a small area, and off clothing, or body, and;

d. Is not explosive.

<u>In Case of an Accident</u>

a. Cover any spilled material with the plastic sheeting provided in the transporter utilizing equipment supplied in emergency equipment box. The box contains the following equipment:

1. Polyethylene sheeting (2,000 square feet)
2. Shovels (2, short handle)
3. Disposable coveralls (3 pair)
4. Rubber boots (3 pair, mixed sizes)
5. Rubber gloves (4 pairs)
6. Respirators (3, use only for dry product spills)
7. Fiber tape (2 rolls)
8. Pocket knives (3)
9. Warning signs, and guard rope (1/2 inch polyethylene)

After equipment is used, place under sheeting for later decontamination, and prevention of theft.

b. Notify the civil authorities of the nature of the problem by:

1. Giving them the accompanying letter;

2. Telling them the nature of the problem, and;

3. Requesting their help in securing the site from interference of bystanders, and notifying the HRI personnel listed below as soon as possible. Call collect, and tell the operator that this is an emergency call. Call until one of the following individuals is notified.

Craig Bartels	Alburqurque	505/883-1777 Off. 505/792-1412 Home
Mark S. Pelizza	Dallas	214/387-7777 Off. 214/618-5780 Home
Salvador Chavez	Grants	505/786-5845 Off. 505/287-4165 Home

c. Initial containment prior to arrival of HRI

1. Containers not leaking

a. Rope off area, and restrain people from tampering with any material. Request the police for assistance in keeping people about 20-25 feet from the accident.

b. Assure everyone professional assistance, and equipment are on the way, and there is no danger with closed uncontaminated containers.

2. Drums/Tank Leaking

a. Rope off area, and caution everyone to stay away from the material. Use the police for assistance.

b. Assure the police that there is no radiation danger, but dusts from the material is poisonous, and should not be inhaled.

c. Request to the civil authorities that the traffic be routed in such a fashion as to prevent tracking.

d. If possible, prevent the material from running into streets, gutters, sewers, etc. A simple method is utilizing dirt ditches, dikes and, tarps.

e. Minimize dispersion, and wear your supplied respirators.

3. Fire involved with accident

a. If necessary, isolate area from entry by using civil authorities.

b. The material will not explode; but, if possible, keep the fire away.

c. If the tank is ruptured, use respirators to preclude material inhalation.

9.14.9 Instructions to Civil Authorities

Detailed instruction to civil authorities will be maintained in the glove compartment of the transport. They will be prominently marked, and contain the following information.

Hydro Resources, Inc. (HRI) has a fully trained, and equipped Clean-UP Team for this type of hazardous material. A notification system has been developed, and the following regulatory agencies have the responsibility for handling this problem. Hydro Resources will notify the responsible regulatory agencies. You may wish to call the Highway Patrol for assistance.

Regulatory Agencies

New Mexico Environmental Department	**(505) 827-0219**
Navajo Environmental Protection Agency	**(520)** 871-7812
U.S. Nuclear Regulatory Commission	**(301) 816-5100**

9.14.10 Coordination With Local Emergency Services

To assess the local response, HRI has held meetings with officials of the Crownpoint Health Care Facility. The main focus of the meeting was to discuss the capability of the health care facility to respond to an accident, specifically one that might involve a person whose skin, or clothing has product contamination. While discussing this topic the IHS officials expressed some concerns regarding the current lack of equipment, and personnel training needed to effectively respond to this type of scenario. Three other points that were raised included: (1) the need for a separate room equipped for cleaning an injured person whose clothing, or body might have surface contamination; (2) the need for on-going technical training because of the relatively high turnover in hospital staff, and (3) the need for hospital staff to feel comfortable with working in this situation.

HRI will, if allowed, provide proper survey equipment, on-going training for hospital staff, and a separate room equipped for decontamination. Additionally, HRI is proposing that a memorandum of understanding (MOU) be prepared which clearly outlines respective responsibilities.

One final, but equally important topic of discussion, included the suggestion that HRI hold a similar meeting with the hospital's Area Office, and the EMT.

Consistent with PBLC Format, HRI will develop an action plan as part of a SOP which will provide for equipping, and training Local Emergency Officials in the event an accident occurs involving source, or byproduct material.

9.15 Incident Response and Reporting Procedures

HRI has established incident response, and reporting procedures which will be put into effect in the event of any incident with potential significant radiological impacts, and/or regulatory reporting requirements. This plan will be reviewed annually, and revised as necessary to accurately reflect current operations. Up-to-date copies of the plan will be distributed to each supervisor, and each major work location. Proper reporting will ensure that appropriate individuals, and agencies are informed in a timely manner so that appropriate corrective actions can be taken. The initial incident review will center around the completion of a 10 CFR Part 20, and 40 incident reporting requirements. The requirements of 10 CFR 21, and 71, and 49 CFR 172, and 173 will also be considered during the review to determine specific follow-up, and reporting requirements.

Any unusual, or unplanned event with potential significant radiological impact will be evaluated, documented, and appropriately reported. The nature of the event will determine the actions to be taken. All information, data, and evaluations, along with the names, and times of regulatory agencies contacted in relation to respective incidents will be properly documented, and retained on site.

9.16 Management Control and Administrative Procedures

All principal work assignments will be conducted in accordance with written operating procedures. Supervisory, and management personnel will routinely observe their employees at work, and thus will be able to ensure adherence to the written procedures.

If employees are found deviating from a procedure, they will be counseled by their supervisors, and instructed to adhere to the written instructions. Follow up supervision will ensure the success of the counseling session. Such deviations, and follow up counsel will be documented, and the documentation maintained on file at the project site. All new operating procedures which will affect radiation safety will be reviewed by the SERP. Review of all operating procedures involving radioactive materials by the RSO will be performed at least annually to ensure that radiation exposures will be maintained as low as is reasonably achievable.

Non-routine work, or maintenance activities which may result in significant personnel exposure to radioactive materials, and for which there is no SOP will be carried out in accordance with a Radiation Work Permit (RWP). These procedures include contacting the radiation safety staff prior to the start of work. The RSO, or RST will survey the area for radiation, and/or contamination levels, as appropriate, and conduct a discussion of precautions to be taken during the repair to keep personnel exposures as low as is reasonably achievable. Job supervisors will direct the work in such a manner as to minimize exposure to radiation, or airborne radioactive materials. Air samples will be taken as necessary to evaluate the exposures of all involved personnel. Additionally, techniques such as the use of respirators will be used to reduce exposures.

9.17 Inspections and Compliance Audits

The Crownpoint RSO will conduct weekly inspections of all work, and storage areas; his/her findings pertaining to compliance with license requirements, and radiation safety practices will be documented. The Crownpoint RSO, or designated radiation safety technician will conduct a daily walk-through inspection of all work, and storage areas of the CP to insure proper implementation of good radiation safety procedures. The results of these inspections are documented, and maintained on site.

Licensee management will conduct annual audits of the radiation protection, and ALARA program, under the direction of the EM, and the VPHSE. The Crownpoint RSO will accompany the audit team. The audit will address similar topics listed in Regulatory Guide 8.31, Section 2.3.3. The results of the audit will be reviewed, and approved by the President prior to submittal to NRC.

9.18 Training

Appropriate levels of safety training will be provided to all individuals who are permitted to gain access into restricted portion of the location. The level of training will be dependent on the visitor/employment status of an individual, and the ability of each individual to access various locations within the restricted area. Training will cover some topics according to NUREG 1159, "Training Manual for Uranium Mill Workers on Health Protection from Uranium" with noted exception that the Crownpoint Uranium Project is <u>not</u> a mill but an *in situ* mine. Each anticipated training level is broken out below.

9.18.1 Initial Training

All new employees will provide a slip authorizing the Employer to request from previous employers all records relative to occupational exposures to ionizing radiation. This report is to be obtained from the former employer, if possible. This will become a permanent part of the employees' Radiation Exposure Record in the Applicants' files, and will be kept current, and available at all times.

Training will be mandatory for all new employees in order for them to understand the potential problems of radiation exposure, and their own personal responsibility to adhere to all safety rules, particular Radiation Safety, for their own protection as well as others. Workers will be made knowledgeable of the procedures for making suggestions for better radiation protection, and the importance of working together in order to lower radiation exposure.

New employees, for their own safety, will be made aware of the, origin, location, and operation of job categories that require the strictest possible compliance with the Radiation Safety Program. New employees will be schooled in all aspects of Radiation Safety. This will ensure that all personnel can correctly apply Radiation Safety Protection as it relates to their primary duties, and to temporary placement in the Pant area. A follow-up safety session will be to be conducted with each new employee during the first three months of employment, and a written record maintained. Thereafter, an annual test by the RSO of each employees' understanding of the Radiation Safety Program will be conducted, and a record maintained on file.

9.18.2 Visitor Training

Visitor Training will be minimal, and visitors will be instructed as to the primary hazard at an *in situ* uranium mine, yellowcake ingestion. Visitors will be instructed to avoid contact with visible yellowcake in any location containing radioactive materials. Visitors will also be informed that the HRI performs routine surveys of the radiation levels, and surface contamination in any area which will be visited, and that safe conditions have been documented in each of these areas.

9.18.3 Clerical and Office Support Staff

Clerical, and office support staff, and non-operations technical staff will be employees who typically work outside the "Work Area". Particularly, they will not require frisking before leaving the work area on a regular basis. Their training will be an abridged version of that given to the operation staff. Training, and testing will be documented within the employees files.

9.18.4 Operations Personnel

Personnel who work within the "Work Area" will be provided Operations Personnel training. These individuals will typically be required to work with radioactive materials, and therefore, require more intense monitoring, and frisking before leaving the work area.

In addition to classroom training, employees will receive continuous on-the-job training (OJT) from plant supervisors, and the RSO. Plant employees job performance with respect to radiation protection will be appraised annually by his immediate supervisor, and the RSO to determine if retraining is necessary. A training evaluation sheet signed by the supervisor, and the RSO will be placed in the employees' personnel file. A training completion, and Radiation Safety Rules will be signed by the RSO, and the employee, and included in the employees' personnel file. The supervisor will be responsible for a continuous evaluation, and OJT as necessary to ensure the employees' exposure is maintained "As Low As Reasonably Achievable".

9.18.5 Supervisory Personnel

Supervisors will receive all training received at Operations Personnel Level instruction, and additional training which will be appropriate for supervisors including: ALARA philosophy, contamination control, and work practices. Supervisors will be required to be fluent in certain surveys which may be required prior to releasing equipment in the absence of the RSO/RST, and will be able to provide specific job related training, and evaluate their subordinates performance.

9.18.6 Prenatal Training

Female employees will be given training operations or, supervisory level depending on position of employment as above. Additionally, all female employees will be given instructions concerning prenatal radiation exposure, and controlling radiation dose in the case of pregnancy similar to U.S. NRC Regulatory Guide 8.13, "Instruction Concerning Prenatal Radiation Exposure".

9.18.7 Special Training for Yellowcake Transport Accidents

HRI will select, and train capable personnel to prepare for a potential transport accident according to Section 9.14. A team will be supervised by the Production Manager, Environmental Manager, and Plant Superintendent, and must contain members from the Radiation Safety Department, and plant personnel. This team will have good background knowledge in radiation safety as per required in employee orientation. Further training in containment, recovery, decontamination, and the equipment needed to control such a spill will be given on an annual basis. In the event of any magnitude, the team will have been adequately trained, and provided with the equipment to contain, and decontaminate any accident site according to Section 9.14.

10.0 RECLAMATION PLAN

10.1 General

Reclamation at the project site will be comprised of four major activities which include the following:

- Radiological decontamination of buildings, process vessels, and other structures, or affected areas.
- Removal, and reclamation of the CCP, Satellites, and auxiliary structures.
- Surface reclamation, and revegetation of restored well fields.
- Ground water restoration within affected wellfields, including production, and monitor well plugging.

The preliminary schedule for mining related activities, and restoration has been discussed in Section 2 of the COP. Decommissioning, and reclamation of the CCP, and Satellite sites will take place after mining is complete. Ground water restoration, and wellfield decommissioning will be accomplished as wellfields are completely mined out. Satellite facilities will also be decommissioned as soon as ground water restoration is complete, and they are no longer needed.

Pursuant to regulatory requirements, HRI will submit a detailed reclamation plan to the NRC for review, and approval at least 12 months prior to the planned final shutdown of mining operations. If depressions appear at the land surface due to subsurface collapse, HRI will return the land surface to its general contour as part of the project's surface reclamation activities. Before release of an area to unrestricted use, HRI will provide information to the NRC verifying that radionuclide concentrations meet applicable radiation standards.

Both the surface reclamation plan, and ground water restoration plan are intended to return areas affected by mining activities to a condition which supports the premining land use of sheep, and cattle grazing, and associated wildlife habitat.

10.2 Radiological Decontamination

All radiologically contaminated buildings, process vessels, and other structures, and affected areas will be decontaminated prior to final reclamation to unrestricted release standards in accordance with NRC requirements, or removed to the appropriate disposal facilities. Decontamination will include acid, and water washdown of structures, and concrete. The resulting waste water will be disposed by disposal well, brine concentration, and evaporation. Equipment which cannot be decontaminated will be dismantled, and disposed in an U.S. NRC licensed waste disposal facility, or utilized at another NRC licensed uranium facility. All uncontaminated foundations will be removed, or broken, and buried in place.

10.3 Reclamation and Revegetation

The purpose of the reclamation program will be to stabilize the site with self-sustaining vegetative cover, and to restore all land disturbed by mining, and related activities to a productive condition for livestock grazing, and wildlife habitat consistent with the present, and historical use of the area. Because of present overgrazing practices in the area, it is anticipated the reclamation program will substantially improve the project site. It is anticipated that future land use will be similar to current uses. Therefore, all revegetation treatments, and plant species used will be selected for their desirability as cover, and food for domestic, and native fauna, soil stability, and surface, and subsurface water conservation.

10.3.1 Wellfield

During drilling operations, topsoil will be carefully removed from drill pit locations, and separated from the subsoil. After the drilling is complete, and the subsoil will be replaced followed by the topsoil. The drill site will then be graded, and seeded as outlined in Section 10.3.4.

After ground water restoration is complete, all surface laterals, and pipelines will be removed. Any vegetation which has been disrupted will be reseeded.

10.3.2 Plant Areas

Topsoil will be stockpiled as necessary in the location of all new plant facilities including buildings, and ponds. Temporary grass will be established on these piles to prevent erosion.

After operations, all buildings, ponds, and equipment will be demolished, and removed from the CUP area. All contaminated material will be reused for licenses activities, decommissioned below release limits, and disposed of in an approved landfill, or disposed of in an approved byproduct disposal area.

Topsoil will be placed in the location where it was removed, and the area seeded as outlined in Section 10.3.4.

10.3.3 Wells

All production, and injection wells will be permanently plugged, and abandoned upon completion of ground water restoration and, stabilized in a manner which prevents interformational transfer of fluids. In particular, wells will be plugged from TD to surface with a neat cement with a weight of 15.6 ppg, or as otherwise determined by the New Mexico State Engineer. The casing will be cut off three feet from the surface and, the site seeded as outlined below.

10.3.4 Seeding Rates, Species, and Methods of Application

Species mixtures adapted to the climate, and soil conditions existing on the properties, with forage characteristics of palatability, tolerance to grazing, and availability for year-round use, will be established. General species, and treatments for revegetation will include varieties of species, and species mixtures that have been tested.

The following mixture of native plants, and rates of seeding are planned to be used for the various soil types that may occur on the disturbed area. Normally, a maximum of three species of grass is used in the planned mixture (Table 10.3-1).

TABLE 10.3-1 POUNDS OF PURE LIVE SEED PER ACRE (KG/HA)

	Clay Site	Loamy Site	Sandy Site
Arriba Western Wheatgrass	6.4(7.3)	4.8(5.4)	6.4(7.2)
Alkali Sacaton	.8(.9)	.7(.8)	.5(.6)
Vaughn Sideoats Gramma		2.0(2.2)	1.6(1.8)
Paloma Indian Ricegrass			2.4(2.7)
Bandera Rocky Mtn. Penstemon			.3(.3)
Pastura Little Bluestem	.3(.3)	.6(.7)	
Fourwing Saltbrush	1.2(1.3)		
Rabbit Brush			

When surface conditions, and slopes permit, approved seed mixtures will be mechanically drilled with a drill suited to handling a variety of grass, and legume seeds. If situations occur where slopes are too steep, or rocky for seedling equipment, the mixture will be broadcast at approximately twice the recommended rate followed by harrowing, brush drag, or similar treatment to ensure seed coverage.

Mulch will be used in areas where water retention, soil temperature, or soil crusting are potential problems for seed germination, and seedling growth. The mulch will be spread, or blown uniformly over the area immediately after seeding. The mulch will consist of grass hay, straw, or woodchip applied at the rate of approximately 4.5 t/ha (2 ton/acre). It will be anchored mechanically with a mulch tiller, crimper, or if necessary with a chemical compound. Bark, wood chips, and jute netting may be used for special situation.

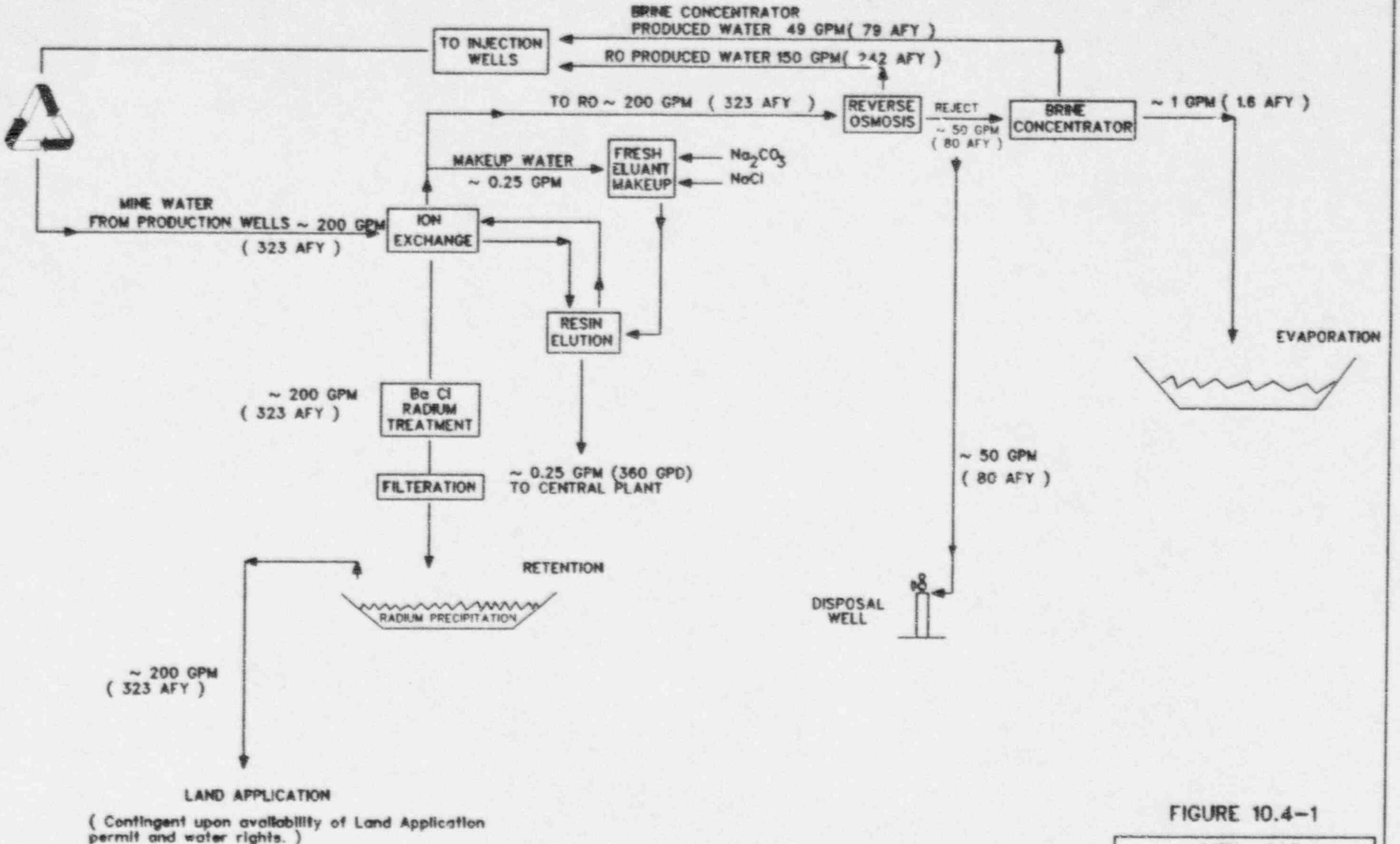
The limiting factor in establishment of plants in the Crownpoint area will be available moisture. However, fertilizer can be applied with proper moisture, to effectively establish seeded species. The need, and benefit of fertilizer will be determined by site specific soil analysis, and available moisture. When used, fertilizer will be placed near the drill row for maximum benefit. Broadcast application may be necessary in certain situations, but is less desirable than application with a drill because more fertilizer is required.

Time of seeding under nonirrigated conditions will be very critical in New Mexico. The most desirable time for seeding is during the season of the highest expected precipitation. New Mexico's precipitation records show the greatest moisture comes in McKinley County in July, August, and September. The seeding project will be completed 45 to 60 days before expected long dry periods, or freezing weather. Some species, e.g., Paloma Indian Ricegrass, and Fourwing Saltbush, will germinate in late winter if sufficient moisture is available, and good emergence of these species may occur from seedings in late fall, or early winter.

The mine site will be fenced for the life of the operation. After reclamation, seeded areas will be protected by fencing, herding, or other approved animal control techniques until vegetation is established.

10.4 Ground Water Restoration

Prior to conducting mining operations, HRI will develop a updated groundwater restoration plan for the entire project. At a



REVISED AUG. 29, 1996
REVISED MAY 8, 1997

FIGURE 10.4-1

HRI, INC.

CHURCHROCK PROJECT
RESTORATION FLOW SHEET

RESTOR3

minimum, this plan will include a refined restoration schedule, and a general description of updated methodology of restoration, and post-restoration groundwater monitoring for the entire project.

At this time, HRI proposes to use three groundwater restoration alternatives at each project site:

a. 100 percent groundwater sweep (ground water is pumped from the aquifer, but not returned to the aquifer);

b. Reverse osmosis treatment with 3 parts product, and 1 part reject, and;

c. Brine concentration, and reverse osmosis reject with 99 parts product, and 1 part reject.

Under the 100 percent groundwater sweep option, wastewater will be disposed of by land application. Under the reverse osmosis option, product water will be injected back into the production patterns, and wastewater will be concentrated, and evaporated, or injected into a deep disposal well, or both. HRI will have to acquire an injection permit from the appropriate State, or Federal agency before wastewater can be injected into a deep disposal well. If land application were the chosen option, appropriate State permits will have to be obtained.

Restoration of the production zone, be it conducted by reverse osmosis (RO) treatment, ground water sweep, or a combination of the two, will utilize the injection-extraction wellfield configuration which was employed during mining. By using the existing production wellfield pattern configuration, the efficient reservoir engineering design benefits that were employed during uranium production will be available for restoration. Ground water sweep, and R.O. technology has been widely utilized within the ISL industry, and the resulting restoration history highly is successful.

Restoration progress will be a routine part of the overall mine plan. The core test, and historical experience, by HRI has indicated that restoration to levels consistent with baseline can be achieved after approximately four to five pore volumes of ground water circulation. This is consistent with other industry experience where the sodium bicarbonate leach system was utilized.

10.4.1 Groundwater Restoration Criteria

HRI plans that groundwater restoration criteria be established on a parameter-by-parameter basis, with the primary goal of restoration to return all parameters to average pre-mining baseline conditions. To the extent that water quality parameters cannot be returned to the identical average pre-mining baseline levels, the secondary goal will be to return water quality to the maximum concentration limits as specified in EPA secondary, and primary drinking water regulations (40 CFR part 141 and § 143.3). The secondary restoration goal for barium, and fluoride will be set to the State of New Mexico primary drinking water standard, which is lower than federal standards. A value of 300 pCi/mL (0.44 mg/L) will be used for uranium. This concentration was obtained from 10 CFR Part 20; it is suitable for unrestricted release of natural uranium to water, and is below the State of New Mexico primary drinking water standard for uranium.

Under the conditions discussed above, HRI's secondary restoration goal will be equal to, or below both State of New Mexico, and EPA primary, and secondary drinking water standards. Table 8.6-1 lists the primary, and secondary restoration goals.

These restoration goals are consistent with the NRC Staff Technical Position Paper *Groundwater Monitoring at Uranium In Situ Solution Mines* (NRC 1981b). This document states that

> The following are recommended restoration targets:
>
> **a.** Restoration results in a return to baseline groundwater quality for all indicators in all affected groundwater, and in all restoration water quality monitor wells.
>
> **b.** Where the baseline concentration of a particular indicator is less than drinking water standards, the appropriate established State, and Federal criteria may be used to establish maximum permissible values for restoration purposes.

If a groundwater parameter listed in Table 8.6-1 can not be restored to its secondary goal, HRI will make a demonstration to NRC that leaving the parameter at the higher concentration will not threaten public health, and safety, and that, on a parameter-by-parameter basis, water use will not be significantly degraded. Additionally, it is possible that after groundwater restoration, the TDS secondary goal might be achieved, but the secondary goal for individual major ions that contribute to TDS might not be achieved because they do not have a secondary, or primary drinking water standard (for example bicarbonate, carbonate, calcium, magnesium, potassium). As a result, HRI will make a demonstration to NRC that leaving a parameter at higher than secondary goal concentrations does not threat public health, and safety, and that water use will not be significantly degraded.

10.4.2 Restoration Operations Are Engineered Soundly

The restoration of ground water at the COP has the benefit of a previously engineered array of injection, and production wells that were initially installed in a configuration to maximize sweep efficiently throughout the uranium orebody, and maximize uranium recovery. The same engineering principals hold for maximum sweep efficiently during the restoration phase. In other words, ground water restoration is performed uniformly throughout the mine zone, and verified statistically at individual sampling points. The engineering principle which assures restoration is sound.

10.4.3 Changes in Groundwater Chemistry are Minor

Leach solution is not significantly different than native ground water within the orebody. It is well documented that radionuclides limit the use of water (RA-226, RN-222 and U_3O_8) before mining in uranium-bearing aquifers. These are also the primary parameters which are elevated, and limit water use after restoration. Currently, the presence of high radionuclide concentrations at the CUP properties do not affect surrounding water supply wells. The mining process does not introduce new chemical species to the ground water system but does elevate certain species that are native to the host aquifer.

Specifically, the leaching solution utilized by HRI is simply ground water fortified with oxygen, and is benign compared to the acidic, or ammonia bicarbonate leaching solution that were used in earlier in-situ operations. Early leach solutions had the common trait of introducing foreign substances to the ground water during mining, which ultimately caused restoration difficulties. The proposed leaching solution for this project simply changes the oxidation state of the ground water, and utilize natural ionic materials within the water as complexing agents. The pH remains neutral, and restoration is centered around reducing naturally occurring constituents in ground water which become elevated as a result of the leaching process. Naturally occurring radioactive materials, especially uranium, which will be elevated during the mining process are the most significant parameter limiting premining use of the water and will be subjected to the closest scrutiny during restoration.

10.4.4 Documentation of Effectiveness

After production begins at any mine site at the CUP, HRI will immediately begin work on a field restoration demonstration, outside of the actual production, yet inside the monitor well ring, and within the target ore zone. Key elements of the restoration demonstration will be as follows:

a. An isolated restoration demonstration pattern, completed in the ore zone, constructed to the same basic configuration as the proposed production wellfield pattern, and operated under the same conditions as the proposed mining procedures.

b. Leaching of the pattern will be run for at least three months under commercial activity conditions using leaching agent concentrations equal to, or greater than is expected to be required for production.

c. After leaching phase, a complete chemical description of the produced fluid will be obtained and a demonstration of a restoration will be initiated.

d. Sample analysis of key parameters and fluids will be completed at least every week during the restoration demonstration.

e. Restoration will continue until the ground water is restored to levels consistent with baseline.

f. With each progress report, HRI will calculate and submit the volume of ground water affected, expressed in pore volumes. Factors to be considered include: aerial extent, formation thickness and porosity. Upon the completion of the restoration demonstration, the data, analysis, and conclusions will be compiled into a final report.

g. Authorization for expansion of mining into additional areas will be contingent upon the results of the restoration demonstration within the 24 month period.

In addition to the field restoration demonstration provisions stated above, prior to the injection of lixiviant at either the Unit 1, or Crownpoint site, HRI will complete the restoration demonstration at the Churchrock site. The demonstration will be conducted at a large enough scale to determine the number of pore volumes that will be required to restore a production-scale wellfield. Surety (bonding) for ground water restoration of these initial wellfields will be based on nine pore volumes. Surety will be maintained at this level until HRI can demonstrate the number of pore volumes required to restore a production-scale wellfield.

10.4.5 Restoration Progress

Restoration rates will be monitored through analysis of waters produced from the formation. A sample will be taken weekly from the composite production line and analyzed for conductivity, and uranium. This data will be compiled monthly and reported biannually to the USNRC and UIC regulatory authorities.

When this data indicates that restoration is at, or near completion, each original baseline well will be sampled and analyzed for the parameters listed in Table 10.4-1 below.

If the wellfield average value for each chemical parameter is consistent with baseline quality, restoration is considered to be complete.

Stability will be determined by three sample sets taken at two-month intervals from the original baseline wells, and analyzed for the parameters in Table 8.6-1.

Individual parameters that cannot be returned to baseline by reasonable efforts, on a mine-unit average basis, will be returned at least to concentration levels corresponding to the greatest potential premining use of the ground water, based upon established the drinking water standard. HRI has tabulated these restoration goals on Table 8.6-1 and described them in Section 10.4.1.

TABLE 10.4-1
WATER QUALITY PARAMETERS (SHORT LIST)

Ca	HCO_3	Na	SO_4	Cl	TDS	U-nat

10.4.6 Restoration Surety

Surety (bonding) for ground water restoration of the initial wellfields will be based on nine pore-volume estimates. The nine pore volume estimate is based on the submitted data. Depending on the parameter and the test chosen, the pore volumes required to achieve the lesser water quality of the secondary restoration goal, or background, ranged from less than ore pore volume to greater than 28 pore volumes. However, plots of total dissolved solids, and specific conductivity values (an indirect measure of TDS) show little improvement with continued pumping after eight to ten pore volumes. The Mobil ground water demonstration is the largest restoration demonstration conducted in the local area to date. During ground water restoration activities, after 6.9 and 9.7 pore volumes, TDS concentrations were close to the TDS secondary restoration goal of 500 mg/l. Therefore, it is estimated that practical production scale ground water restoration activities will at most implement a nine pore volume restoration effort. Surety will be maintained at this level until the number of pore volumes required to restore the ground water quality of a production scale wellfield has been demonstrated as stated in Section 10.4.4.

10.4.7 Cost Reimbursement

When ground water restoration activities begin at the production-scale wellfield at either the Unit 1, or the Crownpoint sites, HRI will reimburse the Town of Crownpoint for increased pumping and well work-over costs. Cost Reimbursement does not include smaller restoration demonstration wellfields.

As a conservative estimate of reimbursement amounts, HRI presents the worst case analysis of the most affected wells during operations in Table 10.7-1. Cost reimbursement will be ultimately based on actual affects.

Table 10.7.1

Conservative Case Showing Additonal Pumping Cost per Year Due to Lowered Water Levels at Crownpoint Town Water Wells Caused by ISL Mining & Restoration at Crownpoint / Unit 1

		Additional Cost Due to Crownpoint ISL Operation		Additional Cost Due to Unit 1 ISL Operation		Additional Cost Due to Crownpoint & Unit 1 ISL Operation	
Crownpoint Town Well	Average Summer Flowrate (gpm)	Drawdown (feet) [1]	Annual Cost ($)	Drawdown (feet) [3]	Annual Cost ($)	Drawdown (feet) [2]	Annual Cost ($)
BIA #3	79.4	53	$926	25	$437	78	$1,363
BIA #5	6.2	53	$72	25	$34	78	$106
BIA #6	100	51	$1,122	22	$484	73	$1,606
NTUA #1	27.7	55	$335	25	$152	80	$488
NTUA Conoco	58.7	44	$568	26	$336	70	$904

[1] Drawdown (feet) due to operation of HRI's Crownpoint ISL; estimated from figure shown as Attachment 60-1, HRI's response to NRC Q1 / 60.

[2] Drawdown (feet) due to operation of HRI's Crownpoint & Unit 1 ISL; estimated from figure shown as Attachment 60-2, HRI's response to NRC Q1 / 60.

[3] Drawdown (feet) due to operation of HRI's Unit 1 ISL; estimated by subtracting (1) from (2).

Typically, electrical amperage required by a submersible the pump is reasonably constant over a wide range of flowrates. However, conservatively assuming that amperage varies with hydraulic horsepower, the cost per year would be calculated as follows:

$$\frac{\$}{\text{year}} = \frac{(\text{gpm})\ (\text{head, feet})\ (0.746\ \text{kw/hp})\ (1440\ \text{min/day})\ (365\ \text{day/yr})\ (\$/\text{kw-hr})}{(3960)\ (60\ \text{min/hr})\ (\text{pump efficiency})\ (\text{motor efficiency})}$$

75% <-- Submersible pump efficiency (%).

75% <-- Motor efficiency (%).

$0.075 <-- Cost per Kw-hr ($).

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