NOTE TO: SANDRA WASTLER July 1, 1994

FROM: JOHN BRADBURY

SUBJECT: REVIEW OF ENVIROCARE RESPONSE TO NRC COMMENTS (RITS #33215 TAC #L50919 LINER COMPATIBILITY)

I have reviewed the responses of Envirocare to the NRC comments concerning clay liner compatibility. There were four comments that I had made concerning the testing. Evaluation of these comments is provided below:

Comment 1 - This comment referred to the fact that the synthetic leachate contained concentrations of barium, calcium, sulfate, and fluoride that make the solution supersaturated with respect to barite and fluorite. The reduction of the concentration of barium, for example, should not be used as evidence that the liner is a good scavenger of "trace metals." Furthermore, it is of concern that precipitation of these phases could have reduced the hydraulic conductivity of the liner by plugging flow paths. It was recommended that the licensee provide an explanation of wh/ the synthethic leachate was prepared with concentrations that exceeded solubility limits and whether the possibility of precipitation could affect the results of the liner compatibility tests.

Evaluation of Response - The licensee states that the synthetic leachate was used because the NRC had been concerned that a leachate from one particular site would not represent all possible leachate solutions. Maximum concentrations of contaminants were selected even though it was recognized that some precipitation might occur. The presence of significant precipitate on the clay liner in the permeameter mold was not evident. The NRC considers that it would be unlikely that the precipitate could be seen in the permeameter. The licensee states that the precipitate in the leachate solution storage containers was minimal. The possibility exists that precipitation of the phases occurred prior to addition of the leachate to the permeameter. The NRC considers this response adequate.

Comment 2 - This comment referred to the dissolution of 2% of the liner by 3 liters of the synthetic leachate. The NRC wanted to know if further addition of leachate would result in continued liner dissolution.

Evaluation of Response - The response states that long term contact by leachate solution has not resulted in a significant increase in permeability. The NRC was not concerned so much with the duration of the test as with the amount of leachate contacting the liner material. The licensee should provide this information.

Comment 3 - This comment referred to the fact that although the

solids in the liner material were identified by x-ray diffraction, there was an unidentified source of sodium and chloride as evidence by the change in their respective concentrations before and after contacting the liner material. The NRC recommended that the licesee discuss how much unidentified leachable material is present or provide additional information on the source of the Na and Cl.

Evaluation of Response - The licensee responded that the source of Na and Cl was from the residual groundwater left in the pores of the liner material in the permeameter after the initial hydraulic conductivity test. The licensee states that one pore volume of residual groundwater effluent is mixed with three pore volumes of leachate. However, the concentration of Na and Cl in the groundwater (GW-19A) is 16,000 and 23,000 mg/L, respectively. The concentration of Na and Cl in the leachate is 1000 and 200 mg/L, respectively. Three volumes of leachate and one volume of groundwater should have resulted in an effluent whose composition is 4,750 mg/L Na and 5,900 mg/l Cl. Instead, the effluent (pH4W) contained 11,300 mg/L Na and 13,300 mg/L Cl. The licensee should explain this discrepancy.

Comment 4 - This comment referred to the possibility of physical changes in the liner such as the creation of preferential pathways by gas bubbles generated by the reaction of the acidic leachate with the carbonate liner.

Evaluation of Response - The licensee stated that this type of impact was not observed, nor was there significant changes in permeability for the four tests using leachates of varying pH. The NRC considers this response adequate.

Preliminary Staff Review Comments
Liner Compatibility Report
Results of Tests of Liner Material and Tailings Solution
at Envirocare's 11e.(2) Disposal Site
Clive, Utah

Background

Envirocare proposed to construct a bottom liner in the disposal cell at its proposed 11e.(2) disposal site, near Clive, Utah. Envirocare proposed using clayey material to be obtained from a stratum designated as Unit 4 in the soil profile underlying the disposal site.

Criterion 5E(1) of Appendix A to 10 CFR Part 40 requires that: (a) applicants and licensees of 11e.(2) disposal sites consider installation of bottom liners in their groundwater protection programs; and (b) where clay liners are proposed or relatively thin, in-situ clay soils are to be relied upon for seepage control, tests must be conducted with representative tailings solutions and clay materials to confirm that no significant deterioration of permeability or stability properties will occur with continuous exposure of clay to tailings solution. Accordingly, the staff requested that Envirocare conduct such tests to meet the regulations.

In response, Envirocare indicated that it would be receiving and disposing of tailings from Kerr McGee, and that Kerr McGee had already conducted tests to evaluate the compatibility of the waste solution and a clay deposit (referred to as the F-Stratum) at its facility in northeast Illinois. The Kerr McGee tests had concluded that a tailings solution did not cause any degradation of the clay. Envirocare took the position that the results of the Kerr McGee tests would be applicable in the proposed disposal site area in Utah. To support this position, Envirocare provided information and pointed out similarities in the mineralogical composition of the F-Stratum and Unit 4. Consequently, Envirocare concluded that the tailings solution and the proposed liner material at the disposal site were compatible with the tailings solution and, therefore, no additional testing was required.

The staff informed Envirocare that it disagreed with that position because the Kerr McGee tailings, if transferred to the Envirocare facility, will not constitute the only waste disposed at the disposal site by the applicant and the leachate solution generated at the Envirocare site may not therefore be identical to that generated by Kerr McGee tailings. Furthermore, the staff indicated there are notable and important differences in the compositions of the F-Stratum and Unit 4, which can be seen from the mineralogical analyses provided by the applicant (see attached pages from license application and summary of x-ray diffraction analysis in attachment 1 of the test report). These

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are: (1) The clay minerals (kaolinite, illite/mica, and smectite) constitute 39% of the F-Stratum, compared to only 18% for Unit 4; (2) the silicate minerals (quartz, plagioclase, and feldspar) constitute 38% of the F-Stratum, compared to 17% for Unit 4; and (3) the carbonate minerals (calcite, dolomite, and aragonite) constitute 17% of the F-Stratum, compared to 65% for Unit 4. These data indicate that while the F-Stratum depicts a typical clay composition (a high content of clay and silicate minerals), Unit 4 does not. The high content of carbonate minerals in Unit 4 is particularly alarming since these minerals can dissolve as the pH declines below 7, which can be expected to take place in the tailings solution.

The staff recognized that the dissolution of the carbonate minerals may not be the only outcome of the chemical reactions that can take place between the tailings solution and the liner material. New minerals/mineral compounds can also precipitate that could replace any dissolved carbonates. There is no way of knowing how the tailings solution will impact the liner without conducting compatibility tests using representative samples of the tailings solution and the liner material.

In response, Envirocare indicated that tests would be conducted to verify the compatibility of the leachate solution and the liner material, to satisfy the regulations, and may require four months to complete. It was further indicated that the tests would be performed using a laboratory-generated leachate solution with constituents and concentrations that are representative of the constituents and permitted levels in the 11e.(2) waste material to be received and disposed at the site. Section 4.1.4 in the license application was revised to include a commitment to conduct these tests as required by NRC. The staff indicated that proper testing of a sufficient duration should be carried out.

Envirocare has completed the compatibility tests, and submitted the results in a report dated March, 1994, which is currently under review by the staff. the report indicates that the leachate solution will not cause the liner to deteriorate over time.

Preliminary Staff Review Comments

The report should be carefully and thoroughly reviewed to insure that the tests were conducted properly, and the results are credible. I feel we need a professional review of the compatibility tests results for the following reasons:

1. The mineralogy of the "clay" in Unit 4 indicates a high carbonate content; the report indicates that the leachate permeate after the hydraulic conductivity test was concluded had a pH of 7.5, and indicated that the high calcium carbonate

content in the clay buffers the largely acid leachate (pH of 2, 4, and 7). This also indicates that the liner material is being dissolved by the leachate, and the report indicates that the solids loss due to solubility is 2% when freshwater is used in the hydraulic conductivity test and 0.2% when local groundwater is used. However, the report is silent on the changes in the physical properties of the clay that can be expected to occur as a result of the carbonate removal.

2. The tests were conducted by Bingham Engineering Material Lab, for the first time; this lab did not conduct any such tests previous to Envirocare's tests.

3. A synthetic leachate solution was used in the tests; the review needs to ascertain that the leachate solution used in the tests is representative of the leachate solution that can be expected based on the waste characteristics. Toxicity Characteristic Leaching Procedure (TCLP) was used to determine metal concentration in the leachate. Reviewing the synthesized leachate requires a chemistry background and a familiarity with the TCLP test.

4. The tests were completed in three months. This may be too short a time to confirm compatibility; it is noted that Criterion 5E(1) requires that test be run for a sufficient period of time to reveal any effects if they are going to occur, and that "in some cases deterioration has been observed to occur rather rapidly after about nine months of exposure", implying a test duration of at least nine months would be required. The review should ascertain that the duration of the tests conducted by Bingham is sufficient to establish compatibility.

5. Report indicates that three pore volumes of syntnesized leachate were used in testing cylindrical samples, of a 6"-diameter and 4"-height. Assuming an effective porosity of 0 .20, I have calculated that 1.111 liters was used in each test. The cross surface area for the cylinder is 7.5*7.5*3.14 or 182.3 square cm, and the total flux through the sample throughout the test is therefore evaluated at 1111/182.3=6.09 cm. Even if we accept the infiltration rate of 2.47 cm/year from the UNSAT and PATHRAE models (which is believed to be an underestimate), the computed flux is equivalent to about 12 or 13 years of exposure (i.e., (6.09/0.2)/2.47). Unless I missed up the arithmetic, Bingham's estimate of a 80-year equivalent needs to be explained. Furthermore, we need to decide if the liner should be designed for the operational period only, or for the entire design life of the disposal cell of 200-1000 years, as required by Criterion 6.

LH
4/14/94

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1
 Date of Simulation Run:  1994/05/04
 Time of Simulation Run:  17:07:46

          DATA READ FROM DISK

 ELEMENTS
 SPECIES
 LOOK MIN
1liner 1sttime

 0050000000 0 0           .00000
 ELEMENTS
 c          15          .44010E+02
             0          .00000E+00
 SOLUTION 1
 leachate

  8  0 2     4.00         .0      20.0      1.00
    4  6.000D+02    5  1.500D+02    6  1.000D+03    7  3.000D+01   11  8.000D+03
   14  2.000D+02   16  3.000D+03   20  2.500D+01
 MINERALS
 Aragonit   2       4.0       -8.3       -2.6          1                .000
   15   1.00         4   1.00
  -1.7198E+02 -7.7993E-02  2.9033E+03  7.1595E+01  0.0000E+00
 Dolomite   3       8.0       -17.       -9.4          0                .000
    4   1.00         5   1.00       15   2.00
             0       .00        .00        .00          0                .000
1SOLUTION NUMBER 1
 leachate
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TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.516731D-02	-1.8191
Mg	6.252888D-03	-2.2039
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429
S	3.164198D-02	-1.4997
F	1.333239D-03	-2.8751

----DESCRIPTION OF SOLUTION----

PH = 4.0000
PE = 12.0000
ACTIVITY H2O = .9976
IONIC STRENGTH = .1612
TEMPERATURE = 20.0000
ELECTRICAL BALANCE = 1.3566D-01
THOR = 1.8985D-01
TOTAL ALKALINITY = 1.9907D-10
ITERATIONS = 19

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	1.239E-04	-3.907	1.000E-04	-4.000	8.070E-01	-.093
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.976E-01	-.001	9.976E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	1.279E-02	-1.893	4.393E-03	-2.357	3.435E-01	-.464
5	Mg+2	2.0	5.076E-03	-2.294	1.844E-03	-2.734	3.633E-01	-.440
6	Na+	1.0	4.344E-02	-1.362	3.287E-02	-1.483	7.566E-01	-.121
7	K+	1.0	7.632E-04	-3.117	5.569E-04	-3.254	7.297E-01	-.137
11	Ba+2	2.0	4.059E-02	-1.392	1.311E-02	-1.882	3.231E-01	-.491
14	Cl-	-1.0	5.716E-03	-2.243	4.171E-03	-2.380	7.297E-01	-.137
16	SO4-2	-2.0	9.143E-03	-2.039	2.910E-03	-2.536	3.183E-01	-.497
20	F-	-1.0	1.068E-03	-2.972	7.747E-04	-3.111	7.257E-01	-.139
31	OH-	-1.0	9.333E-11	-10.030	6.773E-11	-10.169	7.257E-01	-.139
32	O2 AQ	.0	1.647E-24	-23.783	1.709E-24	-23.767	1.038E+00	.016
69	HF AQ	.0	1.024E-04	-3.990	1.063E-04	-3.974	1.038E+00	.016
78	CaSO4	.0	2.344E-03	-2.630	2.432E-03	-2.614	1.038E+00	.016
83	CaF+	1.0	3.475E-05	-4.459	2.632E-05	-4.580	7.575E-01	-.121
88	MgSO4	.0	1.063E-03	-2.973	1.104E-03	-2.957	1.038E+00	.016
92	MgF+	1.0	1.136E-04	-3.944	8.608E-05	-4.065	7.575E-01	-.121
96	NaSO4-	-1.0	6.128E-04	-3.213	4.642E-04	-3.333	7.575E-01	-.121
98	NaF aq	.0	1.412E-05	-4.850	1.465E-05	-4.834	1.038E+00	.016
100	KSO4-	-1.0	1.420E-05	-4.848	1.076E-05	-4.968	7.575E-01	-.121
173	BaSO4	.0	1.843E-02	-1.734	1.913E-02	-1.718	1.038E+00	.016

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Gypsum	-4.8954	-4.5811	-.3143
Anhydrit	-4.8933	-4.3438	-.5495
Barite	-4.4183	-10.0528	5.6345
Fluorite	-8.5790	-10.6599	2.0809
O2 gas	-23.7673	-2.9369	-20.8303
H2 gas	-35.1280	-3.1280	-32.0000

1STEP NUMBER 1
0----------

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.516731D-02	-1.8191
Mg	6.252888D-03	-2.2039
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429
S	3.164198D-02	-1.4997
F	1.333239D-03	-2.8751

----PHASE BOUNDARIES----

PHASE	DELTA PHASE*	LOG IAP	LOG KT	LOG IAP/KT
Aragonit	-2.404613D-04	-8.3059	-8.3059	.0000
Dolomite	2.607529D-04	-16.9720	-16.9720	.0000

* NEGATIVE DELTA PHASE INDICATES PRECIPITATION
AND POSITIVE DELTA PHASE INDICATES DISSOLUTION.

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Calcite	-8.3059	-8.4533	.1474
Aragonit	-8.3059	-8.3059	.0000
Dolomite	-16.9720	-16.9720	.0000
Witherit	-7.8311	-8.5749	.7438
Gypsum	-4.8956	-4.5811	-.3145
Anhydrit	-4.8935	-4.3438	-.5497
Barite	-4.4187	-10.0528	5.6341*
Fluorite	-8.5127	-10.6599	2.1472*
PCO2	-5.6100	-1.4069	-4.2031
O2 gas	-6.9268	-2.9369	-3.9899
H2 gas	-43.5482	-3.1280	-40.4202

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY

Ca	1.518760D-02	-1.8185
Mg	6.513641D-03	-2.1862
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429
c	2.810445D-04	-3.5512
S	3.164198D-02	-1.4997
F	1.333239D-03	-2.8751

----DESCRIPTION OF SOLUTION----

PH =	8.2101
PE =	12.0000
ACTIVITY H2O =	.9976
IONIC STRENGTH =	.1617
TEMPERATURE =	20.0000
ELECTRICAL BALANCE =	1.3566D-01
THOR =	1.9098D-01
TOTAL ALKALINITY =	2.6519D-04
ITERATIONS =	34

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	7.639E-09	-8.117	6.164E-09	-8.210	8.069E-01	-.093
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.976E-01	-.001	9.976E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	1.279E-02	-1.893	4.389E-03	-2.358	3.432E-01	-.464
5	Mg+2	2.0	5.274E-03	-2.278	1.915E-03	-2.718	3.630E-01	-.440
6	Na+	1.0	4.344E-02	-1.362	3.286E-02	-1.483	7.564E-01	-.121
7	K+	1.0	7.632E-04	-3.117	5.568E-04	-3.254	7.295E-01	-.137
11	Ba+2	2.0	4.058E-02	-1.392	1.310E-02	-1.883	3.227E-01	-.491
14	Cl-	-1.0	5.716E-03	-2.243	4.170E-03	-2.380	7.295E-01	-.137
15	CO3-2	-2.0	3.371E-06	-5.472	1.127E-06	-5.948	3.342E-01	-.476
16	SO4-2	-2.0	9.156E-03	-2.038	2.911E-03	-2.536	3.180E-01	-.498
20	F-	-1.0	1.153E-03	-2.938	8.365E-04	-3.078	7.254E-01	-.139
31	OH-	-1.0	1.515E-06	-5.820	1.099E-06	-5.959	7.254E-01	-.139
32	O2 AQ	.0	1.140E-07	-6.943	1.183E-07	-6.927	1.038E+00	.016
34	HCO3-	-1.0	2.169E-04	-3.664	1.649E-04	-3.783	7.603E-01	-.119
76	CaCO3	.0	7.307E-06	-5.136	7.584E-06	-5.120	1.038E+00	.016
77	CaHCO3+	1.0	1.116E-05	-4.952	8.482E-06	-5.071	7.603E-01	-.119
78	CaSO4	.0	2.342E-03	-2.630	2.431E-03	-2.614	1.038E+00	.016
83	CaF+	1.0	3.750E-05	-4.426	2.840E-05	-4.547	7.573E-01	-.121
87	MgHCO3+	1.0	4.783E-06	-5.320	3.622E-06	-5.441	7.573E-01	-.121

88	MgSO4	.0	1.104E-03	-2.957	1.146E-03	-2.941	1.038E+00	.016
92	MgF+	1.0	1.274E-04	-3.895	9.650E-05	-4.015	7.573E-01	-.121
96	NaSO4-	-1.0	6.130E-04	-3.213	4.642E-04	-3.333	7.573E-01	-.121
98	NaF aq	.0	1.524E-05	-4.817	1.582E-05	-4.801	1.038E+00	.016
100	KSO4-	-1.0	1.420E-05	-4.848	1.076E-05	-4.968	7.573E-01	-.121
171	BaCO3	.0	6.642E-06	-5.178	6.894E-06	-5.162	1.038E+00	.016
172	BaHCO3+	1.0	2.335E-05	-4.632	1.769E-05	-4.752	7.573E-01	-.121
173	BaSO4	.0	1.841E-02	-1.735	1.911E-02	-1.719	1.038E+00	.016

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Date of Simulation Run:  1994/05/05
Time of Simulation Run:  15:39:52

         DATA READ FROM DISK

ELEMENTS
SPECIES
LOOK MIN
1liner 1sttime

0050000000 0 0          .00000
ELEMENTS
c          15          .44010E+02
            0          .00000E+00
SOLUTION 1
leachate

 8  0 2     4.00       12.0       20.0       1.00
   4  6.000D+02   5  1.500D+02   6  1.000D+03   7  3.000D+01  11  8.000D+03
  14  2.000D+02  16  3.000D+03  20  2.500D+01
MINERALS
Aragonit   2       4.0       -8.3       -2.6          1                .000
  15   1.00        4   1.00
 -1.7198E+02 -7.7993E-02  2.9033E+03  7.1595E+01  0.0000E+00
Barite     2       6.0       -10.        6.3          1                .000
  11   1.00       16   1.00
  1.3603E+02  0.0000E+00 -7.6804E+03 -4.8595E+01  0.0000E+00
Dolomite   3       8.0       -17.       -9.4          0                .000
   4   1.00        5   1.00       15   2.00
Quartz     2       .00       -4.0        6.0          1                .000
  13   1.00        3  -2.00
  4.1000E-01  0.0000E+00 -1.3090E+03  0.0000E+00  0.0000E+00
Kaolinit   4       .00        7.4       -35.          0                .000
   3   1.00        1  -6.00       13   2.00       10   2.00
               0       .00        .00        .00          0                .000
1SOLUTION NUMBER 1
 leachate
```

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.516731D-02	-1.8191
Mg	6.252888D-03	-2.2039
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429

J/12c

S	3.164198D-02	-1.4997
F	1.333239D-03	-2.8751

----DESCRIPTION OF SOLUTION----

PH =	4.0000
PE =	12.0000
ACTIVITY H2O =	.9976
IONIC STRENGTH =	.1612
TEMPERATURE =	20.0000
ELECTRICAL BALANCE =	1.3566D-01
THOR =	1.8985D-01
TOTAL ALKALINITY =	1.9907D-10
ITERATIONS =	19

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	1.239E-04	-3.907	1.000E-04	-4.000	8.070E-01	-.093
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.976E-01	-.001	9.976E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	1.279E-02	-1.893	4.393E-03	-2.357	3.435E-01	-.464
5	Mg+2	2.0	5.076E-03	-2.294	1.844E-03	-2.734	3.633E-01	-.440
6	Na+	1.0	4.344E-02	-1.362	3.287E-02	-1.483	7.566E-01	-.121
7	K+	1.0	7.632E-04	-3.117	5.569E-04	-3.254	7.297E-01	-.137
11	Ba+2	2.0	4.059E-02	-1.392	1.311E-02	-1.882	3.231E-01	-.491
14	Cl-	-1.0	5.716E-03	-2.243	4.171E-03	-2.380	7.297E-01	-.137
16	SO4-2	-2.0	9.143E-03	-2.039	2.910E-03	-2.536	3.183E-01	-.497
20	F-	-1.0	1.068E-03	-2.972	7.747E-04	-3.111	7.257E-01	-.139
31	OH-	-1.0	9.333E-11	-10.030	6.773E-11	-10.169	7.257E-01	-.139
32	O2 AQ	.0	1.647E-24	-23.783	1.709E-24	-23.767	1.038E+00	.016
69	HF AQ	.0	1.024E-04	-3.990	1.063E-04	-3.974	1.038E+00	.016
78	CaSO4	.0	2.344E-03	-2.630	2.432E-03	-2.614	1.038E+00	.016
83	CaF+	1.0	3.475E-05	-4.459	2.632E-05	-4.580	7.575E-01	-.121
88	MgSO4	.0	1.063E-03	-2.973	1.104E-03	-2.957	1.038E+00	.016
92	MgF+	1.0	1.136E-04	-3.944	8.608E-05	-4.065	7.575E-01	-.121
96	NaSO4-	-1.0	6.128E-04	-3.213	4.642E-04	-3.333	7.575E-01	-.121
98	NaF aq	.0	1.412E-05	-4.850	1.465E-05	-4.834	1.038E+00	.016
100	KSO4-	-1.0	1.420E-05	-4.848	1.076E-05	-4.968	7.575E-01	-.121
173	BaSO4	.0	1.843E-02	-1.734	1.913E-02	-1.718	1.038E+00	.016

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT

Gypsum	-4.8954	-4.5811	-.3143
Anhydrit	-4.8933	-4.3438	-.5495
Barite	-4.4183	-10.0528	5.6345
Fluorite	-8.5790	-10.6599	2.0809
O2 gas	-23.7673	-2.9369	-20.8303
H2 gas	-35.1280	-3.1280	-32.0000

1STEP NUMBER 1
0----------

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.516731D-02	-1.8191
Mg	6.252888D-03	-2.2039
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429
S	3.164198D-02	-1.4997
F	1.333239D-03	-2.3751

----PHASE BOUNDARIES----

PHASE	DELTA PHASE*	LOG IAP	LOG KT	LOG IAP/KT
Aragonit	-1.695761D-04	-8.3059	-8.3059	.0000
Barite	-3.164190D-02	-10.0528	-10.0528	.0000
Dolomite	2.236572D-04	-16.9720	-16.9720	.0000
Quartz	8.691171D-05	-4.0553	-4.0553	.0000
Kaolinit	5.191537D-08	7.8763	7.8763	.0000

* NEGATIVE DELTA PHASE INDICATES PRECIPITATION
AND POSITIVE DELTA PHASE INDICATES DISSOLUTION.

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Calcite	-8.3059	-8.4533	.1474
Aragonit	-8.3059	-8.3059	.0000
Dolomite	-16.9720	-16.9720	.0000
Witherit	-8.0697	-8.5749	.5052
Gypsum	-10.2905	-4.5811	-5.7094
Anhydrit	-10.2890	-4.3438	-5.9452

Barite	-10.0528	-10.0528	.0000
Fluorite	-8.4129	-10.6599	2.2470
SiO2 (a)	-4.0553	-2.7536	-1.3017
Chalcedy	-4.0553	-3.6104	-.4449
Quartz	-4.0553	-4.0553	.0000
Gibbs(c)	7.9931	8.3951	-.4020
Al(Oh)3a	7.9931	11.1313	-3.1382
Kaolinit	7.8763	7.8763	.0000
Albite	-20.7430	-18.3238	-2.4192
Anorth	-24.5786	-19.5492	-5.0294
Microcln	.6862	1.0309	-.3447
Muscovit	16.6738	13.7123	2.9615
Chlorite	-88.0502	-91.2946	3.2444
Ca-Mont	-48.0023	-45.7298	-2.2725
Talc	-60.5117	-62.8534	2.3417
Illite	-42.8479	-40.9937	-1.8542
Chrysotl	32.6072	32.8310	-.2238
Sepiolit	14.9777	15.8938	-.9161
PCO2	-5.4818	-1.4069	-4.0749
O2 gas	-7.3960	-2.9369	-4.4590
H2 gas	-43.3134	-3.1280	-40.1854
Alunite	-19.6066	-.7718	-18.8348

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.522139D-02	-1.8175
Mg	6.476546D-03	-2.1887
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Al	1.038307D-07	-6.9837
Ba	2.737952D-02	-1.5626
Si	8.701554D-05	-4.0604
Cl	5.715603D-03	-2.2429
c	2.777383D-04	-3.5564
S	8.538794D-08	-7.0686
F	1.333239D-03	-2.8751

----DESCRIPTION OF SOLUTION----

PH =	8.0927
PE =	12.0000
ACTIVITY H2O =	.9983
IONIC STRENGTH =	.1237
TEMPERATURE =	20.0000
ELECTRICAL BALANCE =	1.3566D-01

THOR = 1.1116D-03
TOTAL ALKALINITY = 2.7023D-04
ITERATIONS = 54

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	9.880E-09	-8.005	8.078E-09	-8.093	8.176E-01	-.087
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.983E-01	-.001	9.983E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	1.515E-02	-1.820	5.608E-03	-2.251	3.701E-01	-.432
5	Mg+2	2.0	6.308E-03	-2.200	2.446E-03	-2.612	3.878E-01	-.411
6	Na+	1.0	4.405E-02	-1.356	3.398E-02	-1.469	7.715E-01	-.113
7	K+	1.0	7.774E-04	-3.109	5.828E-04	-3.234	7.497E-01	-.125
10	Al+3	3.0	3.194E-16	-15.496	5.215E-17	-16.283	1.633E-01	-.787
11	Ba+2	2.0	2.736E-02	-1.563	9.659E-03	-2.015	3.531E-01	-.452
13	H4SiO4	.0	8.528E-05	-4.069	8.774E-05	-4.057	1.029E+00	.012
14	Cl-	-1.0	5.716E-03	-2.243	4.285E-03	-2.368	7.497E-01	-.125
15	CO3-2	-2.0	2.425E-06	-5.615	8.818E-07	-6.055	3.637E-01	-.439
16	SO4-2	-2.0	2.626E-08	-7.581	9.167E-09	-8.038	3.491E-01	-.457
20	F-	-1.0	1.112E-03	-2.954	8.301E-04	-3.081	7.465E-01	-.127
31	OH-	-1.0	1.124E-06	-5.949	8.390E-07	-6.076	7.465E-01	-.127
32	O2 AQ	.0	3.906E-08	-7.408	4.018E-08	-7.396	1.029E+00	.012
34	HCO3-	-1.0	2.178E-04	-3.662	1.691E-04	-3.772	7.766E-01	-.110
35	H2CO3	.0	3.205E-06	-5.494	3.297E-06	-5.482	1.029E+00	.012
76	CaCO3	.0	7.371E-06	-5.132	7.584E-06	-5.120	1.029E+00	.012
77	CaHCO3+	1.0	1.431E-05	-4.844	1.112E-05	-4.954	7.766E-01	-.110
78	CaSO4	.0	9.506E-09	-8.022	9.781E-09	-8.010	1.029E+00	.012
83	CaF+	1.0	4.671E-05	-4.331	3.601E-05	-4.444	7.708E-01	-.113
87	MgHCO3+	1.0	6.158E-06	-5.211	4.747E-06	-5.324	7.708E-01	-.113
88	MgSO4	.0	4.482E-09	-8.349	4.611E-09	-8.336	1.029E+00	.012
92	MgF+	1.0	1.587E-04	-3.799	1.224E-04	-3.912	7.708E-01	-.113
95	NaHCO3	.0	2.822E-06	-5.549	2.904E-06	-5.537	1.029E+00	.012
96	NaSO4-	-1.0	1.961E-09	-8.707	1.512E-09	-8.820	7.708E-01	-.113
98	NaF aq	.0	1.578E-05	-4.802	1.623E-05	-4.790	1.029E+00	.012
153	AlOH4-	-1.0	1.007E-07	-6.997	7.765E-08	-7.110	7.708E-01	-.113
159	AlF3	.0	1.719E-09	-8.765	1.769E-09	-8.752	1.029E+00	.012
164	H3SiO4-	-1.0	1.736E-06	-5.760	1.338E-06	-5.873	7.708E-01	-.113
171	BaCO3	.0	3.868E-06	-5.412	3.980E-06	-5.400	1.029E+00	.012
172	BaHCO3+	1.0	1.736E-05	-4.760	1.338E-05	-4.874	7.708E-01	-.113
173	BaSO4	.0	4.313E-08	-7.365	4.438E-08	-7.353	1.029E+00	.012

----DESCRIPTION OF SOLUTION----

PH =	4.0000
PE =	12.0000
ACTIVITY H2O =	.9976
IONIC STRENGTH =	.1612
TEMPERATURE =	20.0000
ELECTRICAL BALANCE =	1.3566D-01
THOR =	1.8985D-01
TOTAL ALKALINITY =	1.9907D-10
ITERATIONS =	19

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	1.239E-04	-3.907	1.000E-04	-4.000	8.070E-01	-.093
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.976E-01	-.001	9.976E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	1.279E-02	-1.893	4.393E-03	-2.357	3.435E-01	-.464
5	Mg+2	2.0	5.076E-03	-2.294	1.844E-03	-2.734	3.633E-01	-.440
6	Na+	1.0	4.344E-02	-1.362	3.287E-02	-1.483	7.566E-01	-.121
7	K+	1.0	7.632E-04	-3.117	5.569E-04	-3.254	7.297E-01	-.137
11	Ba+2	2.0	4.059E-02	-1.392	1.311E-02	-1.882	3.231E-01	-.491
14	Cl-	-1.0	5.716E-03	-2.243	4.171E-03	-2.380	7.297E-01	-.137
16	SO4-2	-2.0	9.143E-03	-2.039	2.910E-03	-2.536	3.183E-01	-.497
20	F-	-1.0	1.068E-03	-2.972	7.747E-04	-3.111	7.257E-01	-.139
31	OH-	-1.0	9.333E-11	-10.030	6.773E-11	-10.169	7.257E-01	-.139
32	O2 AQ	.0	1.647E-24	-23.783	1.709E-24	-23.767	1.038E+00	.016
69	HF AQ	.0	1.024E-04	-3.990	1.063E-04	-3.974	1.038E+00	.016
78	CaSO4	.0	2.344E-03	-2.630	2.432E-03	-2.614	1.038E+00	.016
83	CaF+	1.0	3.475E-05	-4.459	2.632E-05	-4.580	7.575E-01	-.121
88	MgSO4	.0	1.063E-03	-2.973	1.104E-03	-2.957	1.038E+00	.016
92	MgF+	1.0	1.136E-04	-3.944	8.608E-05	-4.065	7.575E-01	-.121
96	NaSO4-	-1.0	6.128E-04	-3.213	4.642E-04	-3.333	7.575E-01	-.121
98	NaF aq	.0	1.412E-05	-4.850	1.465E-05	-4.834	1.038E+00	.016
100	KSO4-	-1.0	1.420E-05	-4.848	1.076E-05	-4.968	7.575E-01	-.121
173	BaSO4	.0	1.843E-02	-1.734	1.913E-02	-1.718	1.038E+00	.016

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Gypsum	-4.8954	-4.5811	-.3143
Anhydrit	-4.8933	-4.3438	-.5495
Barite	-4.4183	-10.0528	5.6345

Fluorite	-8.5790	-10.6599	2.0809
O2 gas	-23.7673	-2.9369	-20.8303
H2 gas	-35.1280	-3.1280	-32.0000

1STEP NUMBER 1
0----------

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.516731D-02	-1.8191
Mg	6.252888D-03	-2.2039
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429
S	3.164198D-02	-1.4997
F	1.333239D-03	-2.8751

----PHASE BOUNDARIES----

PHASE	DELTA PHASE*	LOG IAP	LOG KT	LOG IAP/KT
Aragonit	3.706635D-04	-8.3059	-8.3059	.0000
Barite	-3.164190D-02	-10.0528	-10.0528	.0000
Dolomite	-4.725364D-05	-16.9720	-16.9720	.0000
Fluorite	-6.162207D-04	-10.6599	-10.6599	.0000

* NEGATIVE DELTA PHASE INDICATES PRECIPITATION
AND POSITIVE DELTA PHASE INDICATES DISSOLUTION.

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Calcite	-8.3059	-8.4533	.1474
Aragonit	-8.3059	-8.3059	.0000
Dolomite	-16.9720	-16.9720	.0000
Witherit	-8.0607	-8.5749	.5142
Gypsum	-10.2995	-4.5811	-5.7184
Anhydrit	-10.2980	-4.3438	-5.9542
Barite	-10.0528	-10.0528	.0000
Fluorite	-10.6599	-10.6599	.0000
PCO2	-5.4930	-1.4069	-4.0861
O2 gas	-7.3590	-2.9369	-4.4221

H2 gas	-43.3318	-3.1280	-40.2038

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.487450D-02	-1.8276
Mg	6.205635D-03	-2.2072
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	2.737951D-02	-1.5626
Cl	5.715603D-03	-2.2429
C	2.761562D-04	-3.5588
S	8.490435D-08	-7.0711
F	1.007976D-04	-3.9965

----DESCRIPTION OF SOLUTION----

PH =	8.1019
PE =	12.0000
ACTIVITY H2O =	.9983
IONIC STRENGTH =	.1222
TEMPERATURE =	20.0000
ELECTRICAL BALANCE =	1.3566D-01
THOR =	1.1053D-03
TOTAL ALKALINITY =	2.6680D-04
ITERATIONS =	43

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	9.667E-09	-8.015	7.908E-09	-8.102	8.181E-01	-.087
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.983E-01	-.001	9.983E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	1.485E-02	-1.828	5.514E-03	-2.259	3.713E-01	-.430
5	Mg+2	2.0	6.184E-03	-2.209	2.405E-03	-2.619	3.889E-01	-.410
6	Na+	1.0	4.407E-02	-1.356	3.403E-02	-1.468	7.722E-01	-.112
7	K+	1.0	7.774E-04	-3.109	5.835E-04	-3.234	7.506E-01	-.125
11	Ba+2	2.0	2.736E-02	-1.563	9.697E-03	-2.013	3.545E-01	-.450
14	Cl-	-1.0	5.716E-03	-2.243	4.290E-03	-2.368	7.506E-01	-.125
15	CO3-2	-2.0	2.457E-06	-5.610	8.968E-07	-6.047	3.650E-01	-.438
16	SO4-2	-2.0	2.605E-08	-7.584	9.131E-09	-8.039	3.505E-01	-.455

20	F-	-1.0	8.428E-05	-4.074	6.299E-05	-4.201	7.474E-01	-.126
31	OH-	-1.0	1.147E-06	-5.941	8.570E-07	-6.067	7.474E-01	-.126
32	O2 AQ	.0	4.254E-08	-7.371	4.375E-08	-7.359	1.029E+00	.012
34	HCO3-	-1.0	2.167E-04	-3.664	1.684E-04	-3.774	7.773E-01	-.109
35	H2CO3	.0	3.125E-06	-5.505	3.214E-06	-5.493	1.029E+00	.012
76	CaCO3	.0	7.373E-06	-5.132	7.584E-06	-5.120	1.029E+00	.012
77	CaHCO3+	1.0	1.400E-05	-4.854	1.088E-05	-4.963	7.773E-01	-.109
78	CaSO4	.0	9.314E-09	-8.031	9.579E-09	-8.019	1.029E+00	.012
83	CaF+	1.0	3.483E-06	-5.458	2.687E-06	-5.571	7.715E-01	-.113
87	MgHCO3+	1.0	6.024E-06	-5.220	4.647E-06	-5.333	7.715E-01	-.113
88	MgSO4	.0	4.391E-09	-8.357	4.516E-09	-8.345	1.029E+00	.012
92	MgF+	1.0	1.183E-05	-4.927	9.130E-06	-5.040	7.715E-01	-.113
95	NaHCO3	.0	2.814E-06	-5.551	2.895E-06	-5.538	1.029E+00	.012
96	NaSO4-	-1.0	1.954E-09	-8.709	1.508E-09	-8.822	7.715E-01	-.113
98	NaF aq	.0	1.199E-06	-5.921	1.233E-06	-5.909	1.029E+00	.012
171	BaCO3	.0	3.951E-06	-5.403	4.063E-06	-5.391	1.029E+00	.012
172	BaHCO3+	1.0	1.734E-05	-4.761	1.337E-05	-4.874	7.715E-01	-.113
173	BaSO4	.0	4.315E-08	-7.365	4.438E-08	-7.353	1.029E+00	.012

```
Date of Simulation Run:  1994/05/09
 Time of Simulation Run:  12:10:04

          DATA READ FROM DISK

 ELEMENTS
 SPECIES
 LOOK MIN
1Liner test with barite, fluorite, aragonite and dolomite present

 C050000000 0 0           .00000
 ELEMENTS
 c           15          .44010E+02
              0          .00000E+00
 SOLUTION 1
 leachate

  8  0 2     2.00       12.0       20.0       1.00
    4  6.000D+02   5  1.500D+02   6  1.000D+03   7  3.000D+01  11  8.000D+03
   14  2.000D+02  16  3.000D+03  20  2.500D+01
 MINERALS
 Aragonit   2       4.0       -8.3       -2.6          1                .000
   15   1.00        4   1.00
  -1.7198E+02 -7.7993E-02  2.9033E+03  7.1595E+01  0.0000E+00
 Barite     2       6.0       -10.        6.3          1                .000
   11   1.00       16   1.00
   1.3603E+02  0.0000E+00 -7.6804E+03 -4.8595E+01  0.0000E+00
 Dolomite   3       8.0       -17.       -9.4          0                .000
    4   1.00        5   1.00       15   2.00
 Fluorite   2       .00       -11.        4.7          1                .000
    4   1.00       20   2.00
   6.6348E+01  0.0000E+00 -4.2582E+03 -2.5271E+01  0.0000E+00
            0        .00        .00        .00          0                .000
1SOLUTION NUMBER 1
 leachate
```

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.516731D-02	-1.8191
Mg	6.252888D-03	-2.2039
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429
S	3.164198D-02	-1.4997
F	1.333239D-03	-2.8751

J/1

----DESCRIPTION OF SOLUTION----

PH =	2.0000
PE =	12.0000
ACTIVITY H2O =	.9973
IONIC STRENGTH =	.1710
TEMPERATURE =	20.0000
ELECTRICAL BALANCE =	1.5201D-01
THOR =	1.8985D-01
TOTAL ALKALINITY =	2.0231D-12
ITERATIONS =	16

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	1.243E-02	-1.906	1.000E-02	-2.000	8.047E-01	-.094
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.973E-01	-.001	9.973E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	1.307E-02	-1.884	4.416E-03	-2.355	3.379E-01	-.471
5	Mg+2	2.0	5.272E-03	-2.278	1.889E-03	-2.724	3.582E-01	-.446
6	Na+	1.0	4.352E-02	-1.361	3.279E-02	-1.484	7.533E-01	-.123
7	K+	1.0	7.648E-04	-3.116	5.546E-04	-3.256	7.252E-01	-.140
11	Ba+2	2.0	4.231E-02	-1.374	1.339E-02	-1.873	3.166E-01	-.499
14	Cl-	-1.0	5.716E-03	-2.243	4.145E-03	-2.382	7.252E-01	-.140
16	SO4-2	-2.0	8.310E-03	-2.080	2.590E-03	-2.587	3.117E-01	-.506
20	F-	-1.0	1.249E-04	-3.903	9.007E-05	-4.045	7.210E-01	-.142
31	OH-	-1.0	9.392E-13	-12.027	6.771E-13	-12.169	7.210E-01	-.142
40	HSO4-	-1.0	2.998E-03	-2.523	2.263E-03	-2.645	7.547E-01	-.122
69	HF AQ	.0	1.188E-03	-2.925	1.236E-03	-2.908	1.040E+00	.017
78	CaSO4	.0	2.092E-03	-2.679	2.176E-03	-2.662	1.040E+00	.017
88	MgSO4	.0	9.670E-04	-3.015	1.006E-03	-2.997	1.040E+00	.017
92	MgF+	1.0	1.358E-05	-4.867	1.025E-05	-4.989	7.547E-01	-.122
96	NaSO4-	-1.0	5.460E-04	-3.263	4.121E-04	-3.385	7.547E-01	-.122
100	KSO4-	-1.0	1.263E-05	-4.899	9.532E-06	-5.021	7.547E-01	-.122
173	BaSO4	.0	1.672E-02	-1.777	1.739E-02	-1.760	1.040E+00	.017

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Gypsum	-4.9440	-4.5811	-.3628
Anhydrit	-4.9417	-4.3438	-.5978
Barite	-4.4598	-10.0528	5.5930
Fluorite	-10.4458	-10.6599	.2141
O2 gas	-31.7675	-2.9369	-28.8305

H2 gas	-31.1280	-3.1280	-28.0000

1STEP NUMBER 1
0----------

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.516731D-02	-1.8191
Mg	6.252888D-03	-2.2039
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429
S	3.164198D-02	-1.4997
F	1.333239D-03	-2.8751

----PHASE BOUNDARIES----

PHASE	DELTA PHASE*	LOG IAP	LOG KT	LOG IAP/KT
Aragonit	5.448557D-03	-8.3059	-8.3059	.0000
Barite	-3.164189D-02	-10.0528	-10.0528	.0000
Dolomite	3.482766D-03	-16.9720	-16.9720	.0000
Fluorite	-6.211484D-04	-10.6599	-10.6599	.0000

* NEGATIVE DELTA PHASE INDICATES PRECIPITATION
AND POSITIVE DELTA PHASE INDICATES DISSOLUTION.

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Calcite	-8.3059	-8.4533	.1474
Aragonit	-8.3059	-8.3059	.0000
Dolomite	-16.9720	-16.9720	.0000
Witherit	-8.2593	-8.5749	.3155
Gypsum	-10.1012	-4.5811	-5.5200
Anhydrit	-10.0994	-4.3438	-5.7555
Barite	-10.0528	-10.0528	.0000
Fluorite	-10.6599	-10.6599	.0000
PCO2	-2.3606	-1.4069	-.9537
O2 gas	-13.9511	-2.9369	-11.0142
H2 gas	-40.0360	-3.1280	-36.9079

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	2.347749D-02	-1.6293
Mg	9.735654D-03	-2.0116
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	2.737953D-02	-1.5626
Cl	5.715603D-03	-2.2429
c	1.241409D-02	-1.9061
S	9.673074D-08	-7.0144
F	9.094226D-05	-4.0412

----DESCRIPTION OF SOLUTION----

PH =	6.4540
PE =	12.0000
ACTIVITY H2O =	.9979
IONIC STRENGTH =	.1477
TEMPERATURE =	20.0000
ELECTRICAL BALANCE =	1.5201D-01
THOR =	4.9657D-02
TOTAL ALKALINITY =	7.7157D-03
ITERATIONS =	50

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	4.338E-07	-6.363	3.516E-07	-6.454	8.105E-01	-.091
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.979E-01	-.001	9.979E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	2.283E-02	-1.641	8.038E-03	-2.095	3.520E-01	-.453
5	Mg+2	2.0	9.448E-03	-2.025	3.506E-03	-2.455	3.711E-01	-.430
6	Na+	1.0	4.399E-02	-1.357	3.349E-02	-1.475	7.614E-01	-.118
7	K+	1.0	7.774E-04	-3.109	5.725E-04	-3.242	7.364E-01	-.133
11	Ba+2	2.0	2.688E-02	-1.571	8.947E-03	-2.048	3.328E-01	-.478
14	Cl-	-1.0	5.716E-03	-2.243	4.209E-03	-2.376	7.364E-01	-.133
15	CO3-2	-2.0	1.788E-06	-5.748	6.152E-07	-6.211	3.440E-01	-.463
16	SO4-2	-2.0	3.015E-08	-7.521	9.897E-09	-8.004	3.283E-01	-.484
20	F-	-1.0	7.122E-05	-4.147	5.217E-05	-4.283	7.326E-01	-.135
31	OH-	-1.0	2.630E-08	-7.580	1.927E-08	-7.715	7.326E-01	-.135
32	O2 AQ	.0	1.082E-14	-13.966	1.119E-14	-13.951	1.035E+00	.015

34	HCO3-	-1.0	6.706E-03	-2.174	5.136E-03	-2.289	7.658E-01	-.116
35	H2CO3	.0	4.213E-03	-2.375	4.359E-03	-2.361	1.035E+00	.015
77	CaHCO3+	1.0	6.317E-04	-3.199	4.838E-04	-3.315	7.658E-01	-.116
78	CaSO4	.0	1.463E-08	-7.835	1.514E-08	-7.820	1.035E+00	.015
83	CaF+	1.0	4.259E-06	-5.371	3.244E-06	-5.489	7.617E-01	-.118
87	MgHCO3+	1.0	2.712E-04	-3.567	2.066E-04	-3.685	7.617E-01	-.118
88	MgSO4	.0	6.898E-09	-8.161	7.136E-09	-8.147	1.035E+00	.015
92	MgF+	1.0	1.447E-05	-4.839	1.102E-05	-4.958	7.617E-01	-.118
96	NaSO4-	-1.0	2.112E-09	-8.675	1.609E-09	-8.794	7.617E-01	-.118
98	NaF aq	.0	9.719E-07	-6.012	1.005E-06	-5.998	1.035E+00	.015
172	BaHCO3+	1.0	4.940E-04	-3.306	3.763E-04	-3.424	7.617E-01	-.118
173	BaSO4	.0	4.290E-08	-7.368	4.438E-08	-7.353	1.035E+00	.015

Date of Simulation Run: 1994/05/10
Time of Simulation Run: 09:15:43

DATA READ FROM DISK

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ELEMENTS
SPECIES
LOOK MIN
Linear Test with barite, fluorite, aragonite and dolomite present

0050000000 0 0          .00000
ELEMENTS
C           15          .44010E+02
             0          .00000E+00
SOLUTION 1
leachate

 8  C 2     7.00       12.0       20.0       1.00
   4  6.000D+02   5  1.500D+02   6  1.000D+03   7  3.000D+01  11  8.000D+03
  14  2.000D+02  16  3.000D+03  20  2.500D+01
MINERALS
Aragonit   2       4.0       -8.3       -2.6          1                .000
  15   1.00        4   1.00
 -1.7198E+02 -7.7993E-02  2.9033E+03  7.1595E+01  0.0000E+00
Barite     2       6.0       -10.        6.3          1                .000
  11   1.00       16   1.00
  1.3603E+02  0.0000E+00 -7.6804E+03 -4.8595E+01  0.0000E+00
Dolomite   3       8.0       -17.       -9.4          0                .000
   4   1.00        5   1.00       15   2.00
Fluorite   2       .00       -11.        4.7          1                .000
   4   1.00       20   2.00
  6.6348E+01  0.0000E+00 -4.2982E+03 -2.5271E+01  0.0000E+00
             0       .00        .00        .00          0                .000
1SOLUTION NUMBER 1
leachate
```

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.516731D-02	-1.8191
Mg	6.252888D-03	-2.2039
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429
S	3.154198D-02	-1.4997
F	1.333239D-03	-2.8751

----DESCRIPTION OF SOLUTION----

PH =	7.0000
PE =	12.0000
ACTIVITY H2O =	.9976
IONIC STRENGTH =	.1611
TEMPERATURE =	20.0000
ELECTRICAL BALANCE =	1.3540D-01
THOR =	1.8985D-01
TOTAL ALKALINITY =	1.9891D-07
ITERATIONS =	19

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	1.239E-07	-6.907	1.000E-07	-7.000	8.071E-01	-.093
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.976E-01	-.001	9.976E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	1.278E-02	-1.893	4.391E-03	-2.357	3.435E-01	-.464
5	Mg+2	2.0	5.067E-03	-2.295	1.841E-03	-2.735	3.634E-01	-.440
6	Na+	1.0	4.344E-02	-1.362	3.287E-02	-1.483	7.566E-01	-.121
7	K+	1.0	7.632E-04	-3.117	5.570E-04	-3.254	7.298E-01	-.137
11	Ba+2	2.0	4.057E-02	-1.392	1.311E-02	-1.882	3.231E-01	-.491
14	Cl-	-1.0	5.716E-03	-2.243	4.171E-03	-2.380	7.298E-01	-.137
16	SO4-2	-2.0	9.154E-03	-2.038	2.914E-03	-2.535	3.184E-01	-.497
20	F-	-1.0	1.157E-03	-2.937	8.398E-04	-3.076	7.257E-01	-.139
31	OH-	-1.0	9.333E-08	-7.030	6.773E-08	-7.169	7.257E-01	-.139
32	O2 AQ	.0	1.647E-12	-11.783	1.709E-12	-11.767	1.038E+00	.016
78	CaSO4	.0	2.346E-03	-2.630	2.435E-03	-2.613	1.038E+00	.016
83	CaF+	1.0	3.766E-05	-4.424	2.853E-05	-4.545	7.575E-01	-.121
88	MgSO4	.0	1.063E-03	-2.973	1.103E-03	-2.957	1.038E+00	.016
92	MgF+	1.0	1.230E-04	-3.910	9.316E-05	-4.031	7.575E-01	-.121
96	NaSO4-	-1.0	6.136E-04	-3.212	4.648E-04	-3.333	7.575E-01	-.121
98	NaF aq	.0	1.530E-05	-4.815	1.588E-05	-4.799	1.038E+00	.016
100	KSO4-	-1.0	1.422E-05	-4.847	1.077E-05	-4.968	7.575E-01	-.121
173	BaSO4	.0	1.845E-02	-1.734	1.915E-02	-1.718	1.038E+00	.016

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Gypsum	-4.8950	-4.5811	-.3138
Anhydrit	-4.8929	-4.3438	-.5490
Barite	-4.4179	-10.0528	5.6350
Fluorite	-8.5091	-10.6599	2.1509

O2 gas	-11.7673	-2.9369	-8.8303
H2 gas	-41.1280	-3.1280	-38.0000

1STEP NUMBER 1
0----------

TOTAL MOLAL TIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.516731D-02	-1.8191
Mg	6.252888D-03	-2.2039
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	5.902141D-02	-1.2290
Cl	5.715603D-03	-2.2429
S	3.164198D-02	-1.4997
F	1.333239D-03	-2.8751

----PHASE BOUNDARIES----

PHASE	DELTA PHASE*	LOG IAP	LOG KT	LOG IAP/KT
Aragonit	2.572326D-04	-8.3059	-8.3059	.0000
Barite	-3.164190D-02	-10.0528	-10.0528	.0000
Dolomite	-1.070173D-04	-16.9720	-16.9720	.0000
Fluorite	-6.160707D-04	-10.6599	-10.6599	.0000

* NEGATIVE DELTA PHASE INDICATES PRECIPITATION
AND POSITIVE DELTA PHASE INDICATES DISSOLUTION.

---- LOOK MIN IAP ----

PHASE	LOG IAP	LOG KT	LOG IAP/KT
Calcite	-8.3059	-8.4533	.1474
Aragonit	-8.3059	-8.3059	.0000
Dolomite	-16.9720	-16.9720	.0000
Witherit	-8.0556	-8.5749	.5193
Gypsum	-10.3046	-4.5811	-5.7235
Anhydrit	-10.3031	-4.3438	-5.9593
Barite	-10.0528	-10.0528	.0000
Fluorite	-10.6599	-10.6599	.0000
PCO2	-7.4566	-1.4069	-6.0497
O2 gas	-3.4233	-2.9369	-.4863
H2 gas	-45.2997	-3.1280	-42.1717

TOTAL MOLALITIES OF ELEMENTS

ELEMENT	MOLALITY	LOG MOLALITY
Ca	1.470146D-02	-1.8326
Mg	6.145871D-03	-2.2114
Na	4.407069D-02	-1.3559
K	7.774070D-04	-3.1094
Ba	2.737951D-02	-1.5626
Cl	5.715603D-03	-2.2429
C	4.319791D-05	-4.3645
S	8.465843D-08	-7.0723
F	1.010976D-04	-3.9953

----DESCRIPTION OF SOLUTION----

PH =	9.0858
PE =	12.0000
ACTIVITY H2O =	.9983
IONIC STRENGTH =	.1217
TEMPERATURE =	20.0000
ELECTRICAL BALANCE =	1.3540D-01
THOR =	1.6409D-03
TOTAL ALKALINITY =	7.6[illegible]1D-05
ITERATIONS =	34

DISTRIBUTION OF SPECIES

I	SPECIES	Z	MOLALITY	LOG MOLAL	ACTIVITY	LOG ACT	GAMMA	LOG GAM
1	H+	1.0	1.003E-09	-8.999	8.207E-10	-9.086	8.183E-01	-.087
2	E-	-1.0	1.000E-12	-12.000	1.000E-12	-12.000	1.000E+00	.000
3	H2O	.0	9.983E-01	-.001	9.983E-01	-.001	1.000E+00	.000
4	Ca+2	2.0	1.469E-02	-1.833	5.460E-03	-2.263	3.718E-01	-.430
5	Mg+2	2.0	6.118E-03	-2.213	2.382E-03	-2.623	3.893E-01	-.410
6	Na+	1.0	4.407E-02	-1.356	3.404E-02	-1.468	7.724E-01	-.112
7	K+	1.0	7.774E-04	-3.109	5.838E-04	-3.234	7.509E-01	-.124
11	Ba+2	2.0	2.737E-02	-1.563	9.716E-03	-2.012	3.550E-01	-.450
14	Cl-	-1.0	5.716E-03	-2.243	4.292E-03	-2.367	7.509E-01	-.124
15	CO3-2	-2.0	2.477E-06	-5.606	9.055E-07	-6.043	3.655E-01	-.437
16	SO4-2	-2.0	2.596E-08	-7.586	9.113E-09	-8.040	3.510E-01	-.455
20	F-	-1.0	8.465E-05	-4.072	6.330E-05	-4.199	7.478E-01	-.126
31	OH-	-1.0	1.104E-05	-4.957	8.259E-06	-5.083	7.478E-01	-.126

32	O2 AQ	.0	3.669E-04	-3.435	3.773E-04	-3.423	1.028E+00	.012
34	HCO3-	-1.0	2.269E-05	-4.644	1.765E-05	-4.753	7.775E-01	-.109
76	CaCO3	.0	7.374E-06	-5.132	7.584E-06	-5.120	1.028E+00	.012
77	CaHCO3+	1.0	1.452E-06	-5.838	1.129E-06	-5.947	7.775E-01	-.109
78	CaSO4	.0	9.206E-09	-8.036	9.468E-09	-8.024	1.028E+00	.012
83	CaF+	1.0	3.465E-06	-5.460	2.674E-06	-5.573	7.717E-01	-.113
86	MgCO3	.0	1.853E-06	-5.732	1.906E-06	-5.720	1.028E+00	.012
87	MgHCO3+	1.0	6.249E-07	-6.204	4.822E-07	-6.317	7.717E-01	-.113
88	MgSO4	.0	4.340E-09	-8.362	4.464E-09	-8.350	1.028E+00	.012
92	MgF+	1.0	1.177E-05	-4.929	9.085E-06	-5.042	7.717E-01	-.113
94	NaCO3-	-1.0	5.755E-07	-6.240	4.441E-07	-6.353	7.717E-01	-.113
96	NaSO4-	-1.0	1.951E-09	-8.710	1.505E-09	-8.822	7.717E-01	-.113
98	NaF aq	.0	1.206E-06	-5.919	1.240E-06	-5.907	1.028E+00	.012
171	BaCO3	.0	3.998E-06	-5.398	4.111E-06	-5.386	1.028E+00	.012
172	BaHCO3+	1.0	1.820E-06	-5.740	1.404E-06	-5.853	7.717E-01	-.113
173	BaSO4	.0	4.315E-08	-7.365	4.438E-08	-7.353	1.028E+00	.012

OK SW

TELEPHONE/DISCUSSION LOG	
CONTACT: Vernon Andrews	**DATE:** May 16,1994
TELEPHONE NO.: (801)532-1330	**ORGANIZATION:** Envirocare of Utah
TYPE: Visit Conference Telephone: X In Out	
SUBJECT: Disposal of Chelating Agents at Envirocare's 11e.(2) Facility	

SUMMARY: Vernon Andrews wanted to know if NRC had a "concentration limit" or "technical guidance" for acceptance/disposal of chelating agents in 11e.(2) waste at 11e.(2) waste disposal sites. He indicated that Envirocare is evaluating the prospects for accepting of 11e.(2) materials that have chelating agents, from a Maywood, New Jersey site owned by DOE, for disposal at its 11e.(2) facility near Clive, Utah (License No. SMC-1559).

Mr. Andrews indicated that Envirocare was aware that Part 20 (Appendix F) requires that waste containing more than 0.1% chelating agents by weight must be identified, and the weight percentage of the chelating agent estimated. He indicated that a similar requirement was imposed on Envirocare's low-level waste disposal facility, which is licensed by the State of Utah.

I informed Mr. Andrews that apart from the requirements in Parts 20 and 61, I was not aware of any standards, technical guidance, or regulatory requirements concerning acceptance and disposal of chelating agents. I pointed out to him that the groundwater protection standards for 11e.(2) disposal sites (in Appendix A to 10 CFR Part 40) are performance-based, and did not include any such waste-characterization standards.

I also asked Mr. Andrews if chelating agents were included in the waste-characterization provided in the license application for Envirocare's 11e.(2) facility, and he indicated that they were not. I informed him that in that case, Envirocare ought to officially inform NRC, in writing, of its intention to dispose of chelating agents at its 11e.(2) facility. I explained that chelating agents could increase the dissolution and mobility of hazardous constituents and compromise the integrity of the disposal cell.

It was agreed that Envirocare (Vernon Andrews/George Hellstrom) would pursue the issue concerning disposal of chelating agents at its 11e.(2) facility with the Project Leader from NRC, Sandi Wastler.

ACTION REQUIRED: None.

PERSON DOCUMENTING CONVERSATION: Latif Hamdan

DISTRIBUTION: S. Wastler; D. Brooks; M. Federline; J. Holonich; J. Surmeier; J. Greeves; M. Knapp; R. Bernero; PDR; Docket 40-8989; G. Hellstrom (Envirocare).

J/124

5.16.94

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SW

Telephone Call Log	
PARTICIPANTS: Charles Judd, Stan Plaisier, and Mark Taggard	**DATE:** July 14, 1994
TELEPHONE NO.: (801)532-1330 (Envirocare) (801)532-1330 (Bingham Environmental)	**ORGANIZATION:** Envirocare of Utah and Bingham Environmental (Consultant to Envirocare)
TYPE: Telephone-In (Two Calls).	
SUBJECT: Background Groundwater Quality and Liner Compatibility Testing for Envirocare's 11e.(2) Disposal Site.	

SUMMARY: Charles Judd of Envirocare called first. He wanted to discuss NRC staff response to Envirocare's June 10, 1994 submittal on background groundwater quality and liner compatibility test results. I discussed the background groundwater quality issues with him, and referred him to John Bradbury to discuss the liner compatibility test issues.

Charles Judd indicated that he was concerned about Envirocare's consultant's progress on establishing background groundwater quality. He wanted to know what was still required of Envirocare to meet the 11e.(2) license conditions. I explained to him that NRC regulations that pertain to groundwater monitoring and establishing background water quality have previously been communicated to Envirocare. I explained that one full year of monitoring is required to establish baseline water quality, and that background will then need to be established based on baseline water quality data and other information. I also told Mr. Judd that the data indicating contamination due to corrosion of dedicated steel pumps in the wells cannot be used in establishing baseline or background water quality. Mr. Judd asked if Bingham Environmental had called me to discuss these issues and I told him no.

About 30 minutes after the call with Charles Judd was concluded, I received a call from Stan Plaisier of Bingham Environmental. I talked to both Stan and Mark Taggard, who is also with Bingham. We discussed staff's comments on Envirocare's June 10 background water quality submittal, and their questions were answered. Mr. Plaisier said they understood what was needed and that Bingham would now proceed to complete the remaining background water quality work to meet the regulations.

ACTION REQUIRED: None.

PERSON DOCUMENTING CONVERSATION: Latif Hamdan.

DISTRIBUTION: David Brooks, Margaret Federline, Dan Gillen, J. Holonich, S. Wastler, PDR, Docket 40-8989, K. Semnani.

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TELEPHONE/DISCUSSION LOG	
CONTACT: G. Hellstrom, M. Taggart, S. Plaisier	**DATE:** July 20, 1994
TELEPHONE NO.: (801) 532-2230	**ORGANIZATION:** Envirocare of Utah Bingham Environmental
TYPE: Visit Conference Telephone: X In Out	
SUBJECT: Baseline and Background Groundwater	

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TELEPHONE/DISCUSSION LOG

SUMMARY: Envirocare called to discuss the approach they and their contractor, Bingham Environmental, were proposing for the resolution of NRC's groundwater questions issued July 11, 1994. Envirocare and Bingham had specific concerns about NRC staff's assertion that water quality data indicating contamination from steel pump corrosion cannot be used to establish baseline or background water quality for the 11e.(2) disposal site. They were specifically concerned about their inability to meet the requirement for 1 year of data to determine baseline groundwater values (10 CFR Part 40, Appendix A, Criteria 7A), and to establish site-specific groundwater protection standards based on background values that are acceptable to NRC (10 CFR Part 40, Appendix A, Criterion 5B) for those constituents affected by the corrosion of the pumps. Bingham proposed that:

1. Submit one year of monitoring data for all constituents in all wells and use as baseline groundwater values. (Wells 60 and 63 have only 4 samples.)

2. Flag the constituent values that appear to be unacceptable due to influence of pump corrosion (Cadmium, Nickel, Chromium).

3. Calculate background values after flagged constituent values were eliminated.

4. For those well which would have less than 4 samples after elimination of corrosion contaminated samples, the Lower Limit of Detection would be substituted.

Latif Hamdan indicated that the proposed approach would be acceptable to establish standards based on (a) valid background values and (b) detection limits where background values are not valid due to contamination from steel pump corrosion. But he indicated that the proposed approach may not satisfy Criterion 7A requirement that <u>baseline</u> groundwater quality be established based on one full year of data, where the data are not valid due to contamination from steel pump corrosion. Latif stated that establishing baseline must be based on one full year of data from wells that are not contaminated by steel pump corrosion, but that need not include all of the monitoring wells at the site. However, he requested that all of the data including the results of the analyses that show contamination by steel pump corrosion be fully documented in licensee's submittal for record purposes.

As a result of this discussion, Envirocare and Bingham indicated that they understood the information NRC staff needed to resolve the baseline groundwater question.

ACTION REQUIRED: None

PERSON DOCUMENTING CONVERSATION: Sandra L. Wastler

DISTRIBUTION: L. Hamdan, D. Brooks, M. Federline, D. Gillen, J. Holonich, PDR, Docket 40-8989, K. Semnani