Southwest Research and Information Center
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ANALYSIS OF MOBIL/TVA'S INTERIM MINING AND
RECLAMATION PLAN FOR PILOT TESTING OF IN SITU LEACHING
AT CROWNPOINT, MCKINLEY COUNTY, NEW MEXICO, MAY 1978

June 19, 1978

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INTRODUCTION: THE CONTEXT OF THE PROJECT

Mobil Oil Corporation has submitted a Mining and Reclamation Plan for an in-situ Pilot Uranium Mine west of Crownpoint, New Mexico to both the U. S. Geological Survey (USGS) and the New Mexico Environmental Improvement Division (EID). The Geological Survey reviews the mining plan in its role as the Bureau of Indian Affairs technical expert on mining activity on Indian land. The EID Radiation Protection Section will decide on the issuance of a radioactive materials license to the operation. The EID Water Pollution Control Section will approve a groundwater discharge plan considering the in-situ project's impact on the quality of waters of "present or reasonably forseeable use". (NMWQCC Groundwater Regulations, Jan., 1977). Each of these steps adds to the public role in determining the future health and welfare of New Mexico and the nation.

The project consists of an array of production and injection wells in a "five-spot" pattern (Mining Plan, P.177) surrounded by a circle of monitoring wells. The four 20-gallons per minute (gpm) production wells at 247 milligrams/liter of uranium (Mining Plan, p.39)would yield 18.7 grams of uranium per minute. In a 14 month production period (6.04×10^5 minutes) the mine would extract a high estimate of 47.8×10^6 grams of uranium. At 453 grams per pound this pilot project could yield 1.05×10^5 pounds of yellowcake equivalent worth over 4×10^6 at \$40 per pound. Making similar projections for other metals in the leach solution, the operation will mobilize up to 47 lbs. of arsenic, 29×10^3 lbs. of molybdenum, 389 lbs. of selenium and 61×10^9 pCi of radium during the leaching phase. These are clearly toxic materials in toxic quantities.

The target for the in-situ leaching test is a uranium ore body almost 2,000 feet deep. No in-situ leaching has been developed commercially at this depth. The ore lies in the uranium-rich Westwater Canyon member of the Morrison formation of Jurassic age. This Westwater Canyon member supplies high-quality drinking water to the dispersed population of the Eastern Navajo Agency from wells at Crownpoint, New Mexico. These wells are the only existing beneficial use of Southern San Juan Basin groundwater at this time. These wells pump about 610,000 gallons per day as a community water supply.

The list of uranium projects around the Crownpoint wells is impressive. Mobil's in-situ project lies five miles east of this well field in a set of leases Mobil has purchased. These leases include over 12,480 acres of land east of Crownpoint. Mobil operates a joint venture with Tennessee Valley Authority, a Federal entity, on these leases. The operators plan to develop an underground uranium mine in T17N, R13E, Sec.15, less than 2 miles from the in-situ site. On June 10, 1978 the United States Environmental Protection Agency (EPA) and the State of New Mexico issued a public notice concerning federal water pollution control permits (NPDES permits) on several new uranium mines in the Crownpoint area.

Mines listed in this notice include:

	Mine*	Projected mine dewatering rate*	Distance from In-Situ Site*	Location*
		10^6 gallons/day		
1)	Phillips-Nose Rock	2.0	12 miles	T19N, R11W, Sec. 31
2)	Gulf-Mariano Lake	2.0	8 "	T15N, R14W, Sec. 12
3)	Conoco-Crownpoint	5.0	6 "	T17N, R13W, Sec. 29
4)	Conoco-Borrego Pass	5.7	14 "	T16N, R10W, Sec. 18
5)	United Nuclear-Old Churchrock	?	17 "	T16N, R16W, Sec. 17
6)	Pioneer Nuclear-Narrow Canyon	2.8	4 "	T17N, R14W, Sec. 2

Other mines pending in the area include:

7)	TVA-UNC Dalton Pass Shaft 1	10.8 (Shafts 1–5)	4-6 mls.	T17N, R14W, Sec. 14
8)	Shaft 2		"	Sec. 24
9)	Shaft 3		"	Sec. 23
10)	Shaft 4		"	Sec. 13
11)	Shaft 5		"	T17N, R13W, Sec. 30
12)	TVA/Mobil-Crownpoint	1.4	2 mls.	T17N, R13W, Sec. 15
13)	Mobil-Monument	?	7 "	T17N, R12W, Sec. 28

The following mines are presently in operation 15-17 miles from the proposal in situ site:

14)	Kerr-McGee-Churchrock I	2.2	15-17 mls.	T17N, R16W, Sec. 35
15)	United Nuclear-NE Churchrock	2.0	15-17 "	T17N, R16W, Sec. 35

Kerr-McGee plans:

16)	Kerr-McGee-Churchrock II	2.8	15-17 "	T17N, R16W, Sec. 27
17)	Kerr-McGee-Churchrock III	4.3	15-17 "	T17N, R16W, Sec. 16

* The source for this table is the New Mexico Uranium Inventory, Southwest Research and Information Center, Albuquerque, New Mexico, May 1978. See Appendix A for reference sheet.

Assuming a minimum of 200 exploration and development holes per mine, there are over 3,400 holes in the Westwater Canyon member within 20 miles of the in-situ site. Presently all these mines are projected to be underground shaft operations. Each mine will dewater the ore zone to facilitate production at the rates listed on page 3. This is the same ore horizon to be used in the in-situ project and is the same aquifer as that used by the Crownpoint community wells.

The Mobil in-situ proposal would test the feasibility of a new uranium technology in New Mexico, the United States' primary source of uranium fuel. This technology has been developed in Texas for ore zones perhaps 500 feet deep and has been proposed for Wyoming by Exxon at Highland site (also a shallow site). The Westwater Canyon member lies 2,000 feet below the surface in the project area and presents very different problems than the Texas situation.

This in-situ mining plan covers a project on land leased from a federal agency, is being administered by several state and federal agencies, involves a significant development in the technology of major importance to state and national resources and will affect an aquifer used by several thousand people for a drinking water supply.

Groundwater Regulations Hearing Request

The significant level of public impact and therefore public interest in this project is clearly evident. Southwest Research and Information Center requests a public hearing on the groundwater discharge plan which the state of New Mexico must approve for the operation which affects groundwater of present and reasonably forseeable use. Such a hearing will allow public input to the state's radioactive materials licensing process also. Other comments on the Mining Plan relevant to this hearing request are included below.

Significance Within NEPA

We also recognize the project to be a significant federal action within the understanding of the National Environmental Policy Act (NEPA). The radical nature of the technology proposed, the several federal agencies involved (BIA-leasor, USGS-monitor, TVA-owner), the large size of land area under lease--almost 20 square miles--and the potential impact of the project on water used by thousands of citizens of the United States, including a majority of Indian people to whom the federal government bears a special responsibility all connote a significant federal action under NEPA.

TVA's letter in the Mining Plan, at Appendix A, appears inadequate as a determination of the significance of the in-situ proposal. The unique nature of the project, its role in determining future impacts, its potential effect on drinking water and its involvement of several federal agencies defines the significance of the project. The recent resolution from the Dalton Pass Chapter, Navajo Tribe, which lies just east of the in-situ site, speaking strongly against uranium mining describes the level of public controversy on uranium mining in the region. The TVA letter does not address or negate any of these significant or controversial aspects of the project.

Mining Plan Comments

The following analysis of the Mining Plan raises several questions we feel must be answered before the various state and federal administrative bodies and the public, through open hearings near the site, permit the proposed mine.

This analysis concerns:

- in-situ vs. underground mining and the future Westwater Canyon member hydrologic system;
- restoration goals;
- excursion limiting procedure.

In-situ vs. underground mining and the future Westwater Canyon member hydrologic system.

In-situ leaching has a very different set of impacts on water resources than underground shaft mining. It requires accurately controlling pressures in an aquifer to draw a leachate through ore to a production well. Careful monitoring and adjustment of flow pressure is essential to an effective and sound leaching operation.

The Mining Plan fails to discuss the proposed operation in a generic sense of costs and benefits of operating an in-situ project in an aquifer suffering major withdrawals which translates as important water and pressure quantity changes; that is, what happens when in-situ and underground mining go on within each other's range of effect? This question is key to the decision to authorize this project. It should be answered by the operator for a range of in-situ development scenarios and a range of underground shaft mining development scenerios.

TVA has modeled the effects of the dewatering of six uranium mines (see Appendix B) -- those numbered 1, 3, 6, 7, 11, and 12 -- on page 3 of this paper. Given the seventeen mines listed on page 3, TVA's study clearly uses a low estimate of total dewatering impact. Still, this study shows major changes in the artesian head of the Westwater Canyon member. Drawdown of 1,300 feet at the in-situ site after 10 years of mine water discharge and 1,500 feet after 20 years of mine water discharge are projected. These maps from the TVA study are included as Appendix B.

The Mining Plan does not consider the impacts of these dewatering effects on the feasibility of in-situ uranium mining. The project has a 14-month production life and an 8-month restoration period. This 22-month period will be ending as the earliest projected southern San Juan Basin uranium mines begin reaching their ore zone and seriously affecting the hydrodynamics of the ore bearing zone. Thus the pilot project will occur mainly in a pristine aquifer and with full effects of dewatering being felt only as restoration -- the critical cleansing of the aquifer -- begins. The pilot project will not test "the waters" in the disequilibrium created by major mine dewatering withdrawals, which is the likely environment of any future in-situ leaching. The timing of the pilot project should be addressed by the Mining Plan.

The Nuclear Regulatory Commission's (NRC) Draft Environmental Statement related to operation of Exxon's Highland Uranium Solution Mining Project in Wyoming, May 1978, NUREG-0407 p.3-2, mentions four criteria essential for in-situ leaching:

1. the ore deposit must be in a saturated zone;
2. the ore deposit must be confined both above and below by impervious layers;
3. the deposit must have adequate permeability;
4. the deposit must be amenable to chemical leaching.

The possibility that many new mines will be dewatering the Westwater Canyon formation means the first of the criteria cannot be guaranteed. The in-situ pilot plant may only get through its 14-month production period before large scale dewatering reaches its area of effect (has the site suffered any effects from the two Churchrock area mines now in operation?). However the effect of large scale withdrawals will certainly cause drastic changes in the aquifer in question as a result of desaturating parts of the layer which bear minable concentrations of uranium. This desaturation would be unacceptable in an in-situ leaching project. The high probability of large scale underground uranium mining may make it technically unacceptable to use in-situ leaching processes in the long run. The Mining Plan should address these questions.

Another example should be noted here. Anaconda began using deep-well injection of uranium mill effluent as a disposal technique in the early 1960's. By 1975 this technique had become unacceptable as a disposal technique and is being abandoned. (See recent Anaconda-Bluewater mill discharge plans, EID office, Santa Fe, N.M.). This experience points out the potential dangers inherent in the deep-well injection technique.

Merely an assurance of restoration is not adequate. Restoration to applicable standards, Ground Water Regulations, Drinking Water Standards, twice background or whatever must be proven before experimenting with the best aquifer in Northwestern New Mexico can be allowed. The idea of a pilot test is to assess the effectiveness of a technique before full scale operation. If the pilot test conditions are dissimilar to full scale conditions, the test provides very little good quality information for future use.

Restoration Goals

The Lab scale tests of restoration of Westwater Canyon member water quality are included at p. 39 of the Mining Plan. Selected parameters in this table have been graphed to show their trends in relation to the New Mexico Groundwater Quality Regulations and the base fluid, close to present natural water quality. The parameters graphed include: arsenic, molybdenum, selenium, uranium, and radium-226. These represent a sample of pollutants of concern in uranium mining water quality impact assessment. See Figures 1-5. Inspection of these figures show reduced cleansing with increased flushing. Restoration efficiency decreases with increased pore volumes of flushing.

The Lab scale test only calculates restoration at a maximum of 4.51 pore volumes. At 6.2 pore volumes (p.v.) in 56 days (Mining Plan, p. 75), or 0.11 pore volumes per day, the Lab test represents 41 days of restoration. The Mining Plan proposes 240 days (or over 26 pore volumes) of restoration.

Analysis of the Lab scale restoration effort shows:

Parameter	Factor by which 4.51 p.v. restoration exceed New Mexico Groundwater Standards
Arsenic	2.9
Molybdenum	4.6
Selenium	5.4
Uranium	3.4
Radium-226	6 (assumes Ra-226 and Ra-228 standard and no Ra-226)

The radium measurements are particularly important. This material has the lowest allowable concentrations and the poorest quality data of any of the key parameters graphed. The table also fails to distinguish between dissolved and total radium-

226. The table on p. 39 should present a full analysis of radium (and by analogy other radioactive parameters). Radium is the most hazardous compound of any of the array of toxic compounds the in-situ project will utilize.

The Lab scale test has not shown the mine operator to be capable of maintaining the quality of water allowed by the New Mexico Groundwater Regulations. Clearly this test must be expanded to demonstrate with accuracy that restoration to Groundwater Regulation quality can be obtained for a variety of aquifer use possibilities before the project can begin.

The analysis of restoration with an Initial Groundwater Flush (or 6.2 p.v. in 56 days) from Mining Plan, p.75, shows improved response for most pollutants. The Texas numbers do not include uranium or most other radioactive parameters, does not discern between dissolved or total radium-226, and leaves out the highest expected concentrations of toxics (the concentrations during leaching), and the concentrations after prolonged restoration (the "Present" column of the Mining Plan, p.75).

The differences in leach fluid and the lack of discussion of comparative metallurgy and chemistry of the Texas and New Mexico environment cuts off any direct validity of the Texas numbers to the New Mexico situation.

This in-situ pilot test affects waters with present use as drinking water. The operator should complete its bench scale test of restoration potential and provide a complete comparison of the Texas experience, and other relevant Wyoming examples, and its relevance or irrelevance to specific New Mexico parameters, to allow a comprehensive understanding of the effects of the in-situ leach operation before it is authorized.

Excursion Limiting Procedure

Specific changes can be made to limit potential excursions of pollutants before the project is allowed to proceed. This would be revisions to the Correction of-Excursion section, pp. 172-175 of the Mining Plan. When an excursion occurs and the public is notified, only the fastest actions will be deemed responsible.

Step B - The operator can monitor the excursion on a daily basis. Such an analysis would allow a more accurate description of excursion character.

Step D - Secondary monitors should be installed immediately after the excursion has been identified; monitoring of secondary observation wells should begin as soon as possible.

Step I - Monitoring should be on a daily basis for accurate excursion analysis.

A significant increase should be considered as exceeding New Mexico Groundwater Quality Standards or Public Health Services drinking water standards.

Conclusion

This analysis identifies significant gaps in the Mining Plan for Mobil In-Situ Pilot Project west of Crownpoint, New Mexico. It spells out areas requiring further work in areas of a generic nature regarding the aquifer of concern and the relationship of in-situ and underground mining in close proximity. We also have outlined questions concerning the details provided for both the operation and restoration phases of the project. The analysis supports our request for a public hearing on the operator's request for discharge plan approval and raises questions relevant to the Radioative Materials licensing of the project. The concerns raised also identify areas of significant impact on the human environment within the intent of NEPA.

FIGURE 1 GRAPH OF RESTORATION NUMBERS (LAB SCALE) FOR MOBIL/TVA IN-SITU PILOT PROJECT NEAR CROWNPOINT, NM

SOURCE: IN-SITU MINING PLAN, p. 39

PARAMETER: ARSENIC

UNITS: 10^{-1} milligrams/liter

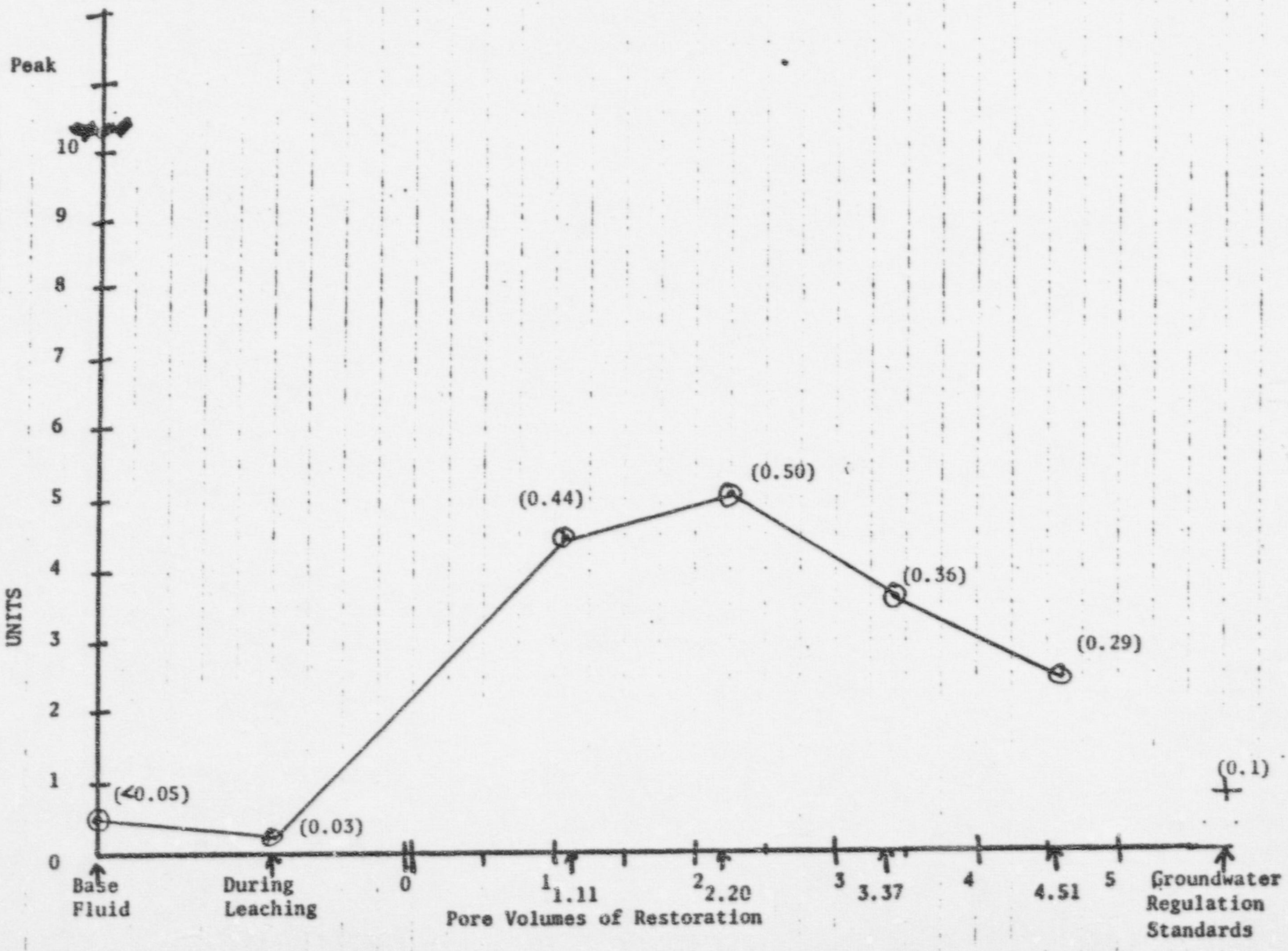


FIGURE 2 GRAPH OF RESTORATION NUMBERS(LAB SCALE) FOR MOBIL/TVA IN-SITU PILOT PROJECT NEAR CROWNPOINT,NM

SOURCE: IN-SITU MINING PLAN,p. 39

PARAMETER:MOLYBDENUM

UNITS:milligrams/liter

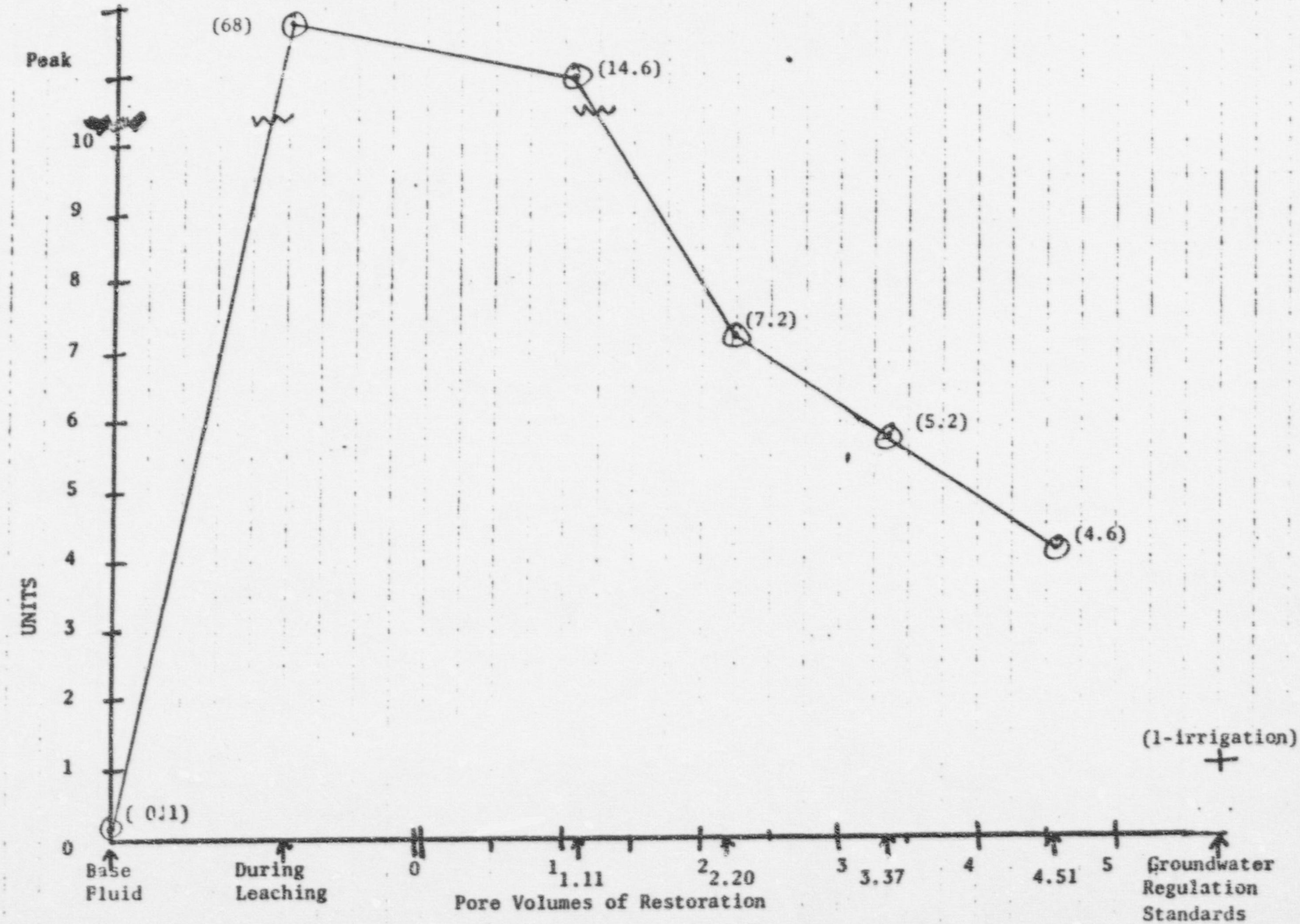


FIGURE 3 GRAPH OF RESTORATION NUMBERS (LAB SCALE) FOR MOBIL/TVA IN-SITU PILOT PROJECT NEAR CROWNPOINT, NM
SOURCE: IN-SITU MINING PLAN, p. 39

PARAMETER: SELENIUM
UNITS: 10^{-1} milligrams/liter

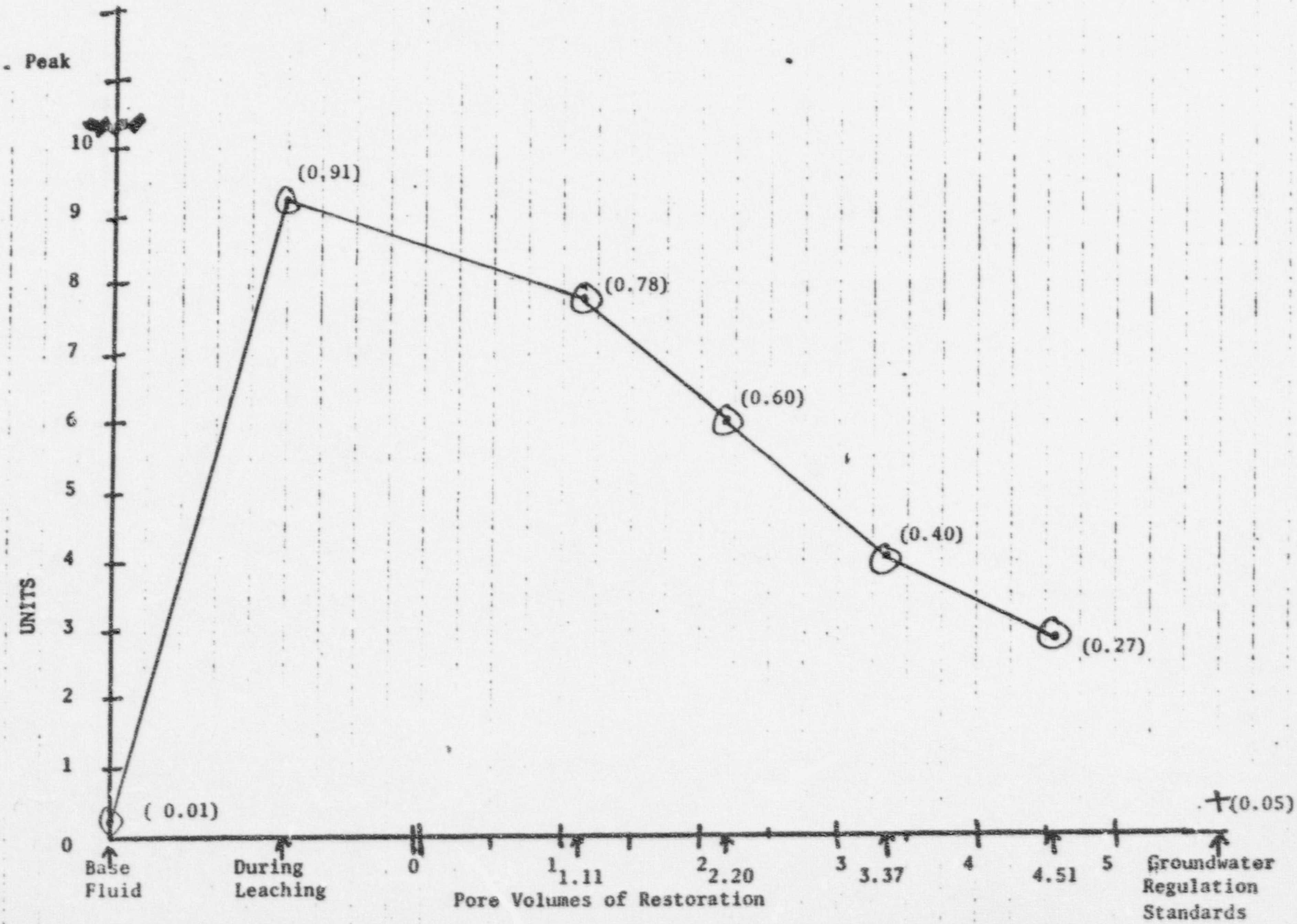


FIGURE 4 GRAPH OF RESTORATION NUMBERS(LAB SCALE) FOR MOBIL/TVA IN-SITU PILOT PROJECT NEAR CROWNPOINT,NM

SOURCE: IN-SITU MINING PLAN,p. 39

PARAMETER: RADIUM-226

UNITS: 10^2 picocuries/liter

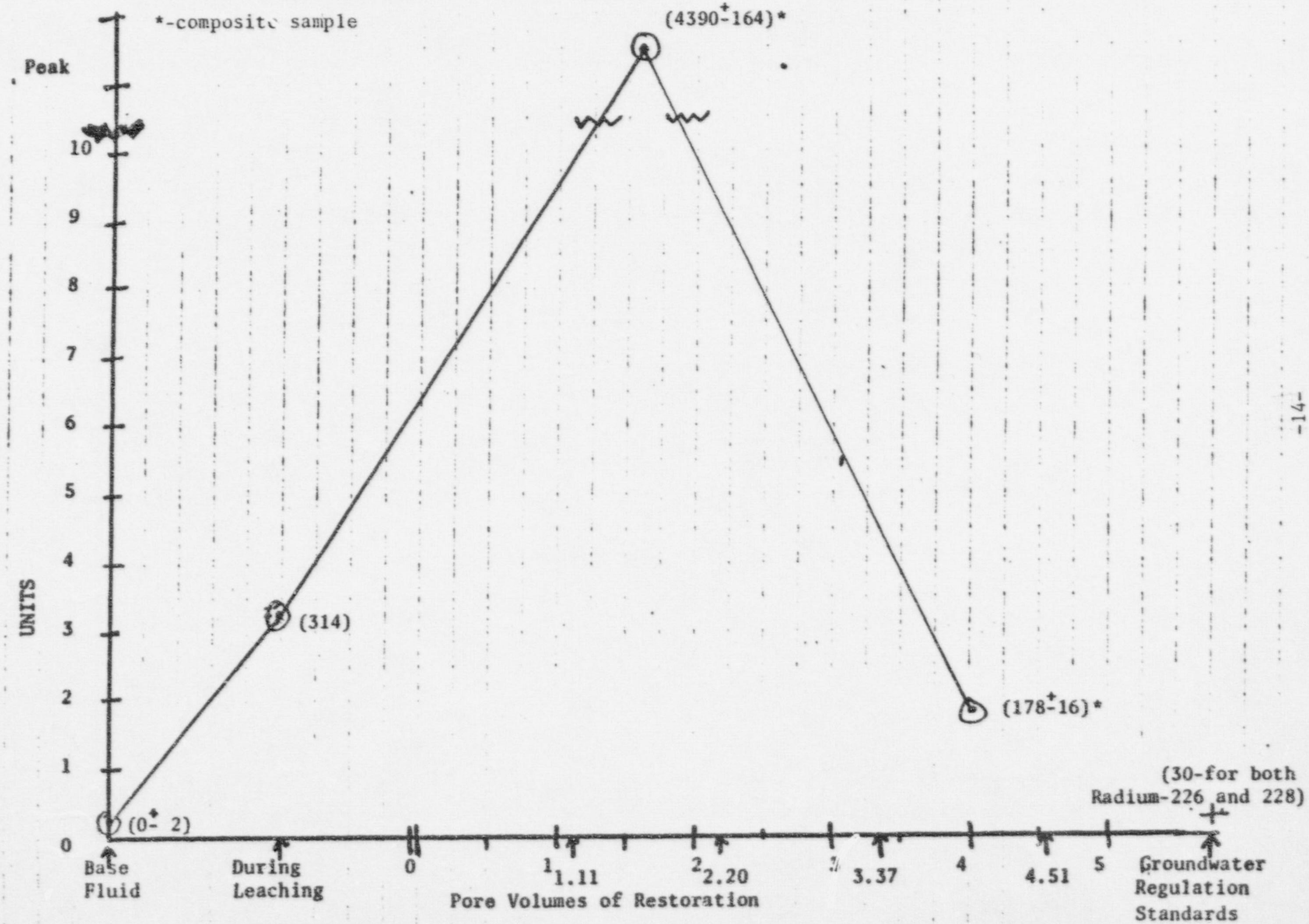
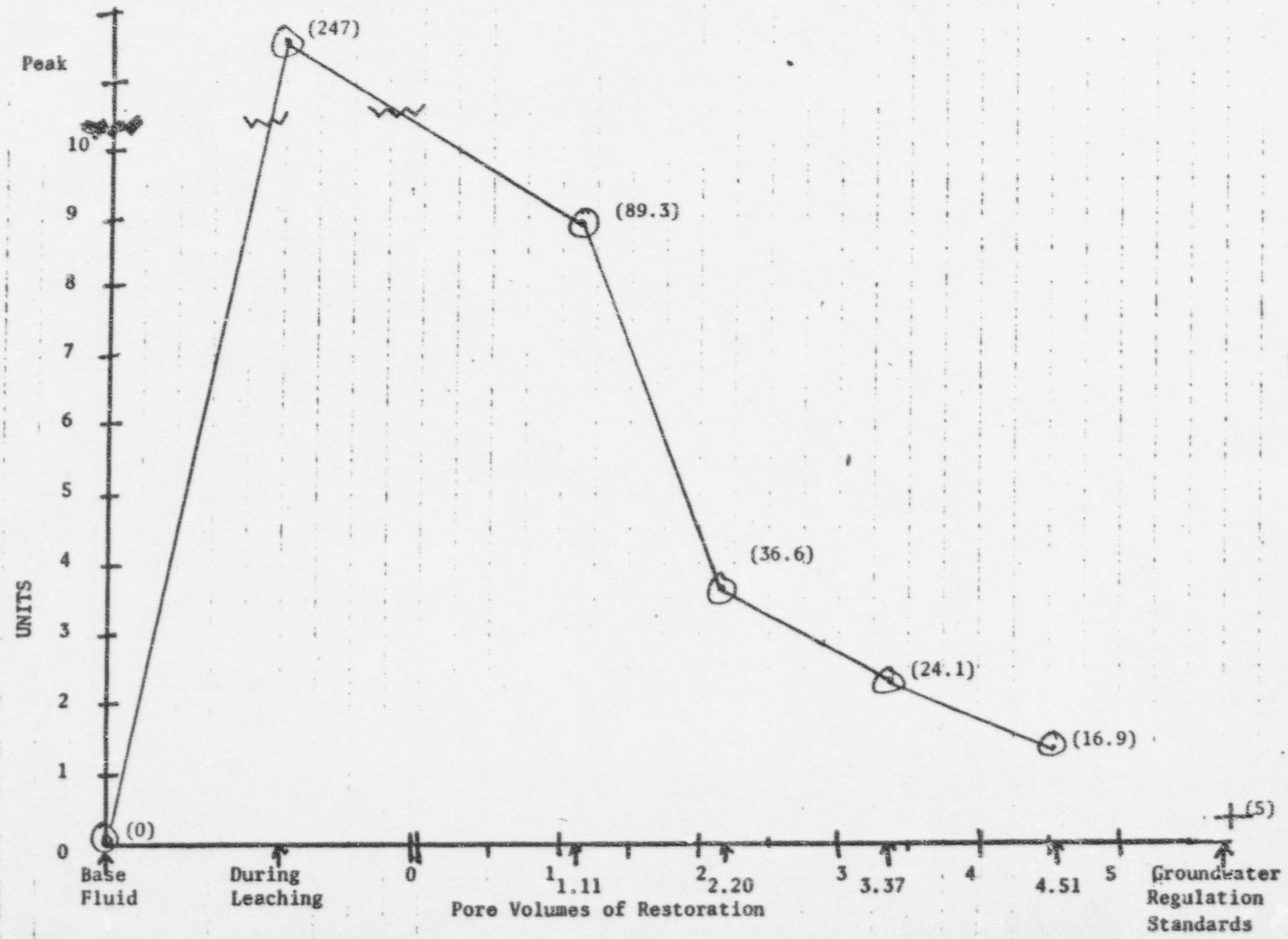


FIGURE 5 GRAPH OF RESTORATION NUMBERS (LAB SCALE) FOR MOBIL/TVA IN-SITU PILOT PROJECT NEAR CROWNPOINT, NM
SOURCE: IN-SITU MINING PLAN, p. 39

PARAMETER: URANIUM
UNITS: 10^1 milligrams/liter



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APPENDIX A

NEW MEXICO URANIUM INVENTORY-REFERENCE LIST

1-State Planning Office, The Grants Uranium Belt, Santa Fe, NM, 1976

2-Environmental Protection Agency, Water Quality Impacts of Uranium Mining and Milling Activities in the Grants Mineral Belt, New Mexico, EPA Regional VI, Dallas, TX, September, 1975

3-Charles Nylander, Assessment of the Adequacy of Selected Legal Controls on the Quality of Effluent Discharged from Uranium Point Sources in the Grants Mineral Belt, New Mexico, Water Resources Management Program, Univeristy of Wisconsin, Madison, Wisconsin, 1977. Mr. Nylander is on the Water Quality staff of the New Mexico Environmental Improvement Agency.

4-Federal Energy Administration, New Mexico Uranium, 1950-2000, FEA Region VI, Dallas, TX, December, 1976

5-New Mexico State Inspector of Mines, Sixty-Forth Annual Report (year ending 12/31/76) Office of the State Inspector of Mines, Albuquerque, NM, April, 1977

6-US Department of Interior, Status Report-Uranium Development on Federal and Indian Lands, Northwest New Mexico, Department of Interior, Southwest Region, Albuquerque, NM, September, 1976

7-Office of the State Geologist, "Summary of Planned or In Progress Uranium Developments," by Orin Anderson, Santa Fe, NM, June, 1977

8-Governor's Energy Impact Task Force, Managing the Boom in Northwest New Mexico, Energy Resources Board, Santa Fe, NM, September, 1977

9-Phillips Petroleum Corp., "Discharge Plan for Section 31 Shaft Excavation," November 15, 1977, in NMEIA Water Quality Division Files.

10-J.W. Schomisch, "Crownpoint Uranium Mine Faces Delay," Gallup Independent, Gallup, NM, December 15, 1977

11-J.B. Cooper and E.C. Johns, Geology and Groundwater Occurance in Southeast McKinley County, New Mexico, State Engineer's Technical Report 35, Santa Fe, NM, 1968

12-J.W. Schomisch, "Cleanup of Uranium Tailings Could Cost $125 Million," Gallup Independent, Gallup, NM, January 4, 1978

13-Files of USGS Conservation Division, Albuquerque, January, 1978

14-Chapman, Wood, and Griswold, Geology of Grants Uranium Region (a set of three maps), New Mexico Bureau of Mines and Mineral Resources Geologic Map 31, Socorro, NM, 1977

15-Tennessee Valley Authority, Draft Environmental Impact Statement-Dalton Pass Uranium Mine, TVA-Chattanooga, TN, December, 1977

16-Files of the New Mexico Environmental Improvement Agency, Santa Fe, NM

17-T. Buhl, Progress Report to the Legislature: Uranium Mine and Mill Tailings Study, Radiation Protection Section, Environmental Improvement Agency, Santa Fe, NM, December 1, 1977

APPENDIX B

TENNESSEE VALLEY AUTHORITY

Division of Water Management
Geologic Services Branch

CROWNPOINT AREA - NEW MEXICO

Potential For Reinjection
Of Mine-Water Discharge

Potential For Interaquifer
Water Movement

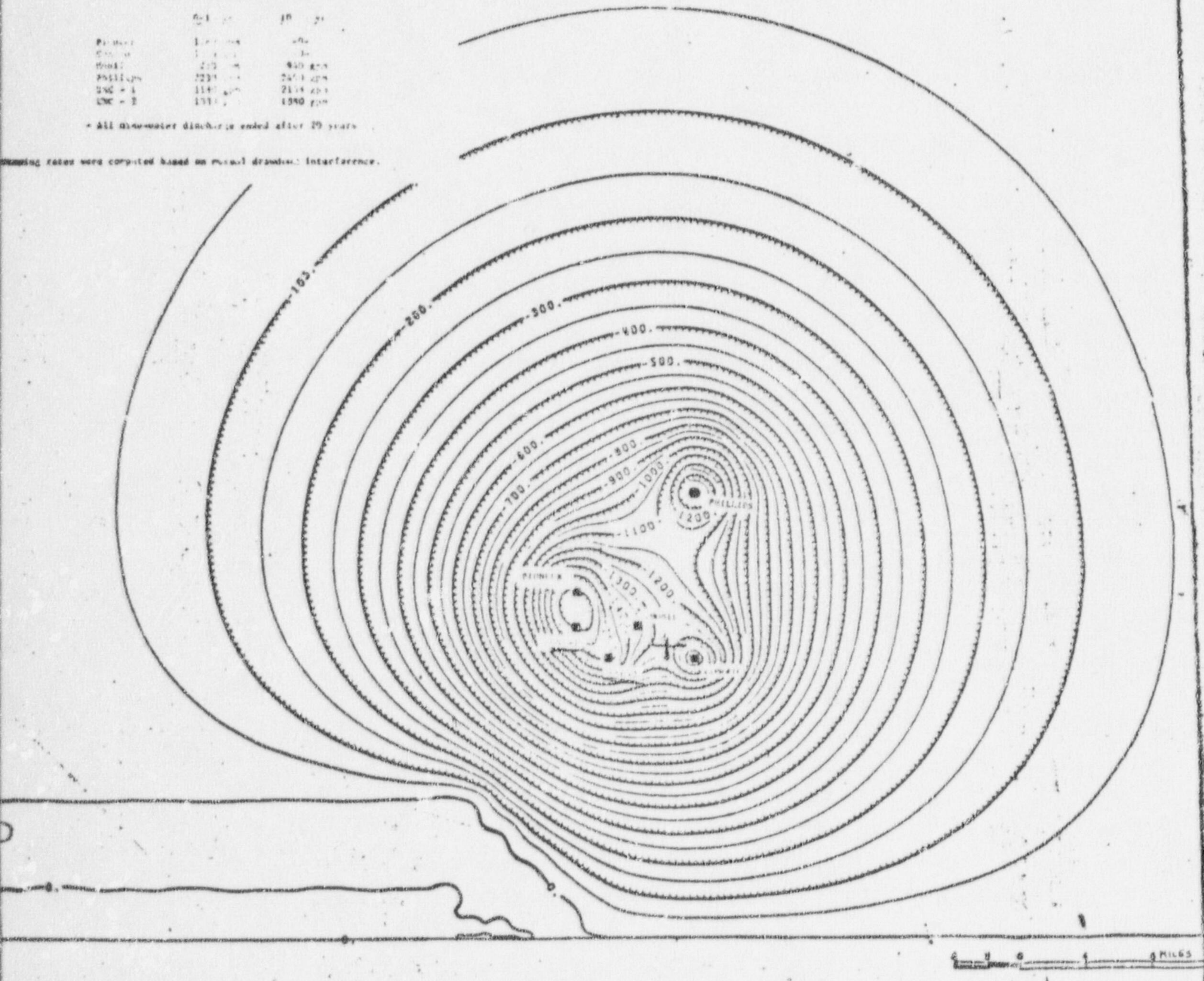
Crownpoint Areal Drawdown Model

Knoxville, Tennessee

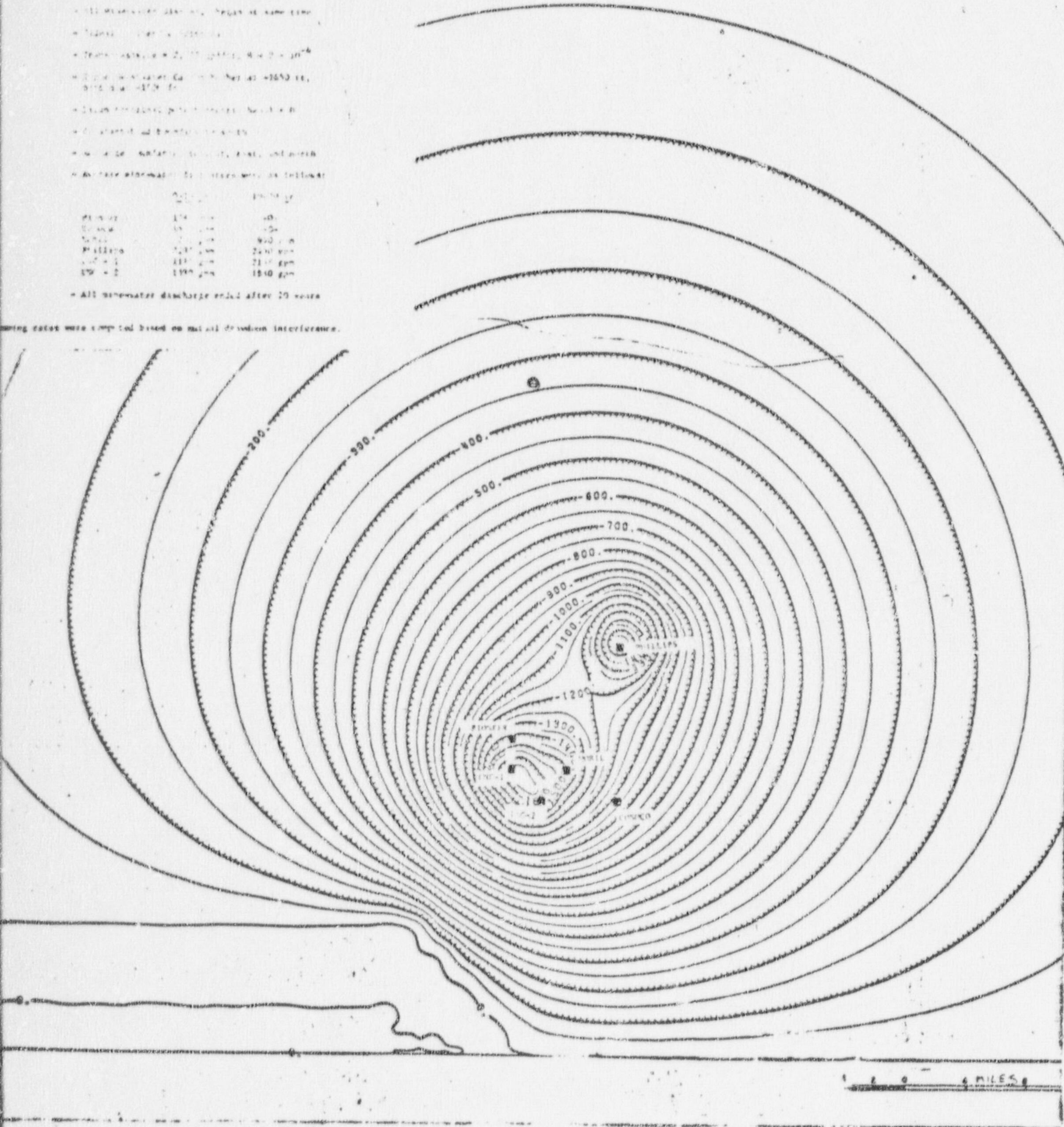
March 1978

CROWNPOINT AREA DRAWDOWN
MODEL SOURCE:TVA,MARCH 1978

"AFTER TEN YEARS OF MINE
WATER DISCHARGE"



CROWNPOINT AREA DRAWDOWN
MODEL-SOURCE: TVA, MARCH 1978
"AFTER TWENTY YEARS OF MINE
WATER DISCHARGE"



5 of 5
CROWNPOINT AREA DRAWDOWN MODEL-SOURCE TVA, MARCH 1978 "ELEVEN YEARS AFTER ALL MINE WATER DISCHARGE ENDS"

CROWNPOINT AREAL DRAWDOWN MODEL

Cumulative Drawdown in the Westwater Canyon Member

11 Years After All Mine-Water Discharge Ends

Locations of mines are approximate to the nearest two-mile node.
The community of Crownpoint is located at the same node as the Conoco Mine.

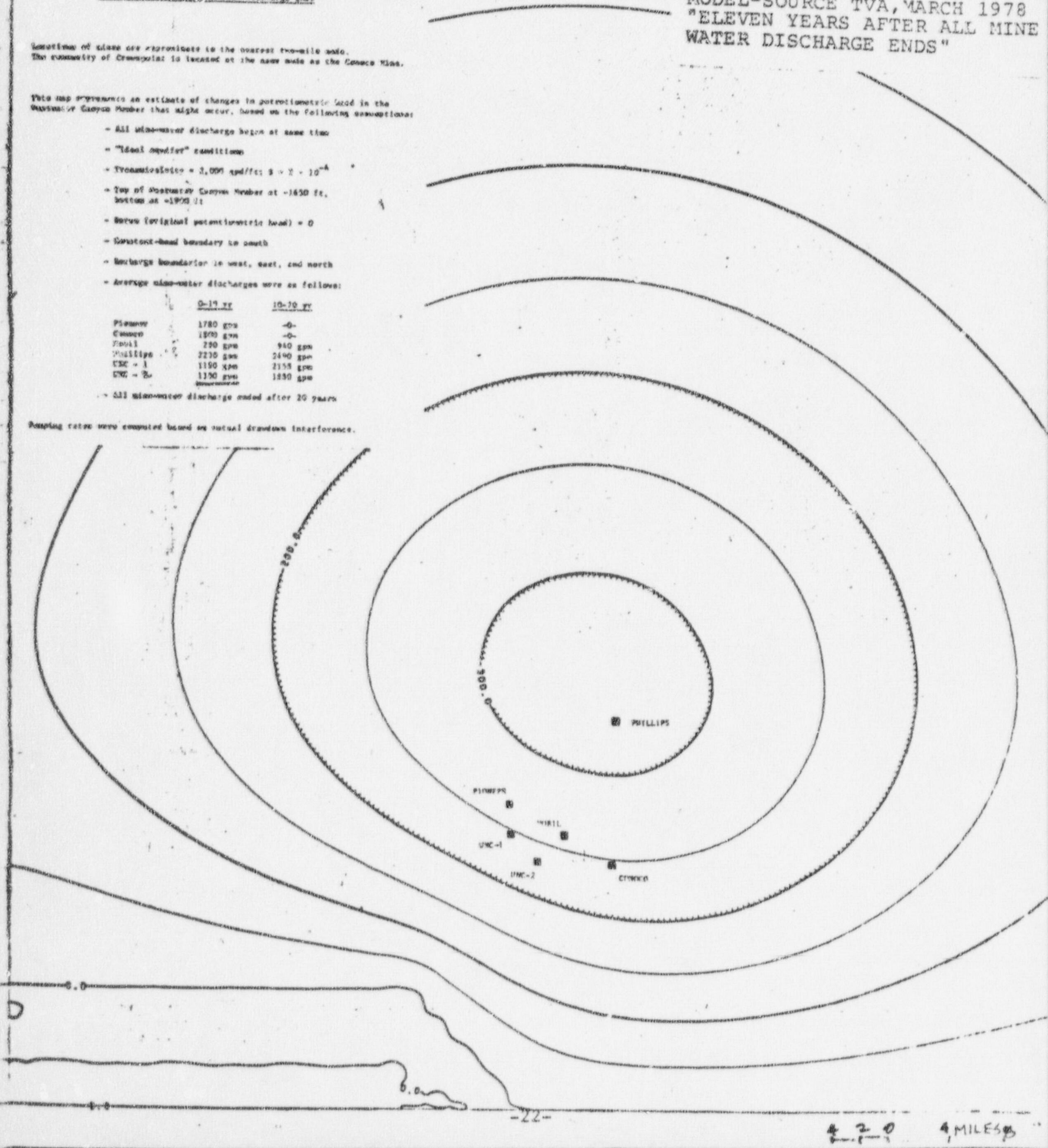
This map represents an estimate of changes in potentiometric head in the Westwater Canyon Member that might occur, based on the following assumptions:

- All mine-water discharge began at same time
- "Ideal aquifer" conditions
- Transmissivity = 3,000 gpd/ft; $S = 2 \times 10^{-4}$
- Top of Westwater Canyon Member at -1650 ft, bottom at -1900 ft
- Datum (original potentiometric head) = 0
- Constant-head boundary to south
- Recharge boundaries to west, east, and north
- Average mine-water discharges were as follows:

	0-10 yr	10-20 yr
Pioneer	1780 gpm	-0-
Conoco	1800 gpm	-0-
Mobil	290 gpm	940 gpm
Phillips	2230 gpm	2490 gpm
UNC - 1	1190 gpm	2155 gpm
UNC - 2	1150 gpm	1830 gpm

- All mine-water discharge ended after 20 years

Pumping rates were computed based on mutual drawdown interference.



CROWNPOINT AREA DRAWDOWN MODEL-SOURCE:TVA,MARCH1978 "ONE YEAR AFTER ALL MINE WATER DISCHARGE ENDS"

CROWNPOINT AREA DRAWDOWN MODEL

Cumulative Drawdown in the Westwater Canyon Member

1 Year After All Mine-Water Discharge Ends

Locations of mines are approximate to the nearest two-mile node.
The community of Crownpoint is located at the same node as the Conoco Mine.

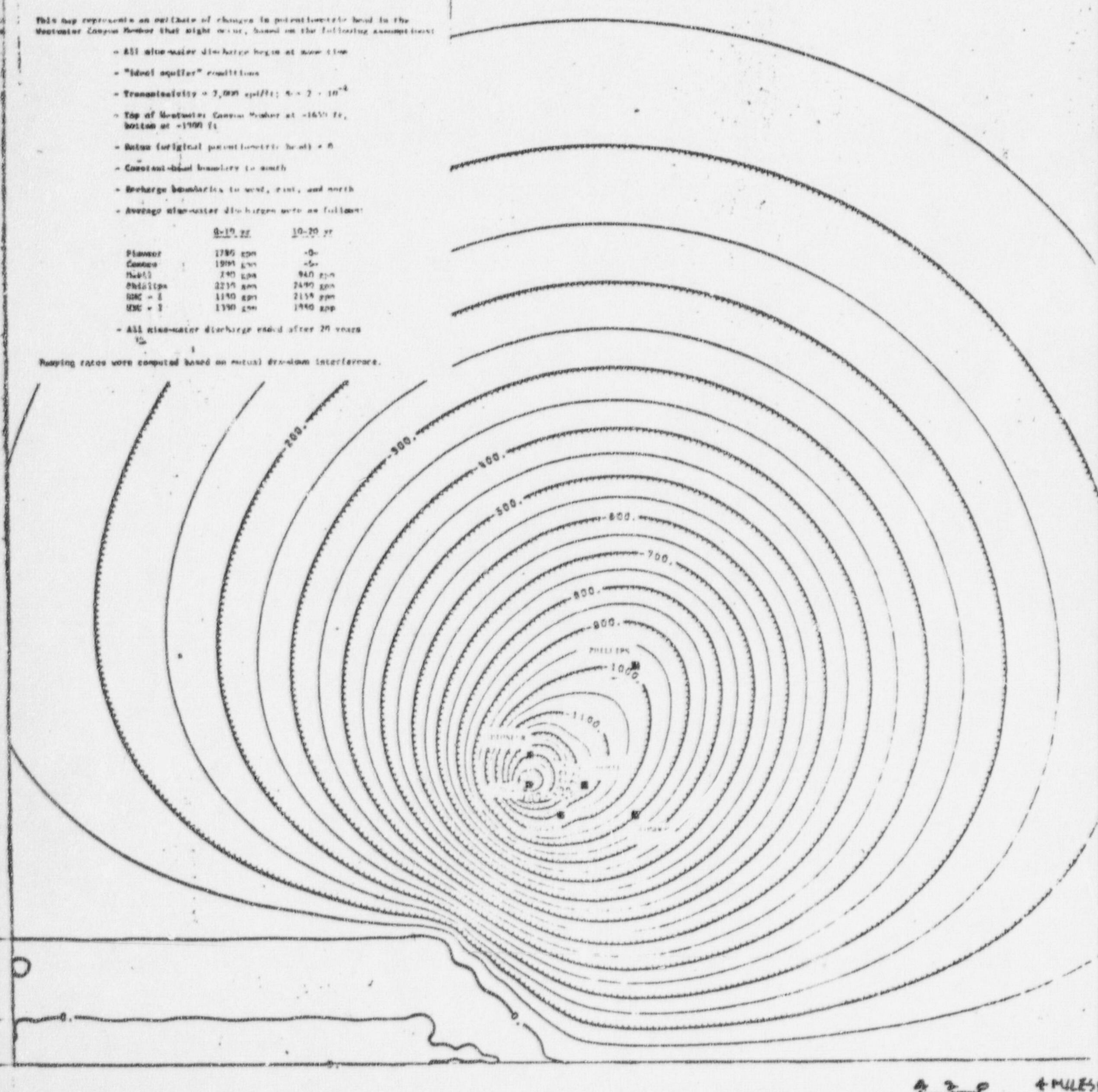
This map represents an estimate of changes in potentiometric head in the Westwater Canyon Member that might occur, based on the following assumptions:

- All mine-water discharge begin at same time
- "Ideal aquifer" conditions
- Transmissivity = 2,000 gpd/ft; S = 2 x 10^{-4}
- Top of Westwater Canyon Member at -1650 ft, bottom at -1900 ft
- Datum (original potentiometric head) = 0
- Constant-head boundary to south
- Recharge boundaries to west, east, and north
- Average mine-water discharges were as follows:

	0-10 yr	10-20 yr
Pioneer	1780 gpm	-0-
Conoco	1990 gpm	-0-
Mobil	290 gpm	940 gpm
Phillips	2210 gpm	2490 gpm
UNC - 1	1150 gpm	2150 gpm
UNC - 2	1390 gpm	1990 gpm

- All mine-water discharge ended after 20 years

Pumping rates were computed based on mutual drawdown interference.

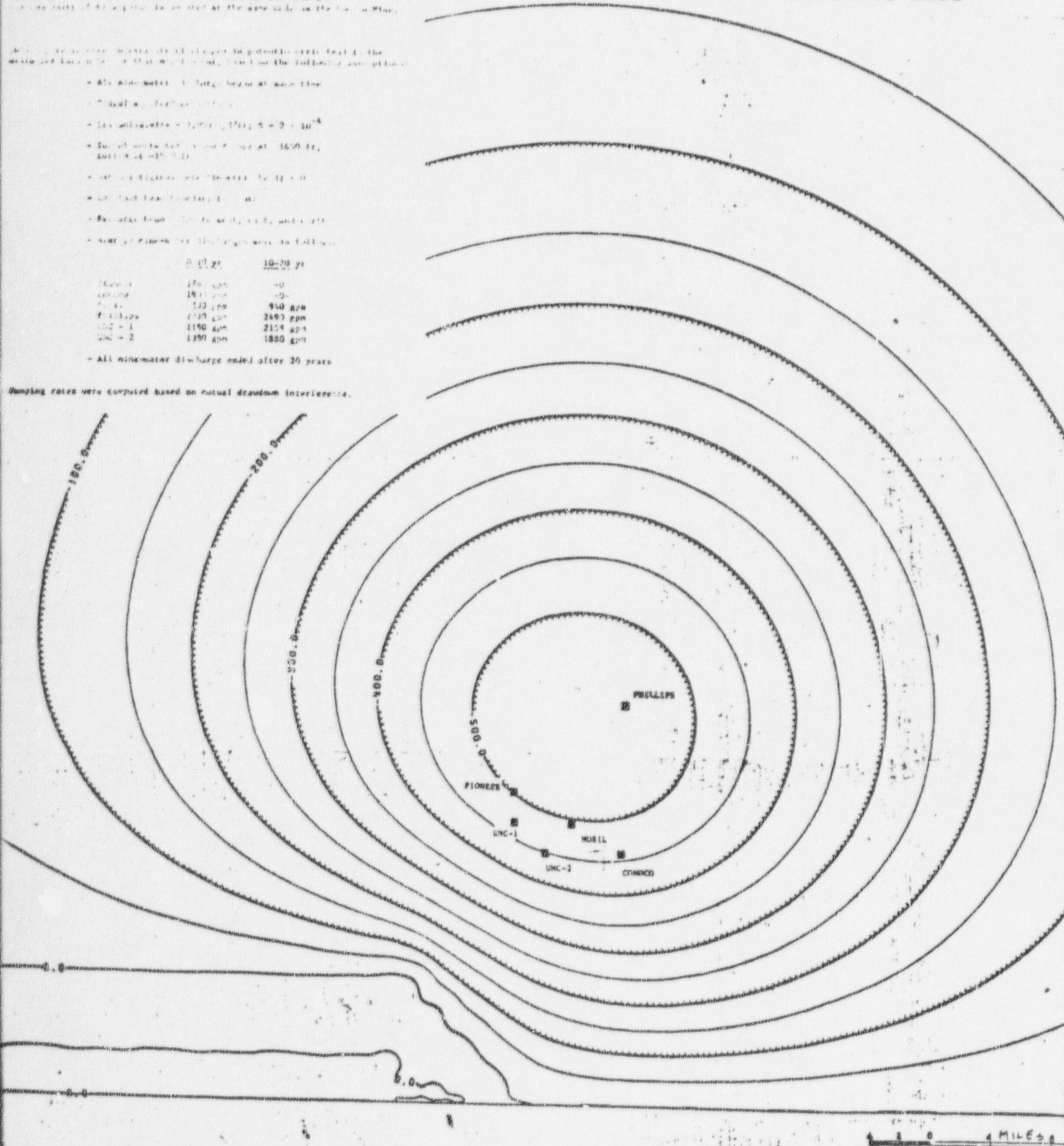


C[illegible]NPOINT AREA DRAWDOWN MODEL-SOURCE:TVA MARCH,1978 "FIVE YEARS AFTER ALL MINE WATER DISCHARGE ENDS"

	0-10 yr	10-20 yr
[illegible]	[illegible] gpm	-0-
[illegible]	[illegible] gpm	-0-
[illegible]	[illegible] gpm	950 gpm
Phillips	[illegible] gpm	2493 gpm
UNC - 1	1190 gpm	2159 gpm
UNC - 2	1390 gpm	1880 gpm

- All minewater discharge ended after 20 years

Pumping rates were computed based on mutual drawdown interference.



MOBIL OIL CORPORATIONS

RESPONSES

TO SWRIC PAPER

DATED JUNE 19, 1978

ANNULAR VELOCITY REQUIRED TO ACHIEVE VARIOUS FLOW PATTERNS AND THE CIRCULATABLE MUD DISPLACED BY EACH FLOW PATTERN

FLOW PATTERN TYPE	ANNULAR VELOCITY (feet/sec.)	CIRCULATABLE MUD DISPLACED (%)
Plug	<1.00	60
Laminar	1.00-5.25	90
Transition Zone	5.25-7.90	90-95
Turbulent	>7.99	>95

6. For the proposed pilot uranium leach project, the operator initially plans to include a quarterly comprehensive water quality analysis program, in addition to the bi-weekly excursion monitoring program. The quarterly program will involve collection of samples from all seven monitor wells. Each of the samples will be analyzed initially for the 27 variables listed in New Mexico Water Quality Control Commission (NMWQCC) Regulations, Section 3-103 plus gross α, gross β, Ra-226, Ra-228, Th-230, Pb-210, specific conductance, alkalinity, and temperature. After an examination of historical data from the lixiviant analyses, excursion monitoring program, and overall pilot leach testing, this list of variables will be modified to reflect only those constituents which are significantly elevated by the leaching activities, and a reduction in the frequency of the suggested analyses may be implemented.

7. Prior to taking samples for the bi-weekly excursion monitoring and quarterly water quality analysis programs (described in Sections 5.1.1 and 5.1.3.2 of the Discharge Plan and in response 6 under Ground Water Monitoring Program, above) each monitor well will be pumped to displace two casing volumes. In the event that packers are placed in the monitor wells, twice the casing volume from the packer to the total depth of the well will be evacuated prior to sample collection.

   For the bi-weekly excursion monitoring program the samples will be analyzed for conductivity and then be filtered prior

TABLE 3.4-2

GROUNDWATER RESTORATION
TWO WELL AMMONIA LEACH TEST - SOUTH TEXAS PROJECT

	CONCENTRATIONS IN TEST AREA (mg/ℓ)				(mg/ℓ) Recommended Drinking Water Limits	
			Restoration			
	Baseline	During Leaching	Initial Groundwater Flush	Present**	EPA	Public Health Service
Total Dissolved Solids	882	3430	766*	1040	-	500
Sodium	291	765	270*	338	-	-
Calcium	14.4	214	3.8*	4.7	-	-
Magnesium	2.7	60	0.58*	2.3	-	-
Chloride	205	516	211*	228	-	250
Sulfate	111	1161	127*	143	-	250
Bicarbonate	361	3464	514*	339	-	-
Nitrates	0.07	0.22	0.35*	0.04	10	45
Ammonia	1.21	850	87*	1.57	-	-
Heavy Metals						
Arsenic	0.001	+	0.1***	0.098	0.05	0.05
Barium	0.12	+	<0.2***	0.01	1.0	1.0
Boron	0.75	+	1.9***	1.5	-	1.0
Cadmium	0.002	+	<0.01***	0.009	0.01	0.01
Chromium	0.002	+	<0.03***	0.001	0.05	0.05
Copper	0.011	+	0.11***	0.006	-	1.0
Iron	0.19	+	14.0***	0.01	-	0.3
Lead	0.005	+	0.26***	<0.001	0.05	0.05
Manganese	0.02	+	0.35***	<0.01	-	0.05
Mercury	<0.0001	+	0.0005***	0.0001	0.002	-
Molybdenum	0.01	+	<0.3***	0.01	-	-
Nickel	<0.01	+	0.06***	<0.01	-	-
Selenium	<0.001	+	<0.01***	<0.001	0.01	-
Silver	<0.01	+	<0.02***	<0.01	0.05	0.01
Vanadium	0.01	+	<0.02***	<0.01	-	0.05
Zinc	0.53	+	0.16***	0.007	-	5.0
Radium-226 (pCi/ℓ)	86.8±10.2	+	68±4***	5±1	-	-

*Groundwater flush only with 6.2 pore volume in 56 days
**Data shown are after 66 day chemical flush and second groundwater flush which is continuing
***Data shown are for groundwater flush of 43 days
+Not available

TABLE 2.4.2-3A

GROUNDWATER RESTORATION

LABORATORY LEACH TESTS CROWNPOINT WELL 9U-174

FLUID SAMPLE COMPOSITION (mg/ℓ UNLESS NOTED)

Parameter	Base Fluid	During Leaching	Restoration with Base Fluid Overflush	
			4.9 to 12.5PV**	12.5 to 16.7PV
Total Dissolved Solids	264	2010	516	324
Conductivity (umhos/cm @ 23°C)	412	2350	726	467
Total Organic Carbon	<0.1	0.05	55.5	30.0
pH @ 23°C	8.46	8.40	8.69	8.74
Carbonate	7.3	18.9	7.4	7.4
Bicarbonate	197	1672	318	173
Chloride	15.4	29.1	23.8	19.6
Sulfate	24.3	116.0	67.5	41.1
Nitrate (as N)	0.08	0.51	0.26	0.20
Fluoride	0.12	0.68	0.79	0.72
Ammonia (as N)	<0.1	<0.1	0.12	0.13
Cyanide	<0.1	0.2	*	*
Phenols	<0.1	<0.01	*	*
Aluminum	<0.1	<0.1	<0.02	<0.02
Arsenic	<0.05	0.12	0.279	0.191
Barium	0.	<0.5	0.099	0.065
Boron	<0.01	0.02	<0.25	<0.25
Cadmium	<0.001	0.003	<0.01	<0.01
Calcium	22.1	51.0	6.3	3.7
Chromium	<0.01	<0.01	<0.02	<0.02
Cobalt	<0.01	<0.01	<0.05	<0.05
Copper	<0.01	2.15	0.19	0.10
Iron	<0.02	<0.01	<0.02	<0.02
Lead	<0.05	<0.05	0.008	0.005
Magnesium	3.1	1.5	0.16	0.09
Manganese	0.09	0.28	0.06	0.02
Mercury (Total)	<0.001	<0.001	0.046	0.038
Molybdenum	<0.1	41	18.75	16.48
Nickel	<0.01	0.03	<0.03	<0.03
Potassium	5.1	7.1	1.82	1.34
Selenium	<0.01	1.67	1.59	0.93
Silicon	10.2	31.0	7.5	12.8
Silver	<0.01	<0.01	0.01	<0.01
Sodium	71.5	650	162	96
Strontium	0.05	0.07	0.05	0.04
Uranium	0	219	21.07	4.80
Vanadium	0.1	0.5	0.338	0.343
Zinc	0.03	0.60	0.07	0.01
Titanium	0.5	<0.5	<0.2	<0.2
Gross α (pCi/ℓ)	0±2	91,200±5,600	***	***
Gross β (pCi/ℓ)	0±2	76,500±4,800	***	***
Radium-226 "	0±2	187±29	***	***
Radium-228 "	0±2	0±200	***	***
Thorium-230 "	0±2	3,287±537	***	***
Lead-210 "	0±1	170±110	***	***

* Insufficient sample.

** Core test was inactive for 15 days prior to this restoration step.

*** Analysis in progress.

ANNULAR VELOCITY REQUIRED TO ACHIEVE VARIOUS
FLOW PATTERNS AND THE CIRCULATABLE MUD
DISPLACED BY EACH FLOW PATTERN

FLOW PATTERN TYPE	ANNULAR VELOCITY (feet/sec.)	CIRCULATABLE MUD DISPLACED (%)
Plug	<1.00	60
Laminar	1.00-5.25	90
Transition Zone	5.25-7.90	90-95
Turbulent	>7.99	>95

6. For the proposed pilot uranium leach project, the operator initially plans to include a quarterly comprehensive water quality analysis program, in addition to the bi-weekly excursion monitoring program. The quarterly program will involve collection of samples from all seven monitor wells. Each of the samples will be analyzed initially for the 27 variables listed in New Mexico Water Quality Control Commission (NMWQCC) Regulations, Section 3-103 plus gross α, gross β, Ra-226, Ra-228, Th-230, Pb-210, specific conductance, alkalinity, and temperature. After an examination of historical data from the lixiviant analyses, excursion monitoring program, and overall pilot leach testing, this list of variables will be modified to reflect only those constituents which are significantly elevated by the leaching activities, and a reduction in the frequency of the suggested analyses may be implemented.

7. Prior to taking samples for the bi-weekly excursion monitoring and quarterly water quality analysis programs (described in Sections 5.1.1 and 5.1.3.2 of the Discharge Plan and in response 6 under Ground Water Monitoring Program, above) each monitor well will be pumped to displace two casing volumes. In the event that packers are placed in the monitor wells, twice the casing volume from the packer to the total depth of the well will be evacuated prior to sample collection.

   For the bi-weekly excursion monitoring program the samples will be analyzed for conductivity and then be filtered prior

TABLE 3.4-2

GROUNDWATER RESTORATION
TWO WELL AMMONIA LEACH TEST - SOUTH TEXAS PROJECT

	CONCENTRATIONS IN TEST AREA (mg/ℓ)				(mg/ℓ) Recommended Drinking Water Limits	
			Restoration			
	Baseline	During Leaching	Initial Groundwater Flush	Present**	EPA	Public Health Service
Total Dissolved Solids	882	3430	766*	1040	-	500
Sodium	291	765	270*	338	-	-
Calcium	14.4	214	3.8*	4.7	-	-
Magnesium	2.7	60	0.58*	2.3	-	-
Chloride	205	516	211*	228	-	250
Sulfate	111	1181	127*	143	-	250
Bicarbonate	361	3484	514*	339	-	-
Nitrates	0.07	0.22	0.35*	0.04	10	45
Ammonia	1.21	850	87*	1.57	-	-
Heavy Metals						
Arsenic	0.001	+	0.1***	0.098	0.05	0.05
Barium	0.12	+	<0.2***	0.01	1.0	1.0
Boron	0.75	+	1.9***	1.5	-	1.0
Cadmium	0.002	+	<0.01***	0.009	0.01	0.01
Chromium	0.002	+	<0.03***	0.001	0.05	0.05
Copper	0.011	+	0.11***	0.006	-	1.0
Iron	0.19	+	14.0***	0.01	-	0.3
Lead	0.005	+	0.26***	<0.001	0.05	0.05
Manganese	0.02	+	0.35***	<0.01	-	0.05
Mercury	<0.0001	+	0.0005***	0.0001	0.002	-
Molybdenum	0.01	+	<0.3***	0.01	-	-
Nickel	<0.01	+	0.06***	<0.01	-	-
Selenium	<0.001	+	<0.01***	<0.001	0.01	-
Silver	<0.01	+	<0.02***	<0.01	0.05	0.01
Vanadium	0.01	+	<0.02***	<0.01	-	0.05
Zinc	0.53	+	0.16***	0.007	-	5.0
Radium-226 (pCi/ℓ)	86.8±10.2	+	68±4***	5±1	-	-

*Groundwater flush only with 6.2 pore volume in 56 days
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TABLE 2.4.2-3A
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LABORATORY LEACH TESTS CROWNPOINT WELL 9U-174
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Ammonia (as N)	<0.1	<0.1	0.12	0.13
Cyanide	<0.1	0.2	*	*
Phenols	<0.1	<0.01	*	*
Aluminum	<0.1	<0.1	<0.02	<0.02
Arsenic	<0.05	0.12	0.279	0.191
Barium	0.	<0.5	0.099	0.065
Boron	<0.01	0.02	<0.25	<0.25
Cadmium	<0.001	0.003	<0.01	<0.01
Calcium	22.1	51.0	6.3	3.7
Chromium	<0.01	<0.01	<0.02	<0.02
Cobalt	<0.01	<0.01	<0.05	<0.05
Copper	<0.01	2.15	0.19	0.10
Iron	<0.02	<0.01	<0.02	<0.02
Lead	<0.05	<0.05	0.008	0.005
Magnesium	3.1	1.5	0.16	0.09
Manganese	0.09	0.28	0.06	0.02
Mercury (Total)	<0.001	<0.001	0.046	0.038
Molybdenum	<0.1	41	18.75	16.48
Nickel	<0.01	0.03	<0.03	<0.03
Potassium	5.1	7.1	1.82	1.34
Selenium	<0.01	1.67	1.59	0.93
Silicon	10.2	31.0	7.5	12.8
Silver	<0.01	<0.01	0.01	<0.01
Sodium	71.5	650	162	96
Strontium	0.05	0.07	0.05	0.04
Uranium	0	219	21.07	4.80
Vanadium	0.1	0.5	0.338	0.343
Zinc	0.03	0.60	0.07	0.01
Titanium	0.5	<0.5	<0.2	<0.2
Gross α (pCi/ℓ)	0±2	91,200±5,600	***	***
Gross β (pCi/ℓ)	0±2	76,500±4,800	***	***
Radium-226 "	0±2	187±29	***	***
Radium-228 "	0±2	0±200	***	***
Thorium-230 "	0±2	3,287±537	***	***
Lead-210 "	0±1	170±110	***	***

* Insufficient sample.
** Core test was inactive for 15 days prior to this restoration step.
*** Analysis in progress.

Attachment #3

Major Concerns in the SWIRC Paper

1. What is the impact on the In-Situ project when nearby mine dewatering operations go into effect?

2. What is the timing of the restoration project relative to drawdown effects timing associated with other dewatering projects in the area?

3. Has the on-site data thus far indicated any effect from the two operating Churchrock mines.

4. The laboratory tests need be expanded to accurately demonstrate that restoration can be accomplished in New Mexico.

5. The metallurgical and geochemical differences between the Texas experiments and the New Mexico project preclude the use of the Texas data to demonstrate the viability of the New Mexico project restoration.

6. Excursions need be monitored on a daily basis and secondary monitors need be installed immediately after the indication of an excursion.