TABLE 6.13

ZONE 1 WATER LEVEL DATA
SECOND AND FOURTH QUARTERS 1989
AND FOURTH QUARTER 1990

Well Number	Distance from Borrow Pit No. 2 (feet)	Second Quarter 1989 Water Level Elevation (feet)	Fourth Quarter 1989 Water Level Elevation (feet)	Change in Elevation (feet)	Fourth Quarter 1990 Water Level Elevation (feet)	Change in Elevation (feet)	Total Change in Elevation (feet)
0515 A	429	6,920.2	6,920.8	+ 0.6	6,917.8	- 3.0	- 2.4
0516 A	440	6,919.1	6,918.5	- 0.6	6,915.6	- 2.9	- 3.5
0604	390	6,919.3	6,919.1	- 0.2	6,915.8	- 3.3	- 3.5
0614	460	6,930.2	6,929.0	- 0.2	6,926.3	- 2.7	- 3.9
0619	460	6,887.9	6,888.2	+ 0.3	6,886.9	- 1.3	- 1.0
EPA 05	690	6,895.2	6,895.4	+ 0.2	6,895.0	- 0.4	- 0.2
EPA 07	650	6,907.8	6,908.0	+ 0.2	6,907.1	- 0.9	- 0.7
EPA 04	1,130	6,868.4	6,869.1	+ 0.7	6,869.1	0	- 0.7
EPA 02	1,750	6,843.3	6,844.3	+ 1.0	6,845.1	+ 0.8	+ 1.8
EPA 08	1,450	6,856.8	6,858.0	+ 1.2	6,859.2	+ 1.2	+ 2.4

Note: Shaded values are decreases in water level.

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TABLE 6.14

ZONE 1 – ESTIMATED RESPONSE TIME TO DEWATERING BORROW PIT NO. 2

Well No.	Distance (a) Outcrop–Well (feet)	Predicted Response Time to Changes in Borrow Pit No. 2 Water Level		Approximate Date of Response to Dewatering
		Months	Years	
604	390	18	1.5	October 1989
515–A	429	20	1.6	December 1989
516–A	440	20	1.7	December 1989
619	460	26	2.2	June 1990
614	460	26	2.2	June 1990
EPA–7	650	31	2.5	December 1990
EPA–5	690	32	2.7	January 1991
EPA–4	1,130	53	4.4	September 1992
EPA–8	1,450	68	5.7	December 1993
EPA–2	1,750	82	6.9	February 1995

Response time = Distance/Velocity where: Velocity (b) = 225 feet/year

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(a) Distance measured on the Geologic Map, Figure 2–3 of the Geohydrologic Report (Canonie, 1987b) from the Zone 1 outcrop in Borrow Pit No. 2 to the monitoring wells.

(b) Velocity estimated from response time in the monitoring wells to changes in water level in Borrow Pit No. 2 and the distance from the outcrop of Zone 1 to the monitoring wells.

TABLE 6.15

SUMMARY OF 1990 OPERATIONAL DATA
ZONE 1 PUMP-BACK WELLS

Well Number	Average Pumping Rate (gpm)
NXD System (a)	
320	0.03
665	0.59
666	1.52
669	0.83
670	0.92
	3.89
Eastern System (a)	
301	0.32
302	0.04
303	0.37
304	0.24
306	0.13
312-A	0.38
615	0.18
620	1.75
621	0.14
622	0.17
623	0.14
636	0.42
	4.28
Revised Eastern System (b)	
615	0.29
616	0.37
617	0.11
EPA-7	0.21
	0.98

Total Volume Pumped = 4.0 million gallons (c)

(a) Average pumping rate calculated for the period between October 13, 1989 and September 24, 1990.

(b) Average pumping rate calculated for the period between September 24, 1990 and October 12, 1990.

(c) Total volume pumped calculated for the period between October 13, 1989 and October 12, 1990.

TABLE 6.16

SUMMARY OF ACTIVITIES FOR ZONE 1 ALARA DEMONSTRATION

Activity	Wells	Frequency	Remarks
PHASE I			
1. Sample Collection	A. Compliance Monitoring Wells (515A, 516A, 604, 614, EPA-7)	one time	Third quarter sampling event
	B. Pump-back Wells (615, 616, 617)	four times	Weekly interval (includes third quarter sampling event)
PHASE II			
1. Reactivate Pump-back Wells	Wells 620, 666, 669, 670		Mid-August - December 31, 1991
2. Sample Collection	A. Reactivated Pump-back Wells (620, 666, 669, 670)	four times	Monthly interval September - December 1991 (includes fourth quarter 1991)
	B. Revised East System Wells 1. Compliance Monitoring Wells (515A, 516A, 604, 614, EPA-7) 2. Pump-back Wells (615, 616, 617)		
PHASE III			
1. Discontinue Pumping Reactivated Pump-back Wells	Wells 620, 666, 669, 670		After final set of samples collected

TABLE 6.17

DATA USED TO GENERATE ISOPACH MAP OF SATURATED THICKNESS (FIGURE 6-19) FOR SOUTHWEST ALLUVIUM REMEDIAL DESIGN

Well	Water Level Elevation April – August 1988 (feet)	Elevation to Base of Alluvium (feet)		Saturated Thickness (feet)	
GW-1	6,869	6,837		32	
GW-2	6,871	6,820		51	
GW-3	6,871	6,852		19	
EPA-23	6,898	6,803		95	
EPA-24	6,861	6,812		49	
EPA-25	6,861	6,829	(b)	32	(c)
EPA-26	6,865	6,832		33	
EPA-27	6,865	6,845	(c)	20	(b)
EPA-28	6,868	6,844		24	
510 AD	6,913	6,829	(c)	84	(b)
510 D	6,912	6,863	(c)	49	(b)
511 D	Dry	6,906		--	
512 AD (a)	6,899	6,843	(c)	56	(b)
512 D (a)	6,882	6,861	(c)	21	(b)
514 AD	6,874	6,800		74	
624	6,860	6,828		32	
625	6,861	6,863		--	
626	6,856	6,827		29	
627	6,946	6,827		19	
632	6,875	6,837		39	
663	6,865	6,855.7		9	

Source: Chuck Johnson, United Nuclear Corporation, personal communication.

(a) Wells 512 AD and 512 D were plugged in 1988 in accordance with NRC license conditions.

(b) Well does not fully penetrate the Southwest Alluvium.

(c) Maximum elevation of bedrock, true bedrock datum unavailable due to insufficient well depth (i.e., total depth in alluvium).

TABLE 6.18

REPRESENTATIVE PERMEABILITY VALUES
FOR THE SOUTHWEST ALLUVIUM REMEDIAL DESIGN

Well No.	Test Conducted By	Transmissivity (gpd/feet)	Saturated (a) Thickness (feet)	Permeability (cm/sec)
637	United Nuclear	30	17.5	8.1×10^{-5}
EPA-28	EPA	1,300	23.7	2.6×10^{-3}
EPA-23	EPA	6,600	95.0	3.3×10^{-3}
642	United Nuclear	8,400	25.4	1.6×10^{-2}

(a) From water level datum closest to test date.

TABLE 6.19

SOUTHWEST ALLUVIUM FLOW RATE CALCULATIONS
FOR THE REMEDIAL DESIGN

Date	(a) Water Elevation (feet)	Area (square feet)	Hydraulic Gradient	Flux (gpm) @ K = 0.01 (cm/sec)	Flux (gpm) @ K = 0.0026 (cm/sec)
Nov 1981	6,887.3	32,315	0.0215	102.23	26.58
Oct 1982	6,886.6	31,679	0.0206	96.14	25.00
Jul 1983	6,885.9	31,164	0.0199	91.29	23.74
Jul 1984	6,885.1	30,480	0.0189	84.99	22.10
Jul 1985	6,884.3	29,805	0.0180	78.91	20.52
Jul 1986	6,883.4	29,138	0.0170	73.04	18.99
Jul 1987	6,883.0	28,804	0.0165	70.16	18.24
Jul 1988	6,881.7	27,824	0.0151	61.90	16.09
Jul 1989	6,880.9	27,180	0.0142	56.64	14.73
Jul 1990	6,880.1	26,543	0.0132	51.57	13.41
Jul 1991	6,879.2	25,913	0.0122	46.70	12.14
Jul 1992	6,878.4	25,290	0.0113	42.01	10.92
Jul 1993	6,877.6	24,675	0.0103	37.51	9.75
Jul 1994	6,876.7	24,069	0.0094	33.20	8.63
Jul 1995	6,875.9	23,469	0.0084	29.07	7.56
Jul 1996	6,875.1	22,876	0.0075	25.10	6.53
Jul 1997	6,874.2	22,292	0.0065	21.32	5.54
Jul 1998	6,873.4	21,715	0.0055	17.71	4.61
Jul 1999	6,872.5	21,147	0.0046	14.27	3.71
Jul 2000	6,871.7	20,584	0.0036	10.99	2.86
Jul 2001	6,870.9	20,030	0.0027	7.87	2.05

(a) Water elevation at Well 513AD. Well 513AD was plugged in 1988 in accordance with NRC license conditions.

TABLE 6.20

DECLINES IN CHLORIDE VALUES WITH INCREASING DISTANCE FROM THE SOUTH CELL TAILINGS IMPOUNDMENT FOR THE REMEDIAL DESIGN

Sample Location	Sample Date	Distance from Impoundment (feet)	Chloride (ppm)
Tailings (a)	01/07/81	0	730
	01/28/81	0	608
513 AD (b)	07/20/88	220	279.0
632	10/17/88	680	252.0
	10/16/89	680	246.0
	10/09/90	680	258.0
GW1	10/17/88	1150	234.0
	10/16/89	1150	236.0
	10/03/90	1150	238.0
EPA 28	10/13/88	1330	112.0
	10/04/89	1330	107.0
	10/16/90	1330	111.0
EPA 26 (c)	04/06/88	1700	70.1
EPA 27	10/13/88	1730	74.7
	10/04/89	1730	74.5
	10/16/90	1730	89.4

Source: United Nuclear Corporation NRC monitoring program unless otherwise noted.

(a) Personal communication, United Nuclear Corporation management, 1989b.

(b) Well plugged in 1988 in accordance with License requirements.

(c) Well EPA 26 is no longer monitored because it was excluded from the list of performance monitoring wells in accordance with License requirements.

TABLE 6.21

PREDICTED PEAK DISCHARGE FROM WELLS IN THE SOUTHWEST ALLUVIUM FOR THE REMEDIAL DESIGN

Initial Saturated Thickness (feet)	Water Level Drawdown (feet)	Peak Discharge at 50 Percent Efficiency (gpm)
10	5	0.4
20	10	1.3
30	16	2.9
40	21	5.1
50	26	7.9
60	31	11.3
70	36	15.2
80	41	19.7

Note: See Tables 6.24 and 6.25 for operational pumping rates.

TABLE 6.22

SOUTHWEST ALLUVIUM MONITORING WELLS

Current Monitoring Wells in Alluvium (License Condition 30, Parts A & B Criteria)	Remedial Action System Wells	Alluvial Wells
GW-1	801	624
GW-2	802	627
GW-3	803	639
GW-4	804 (b)	642
EPA-22A	805 (b)	644
EPA-23	806 (b)	645
EPA-25	807 (b)	
EPA-27 (a)	808 (c)	
EPA-28		
509D		
632		
TWQ-29A (a)		

(a) Data from these wells may not be representative of ground water conditions in the alluvium because of problematic completion.

(b) Wells monitored for water level only.

(c) Well 808 was added in June 1991 in accordance with Amendment 12 of the License.

TABLE 6.23

IMPLEMENTATION OF SOUTHWEST ALLUVIUM REMEDIAL ACTION PROGRAM

	Activity	Date Started or Submitted	Date Completed
1.	Install Southwest Alluvium Wells o Install Extraction Wells 801 - 803 o Install Monitoring Wells 804 - 807 o Aquifer Test using Well 802	8/3/89	8/30/89
2.	Start Southwest Alluvium well operation	10/16/89	N/A
3.	Submit 1989 Annual Review o Description of Southwest Alluvium Well Installation o Performance monitoring evaluation of Southwest Alluvium (water levels and water quality) - Limited because wells had operated for only 6 weeks o Recommendations for continued operation	12/89	N/A
4.	NRC and EPA submit comments to the 1989 Annual Review o Effective hydraulic barrier to seepage migration has not been established o Recommend installation of additional piezometers to monitor hydraulic performance of the system. o Exceedances of the water quality standards continue o Recommend installing two additional monitoring wells downgradient	2/90	N/A
5.	United Nuclear Response to Comments o Recommend continued operation and monitoring; performance evaluation after 1 year o Provide demonstration that water quality exceedances are actually background water quality	3/90	N/A

TABLE 6.23

IMPLEMENTATION OF SOUTHWEST ALLUVIUM REMEDIAL ACTION PROGRAM
(Continued)

	Activity	Date Started or Submitted	Date Completed
6.	Submit 1990 Annual Review o Southwest Alluvium system performing as designed - Hydraulic barrier almost complete - Water quality stable	12/90	N/A
7.	NRC and EPA submit comments to the 1990 Annual Review o Southwest Alluvium system has not created a complete hydraulic barrier o Requires installation of additional extraction well(s)	2/91	N/A
8.	United Nuclear response to comments o Amendment request for installation one additional extraction well - Well 808 - Located between extraction Wells 803 and 802	4/91	N/A
9.	NRC and EPA approve proposal for amendment to Southwest Alluvium o Included in Amendment 12 to the License	7/91	N/A
10.	Install Southwest Alluvium well o Install and test Well 808	6/13/91	6/14/91
11.	Start operation of Southwest Alluvium well	6/26/91	N/A

TABLE 6.24

SUMMARY OF 1989 OPERATIONAL DATA
SOUTHWEST ALLUVIUM EXTRACTION WELLS

Well Number	Initial (a) Pumping Rate (gpm)	Current (b) Pumping Rate (gpm)	Average (c) Pumping Rate (gpm)	Design Pumping Rate (gpm)
801	2.6	2.0	2.0	2.0
802	20.0	11.6	14.9	5.0
803	3.4	2.2	2.8	10.0
		Total	19.7	17.0

Total Volume Pumped: 810,031 (c)

(a) Measured on October 16, 1989.

(b) Average pumping rate reported for the week of November 10 – 17, 1989.

(c) Average pumping rate and total volume pumped estimated for the period between October 16 and November 17, 1989.

TABLE 6.25

SUMMARY OF 1990 OPERATIONAL DATA
SOUTHWEST ALLUVIUM EXTRACTION WELLS

Well Number	Average (a) Pumping Rate (gpm)	Design Pumping Rate (gpm)
801	1.2	--
802	11.1	--
803	2.0	--
	14.3	15.2

Total Volume Pumped = 7.4 million gallons (a)

(a) Average pumping rate and total volume pumped calculated for the period between October 13, 1989 and October 12, 1990.

TABLE 6.26

MONTHLY NET EVAPORATION RATES
USED FOR THE REMEDIAL DESIGN

Month	Estimated Monthly Net Evaporation (In) (a)	g/ac-d
January	-0.51	-462
February	-0.12	-109
March	0.25	769
April	2.62	2,371
May	4.42	4,000
June	6.12	5,539
July	6.46	5,847
August	6.12	5,539
September	5.10	4,616
October	2.75	2,489
November	0.71	643
December	-0.51	-462
Average Annual	34 in/yr	

(a) Monthly net evaporation rates estimated by distributing the average annual rate for the Church Rock site based on the distribution of monthly evaporation rates reported for 30 years of data for the Gallup station.

TAE 6.27

SUMMARY OF PREDICTED AND ACTUAL WATER BALANCE FOR EVAPORATION PONDS
1989 TO 1991
(Millions of Gallons) (a)

	Predicted (c) 1989	Actual (d) 1989	Predicted (c) 1990	Actual (d) 1990	Predicted (c) 1991	Actual (d) 1991
Starting Inventory (b)	0.0	0.0	7.3	7.5	8.5	12.2
Source of Inflow to the Evaporation Pond						
Borrow Pit No. 2 (e)	12.0	4.0	0.0	0.0	0.0	2.8
Northeast Pump-back Wells	6.7	6.3	4.0	7.0		
Zone 1 Pump-back Wells		4.2	0.0	3.2		
Zone 3 Extraction Wells	17.0	8.0	26.0	13.1		
Southwest Alluvium Extraction Wells	4.9	1.7	7.0	8.1		
Precipitation (f)				1.3		
Total Inflow	40.6	24.2	44.3	40.2		
Outflow from Evaporation Pond						
Net Evaporation from Surface	-9.2	-3.5	-9.2	-9.2		
Evaporation from Pond Misters	-4.1	-3.8	-15.0	-5.2		
Evaporation from Misters or Spray	-20.0	-9.4	-11.6	-2.4		
Construction	0.0	0.0	0.0	-11.2		
Total Outflow	-33.3	-16.7	-35.8	-28.0		
Ending Inventory (December 31)	7.3	7.5	8.5	12.2		

(a) Based on detailed monthly water balance.
(b) Must have sufficient end-of-year storage capacity to store first quarter inputs for following year.
(c) Presented in Table 5.1 of the RD (Canonie, 1989d).
(d) Based on reported volumes of inflow and outflow, measured water levels in the evaporation ponds, and calibration of the water balance by adjusting pond mister efficiency and pond surface area. These volumes apply for the period from January 1, 1990 through December 31, 1990.
(e) Borrow Pit No. 2 used to temporarily store seepage from January 29 through April 24, 1991.
(f) Heavy snowfall in December 1990 contributed to the stored volume in the winter of 1990-1991.

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TABLE 6.28

SUMMARY OF PREDICTED AND ACTUAL PUMPING RATES AND VOLUMES
SEEPAGE EXTRACTION WELLS
1989 to 1991

	1988	Predicted 1989	Actual 1989	Predicted 1990	Actual 1990	Predicted 1991	Actual as of July 1991
Design Pumping Rates							
A. Existing Wells							
Number of Existing Wells in Operation:							
NE	6	6	6	4	6	4	4
E	12	12	12	0	12	0	4
NXD	6	6	6	0	4	0	0
Total	24	24	24	4	22	4	8
Total Average Flow Rate Existing Wells (gpm)	18	13	13	8	19.3	6	4
B. New Wells							
Number of New Wells in Operation	0	16	15	16	15	22	22
Total Average Flow Rate New Wells (gpm)	0	74	63	64.4	40.4	53.8	35
C. Total Peak Flow Rate (gpm)	18	87	76	72.4	59.7	59.8	39
mes							
A. Total Gallons (millions/year)	12	28.6	20.2	37.0	31.4	31.1	
Cumulative Total Gallons (millions)	12	40.6	32.2	77.6	63.6	108.7	
B. Zone 3							
Gallons from Zone 3 (millions)	12	23.7	14.3	30.0	20.1	25.1	
Cumulative Gallons from Zone 3 (millions)	12	35.7	26.3	65.7	46.4	90.8	
C. Southwest Alluvium							
Gallons from Alluvium (millions)	0	4.9	0.8	7.0	7.4	6.0	
Cumulative Gallons from Alluvium (millions)	0	4.9	0.8	11.9	8.2	17.9	

Notes:

1. See Section 5.2 of the RD (Canonie, 1989d) for a discussion of the assumptions used to develop the predicted values.
2. Twelve Zone 3 – Stage I wells began pumping August 7 and 8, 1989.
3. Three Southwest Allluvium wells began pumping October 16, 1989.
4. Wells operate 24 hours per day, 365 days per year.
5. January 1991 through April 1991, northeast pump-back wells turned off and Zone 3 – Stage I well pumping rates reduced.
6. Seven Zone 3 – Stage II wells will begin pumping in August 1991.
7. One new Southwest Alluvium extraction well began pumping June 26, 1991.