Waste Isolation Pilot Plant

Compliance Certification Application

Reference 167

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BRINE SAMPLING AND EVALUATION PROGRAM
1988 REPORT

DOE/WIPP--89-015

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ACKNOWLEDGMENTS

The work reported in this document has involved more than one hundred individuals. Many disciplines are represented: geology, hydrology, rock mechanics, numerical modeling, geological engineering, bacteriology, chemistry, geochemistry, geophysics and technical skill in precision drilling, laboratory analyses, and other support.

We make no attempt to mention everyone by name, but this work has clearly been a team effort and is truly multi-authored, mostly by engineers and scientists of the International Technology (IT) Corporation, working out of their Albuquerque and Carlsbad, New Mexico, offices, and the staff of the Geotechnical Engineering Section of Westinghouse Electric Corporation at the Waste Isolation Pilot Plant (WIPP). Most of the underground work has been done by technicians and drillers of the Westinghouse Electric Corporation.

Dwight Deal provided the overall direction and coordination of this work and authored Section 2.1, a discussion of the brine inflow data. Bill Roggenthen, on "loan" to IT and the WIPP from the South Dakota School of Mines, was the lead author of Section 2.2, a study of the weeps and salt encrustations on the walls of the underground openings.

Rich Abitz wrote Section 3.1 on the brine geochemistry, with critical and helpful reviews by Jon Myers and Paul Drez. Analytical difficulties encountered with the analysis of high-ionic-strength brines were overcome through the efforts made by professional and dedicated staff at each analytical laboratory. The work at UNC Geotech at Grand Junction, Colorado, was under the direction of Ron Chessmore. David Dunlop was our major interface at the International Technology Analytical Services lab in Export, Pennsylvania. Jeffry Means, Battelle Memorial Institute in Columbus, Ohio, did some special lab work with the organic components in the brines.

Barry King wrote Section 3.2, describing the bacteriological work. The bacteriological lab work was done by Larry Jones at the University of Texas at El Paso (UTEP), and both he and Dennis Powers contributed significantly.

Joe Tyburski wrote Section 4.1 on the moisture content of the rocks exposed in the excavations and supported several other parts of this work as well. Craig Givens reduced the borehole induction logging data and wrote Section 4.2, with review and suggestions from Bill Roggenthen. Rick Deshler operated the drillhole video camera and authored Section 4.3.

The modeling effort, Section 5 and Appendix J, was complex and involved many individuals under the guidance of Dwight Deal and John Case. Stephen Niou is credited for taking a global approach to the problem of brine flow through deforming salt (Appendix J). Many had a hand in the final product that you find here, notably John Case, John Pietz, and Mike Wallace, with tedious quality control (QC) support by Saeid Saeb, Clayton Carney, Craig Givens, and Bernie Lauctus. Sections 5.4 through 5.10, coupling two finite-element codes to produce useable results, was a major effort for John Pietz and Mike Wallace, again with the suggestions and support of John Case, Bernie Lauctus, Craig Givens, and Bill Roggenthen. Particularly important support was provided by Roy Cook of Westinghouse Electric Corporation at the WIPP, who helped with the VISCOT code and provided a critical reading that greatly improved this section. A final editorial and QC effort was made by John Case and Saeid Saeb to get this section into the form that is included here.

Shifting demands at the WIPP resulted in a complex editorial history. Bill Roggenthen initiated the effort of organizing the various contributions and styles into a single report and outlining summary comments. After he returned to academia, Mark Crawley took over the editorial task, which was finished by Rich Abitz, Joe Tyburski, and Dwight Deal.

The most important single individual has been Dave Belski, a senior Westinghouse Electric Corporation technician at WIPP. He lead the underground and surface support of the Brine Sampling and Evaluation Program (BSEP) at the WIPP site, and was assisted by Mel Balderrama, Steve Azzinaro, and Steve Ozmansky. Dave Beliski collected most of the samples, wrote the field notes, packaged samples for shipping, performed any on-site laboratory analyses, did the routine QC, and maintained the records and files.

Finally, we want to thank our colleagues at Sandia National Laboratories for providing useful comments and sharing their perspectives on the brine phenomenon: Jim Nowak, Jim Krumhansl, Sharon Findley, Rick Beauheim, and David Bornes. A very special thanks to Larry Brush and his crew: Anne Rutledge, Glenn Barker, and Grace Bujewski, who often provided thoughtful as well as physical assistance in collecting the underground brine samples for chemical analysis.

EXECUTIVE SUMMARY

The data presented in this report are the result of Brine Sampling and Evaluation Program (BSEP) activities at the Waste Isolation Pilot Plant (WIPP) during 1988. These activities, which are a continuation and update of studies that began in 1982 as part of the Site Validation Program, were formalized as the BSEP in 1985 to document and investigate the origins, hydraulic characteristics, extent, and composition of brine occurrences in the Permian Salado Formation, and seepage of that brine into the excavations at the WIPP. Previous BSEP reports (Deal and Case, 1987; Deal and others, 1987) described the results of ongoing activities that monitor brine inflow into boreholes in the facility, moisture content of the Salado Formation, brine geochemistry, and brine weeps and crusts. The information provided in this report updates past work and describes progress made during the calendar year 1988.

During 1988, BSEP activities focused on four major areas to describe and quantify brine activity: (1) monitoring of brine inflow parameters, e.g., measuring brines recovered from holes drilled upward from the underground drifts (upholes), downward from the underground drifts (downholes), and near-horizontal holes; (2) characterizing the brine, e.g., the geochemistry of the brine and the presence of bacteria and their possible interactions with experiments and operations; (3) characterizing formation properties associated with the occurrence of brine, e.g., determining the water content of various geologic units, examining these units in boreholes using a video camera system, and measuring their resistivity (conductivity); and (4) modeling to examine the interaction of salt deformation near the workings and brine seepage through the deforming salt.

Monitoring Brine Inflow Parameters. Relative amounts of brine seepage between upholes drilled into the back of the excavations, downholes drilled into the floors, and horizontal holes drilled laterally into the ribs are similar to earlier reports. Typically, upholes produce much smaller amounts of brine than the downholes and tend to cease production after 2 to 3 years. Similarly, the few horizontal holes available for long-term monitoring show an initial brine production that rapidly decreases with time. No horizontal holes older than 2.5 years are producing brine.

Brine recovery from downholes substantially differs from holes drilled in other orientations. Downholes tend to produce brine over extended periods of time and sometimes show increased seepage rates with time. Holes that are very closely spaced may have seepage rates, volumes, and brine levels varying by two orders of magnitude or more. Some holes, such as the one in Waste Storage Panel 1 at S1950-E1320, receive water introduced to the underground from sources other than the Salado Formation. Much of the brine in this and other similar holes throughout the facility appears to be a mixture of Salado Formation brine and construction water spread upon the floors for the purpose of dust control or roadway consolidation. Brine samples contaminated with construction water can be identified by their geochemical signature.

A series of horizontal holes were drilled westward from the western termination of the S2180, S1950, and S1600 drifts in support of the BSEP activities. These holes were drilled into the location of future storage panel access drifts. None of the holes drilled in this phase of the program left the outlines of these access drift locations. Three holes were drilled at each drift location: two 15-meter holes and one 46-meter hole. At each location, one 15-meter hole was located in Map Unit 4, approximately 0.6 meter above the orange band (Map Unit 1) and one 15-meter hole was located in Map Unit 0, approximately 0.3 meter foot below the orange band. The 46-meter boreholes were begun at the top of the orange band. All of the holes were started with a downward slope of 1 or 2 degrees. Consequently, brine entering the hole flowed to the back of the hole, away from the face and any disturbed zone near the face. Pressure-suction moisture-collecting devices have been installed in all nine of the holes. To date, brine has been recovered from five of the nine holes.

Brine weeps, consisting of small salt encrustations on the ribs of many of the underground excavations, develop when brine seeps very slowly out of the ribs and evaporates at the surface due to the ventilation. These surficial salt encrustations have been sampled systematically at three locations: (1) the west end of Room G; (2) along W170, just south of S1650; and (3) along S1950 between W30 and W140. Salt encrustations have been collected and the material weighed, dried at 250°C, and weighed again. X-ray diffraction studies of the salt encrustations have shown that they are composed almost entirely of halite and sylvite. Apparently, not all of the brine evaporates into the facility air at ambient temperatures; the highly soluble components (mostly magnesium and potassium salts) remain in solution and escape with the remaining fluid, probably into fractures and other openings in the ribs and floor. Using the data on salt encrustations and brine chemistry for the mass of sodium, potassium, magnesium, chlorine, and sulfate, the maximum amount of brine responsible for the development of salt encrustations on an 7.4-square-meter sample site is approximately 5.9 liters. The sites have been revisited one year after the initial sampling, and only very small amounts of salt encrustations had reestablished themselves.

This is consistent with the observation that the encrustations cease to grow a few years after initial excavation.

Characterization of Brine Geochemistry. Analysis of the geochemistry of the brine has proven to be an extremely useful tool in understanding the modes of brine occurrence in the rock and the means by which brine enters the excavations. Anomalous compositions of brines recovered from upholes can be accounted for by evaporation due to the slow accumulation of the brine. Analyses of brines coming from many of the downholes indicate that most are not indigenous to the Salado Formation, but rather have been introduced during the course of mining operations for purposes of dust control and roadbed consolidation. Mixing models for these brines have indicated that, in the Panel 1 area, after water was spread to consolidate the floors, as much as 40 percent of the brine recovered from a downhole penetrating Marker Bed 139 may have originated from construction water.

Brines recovered from upholes have been modified by evaporation during the sample collection process. Variation in the composition of brines recovered from downholes suggests spatial heterogeneity exists, which implies mixing and fluid homogenization is limited within the Salado Formation at the WIPP repository horizon. Additionally, the chemistry of downhole brines cannot be linked to larger-scale vertical migration of waters from the overlying Rustler Formation or underlying Castile Formation, because each of these formational waters are chemically distinct from WIPP brines.

Major-element compositions of indigenous WIPP brine suggest an origin from evaporating seawater, modified by diagenetic reactions involving gypsum, magnesite, and polyhalite and ion-exchange reactions with clay minerals. The major-element compositions of brines recovered from downholes are distinct from fluid inclusions in WIPP halite. This observation indicates that the brine recovered in drillholes is largely intergranular fluid, but not intragranular fluid which has been released by migration of fluid inclusions to grain boundaries during stress relief.

Based upon statistical analyses, a composite chemistry for the Salado Formation brines in the vicinity of the repository horizon was constructed. Calculation of a composition brine may not be totally appropriate because separate, stratigraphy-dependent brine compositions may exist. If distinct, then they probably have stratigraphy-dependent sources and the derivation of the brine from a general hydrologic system would be difficult.

Rock-brine equilibria were evaluated using brine analyses and the speciation-solubility code EQ3NR. The modeling results indicated all WIPP brines were saturated with anhydrite, barite, fluorite, glauberite, gypsum, and halite and several brines were calculated to be saturated with celestite, dolomite, magnesite, and polyhalite. Model results agreed with the observed mineralogy at the WIPP repository, and supported the contention that WIPP brines are intergranular fluids which have equilibrated with evaporite salts.

Finally, the analytical results and solubility calculations argue for derivation of WIPP brines from near-field, intergranular fluids. Although the data do not unequivocally rule out large-scale brine migration, the time scale required for migration of the fluid through the halite of the Salado Formation would have to be greater than that required for diagenetic reactions to produce magnesite, polyhalite, and quartz. Excluding human intrusion scenarios, time constraints on fluid migration through halite after the repository is sealed and repressurized suggest that soluble radionuclides will be constrained to the near-field environment of the waste for time periods sufficient to meet regulatory guidelines.

Bacteriological Studies. Bacteriological studies were conducted with cultures prepared from brines present in the facility, from muck present on the floor of the facility, and from Salado Formation cores. No bacterial growth were observed in cultures from the Salado Formation cores, but a total of 48 different bacterial forms were found and presumed to be introduced during the mining activities. Many of the forms cultured were similar to existing forms in the surrounding surficial salt ponds near the WIPP. No bacterial forms were found that constitute a health hazard to the workers in the facility.

Characterization of the Moisture Contents of the Salado Formation. Determination of the moisture content of the map units exposed in the workings continued. Samples from a total of 11 different stratigraphic horizons were measured. Moisture content, defined as the weight percent of water that can be removed from a sample by heating to 95°C, was determined for samples taken throughout the facility at various times since excavation. This should be a reasonable measure of the amount of moisture present in the salt that is available to move into the excavations under local pressure gradients, but only part of that moisture will do so. No clearly discernible temporal or lateral trends in moisture content were found, although moisture content varied with stratigraphy and was correlated with clay content. Moisture content varied from 0.01 percent by weight for clear halite to 6.67 percent by weight for one isolated sample selected for high clay content. After analyzing 545 samples, the conclusion was that an average near-field moisture of 0.5 to 0.75 percent by weight was a reasonable representative value for the amount of moisture present in the repository host rock. The average moisture content for map units exposed at the repository level (Units 0 through 4), taking into account the stratigraphic thickness of each unit, was approximately 0.60 percent by weight.

Direct Examination of Drillholes Using a Video Camera. Completion of the examination of boreholes using a video camera was delayed at the time of the BSEP Phase II report because of equipment failures. This examination was completed during 1988. Although the examination attempted to delineate wet zones and zones of potential inflow in boreholes, it was generally unsuccessful in locating these features. Because of the high reflectance of the salt crystals, zones of wetness could not be identified with the available equipment. However, areas of squeezing of the thin clay seams were evident and appeared to be prevalent in the upholes.

Geophysical Investigations. A program of geophysical logging of upholes and downholes in the northern, experimental end of the facility has been undertaken to characterize the moisture content of the stratigraphic units in areas far from the working face, floor, or back. The induction logging tool that is used has a maximum response approximately 0.5 meters away from the borehole. The tool reacts much more strongly to brine that is intergranular and occupying interconnected spaces than to intracrystalline fluid inclusions that are isolated within the salt crystals. For clear halite units, moisture content calculated from the logging agrees well with measured moisture content of samples taken at the face.

Borehole induction logging has proven to be a reasonably efficient and accurate method of measuring conductivity of the rock units and, thereby, their moisture content. The moisture content measured by laboratory analysis and that calculated from the geophysical logging show an absolute difference of 0.05 percent when the averages of all units are considered, which is a good correlation given the spatial differences in the sampling sets. When measured by the induction logging tool, anhydrites and anhydritic units appear to be substantially wetter, and argillaceous halite units appear to be drier than the samples of the same units taken at the face.

Modeling Rationale and Performance of Modeling. Much of the inflow behavior of brine in the form of weeps, and the small production of brine from upholes and downholes, suggests that sources near the openings may produce most of the brine. Many experiments and modeling efforts are underway to determine the importance of far field or normal hydrologic processes in delivering brine to the underground and to investigate the nearby rock as a source of brine. Studies of the moisture content of the Salado Formation as a function of stratigraphy show that the map units accessible from the drifts contain approximately 0.60 weight percent moisture. This moisture does not include fluid inclusions, but is present as intergranular fluid in interstitial pores between the salt crystals, in the underconsolidated clays in clay seams, and in the argillaceous halite units such as Map Units 0, 2, and 4.

Excavation-induced deviatoric stress results in salt, brine, and gas flow into the mined openings. Salt deformation alters the porosity and permeability of the stratigraphic horizons with respect to both the brine and dissolved gases present in the interstitial pore spaces. The presence of brine and gases in the salt, in turn, affects salt deformation. Consequently, an extensive examination of these processes and the mathematical model describing them has been undertaken to develop a basis for evaluating their importance to brine seepage into the underground.

The first step was to formulate the complex problem of brine and nitrogen flow through deforming salt as completely as possible. The derived equations involved rock mechanics and fluid flow, and were coupled, where appropriate, in order to closely describe the natural phenomena.

In an effort to produce a practical solution to the preceding formulation, a rock deformation computer code, VISCOT, was combined with a flow-modeling code, SUTRA, to examine the coupled effects of rock deformation with the modified flow properties of the salt. A number of important simplifying assumptions were made in the application of the model, including: (1) the effects of exsolution of gases were not considered, (2) all flow was considered to be saturated, (3) the permeability versus porosity relationship could be estimated based upon available experimental information, and (4) the salt was taken to be homogeneous.

The hybrid computer code was applied to a 1.8-meter shaft analogous to the Salt Handling Shaft in the facility horizon. This hybrid model took a standard hydrologic flow model and assumed that the rock in the far field behaved as an elastic, porous solid with a 1.0-nanodarcy effective permeability and added a near-field enhancement to flow resulting from salt creep into the excavation. The subsequent modeling runs showed that, even with a contribution to flow from the far field, the rock in the near field increased in porosity faster than brine would fill those spaces and thus the rock became unsaturated close to the excavation. At this point, the assumption of saturated flow conditions became invalid and the modeling runs were terminated.

It is desirable to be able to distinguish between the consequences of assuming that the ultimate source of the brine seepage is in the far field, in which flow occurs at very slow rates, from the consequences of assuming that the effective far-field permeability is too low to permit flow through the undisturbed salt, requiring that any seepage come from dewatering of the enhanced permeability Disturbed Rock Zone (DRZ) developing around the excavation. The rock mechanics portion of the hybrid code show that, in the case of a 1.8-meter-radius shaft at a depth of 655 meters, the rate of increase in the size of the DRZ is very, very slow after 1,000 days, when it reaches a distance of approximately 12 meters from the surface of the opening.

To compare the amount of brine seepage predicted from the near-field model with that predicted by the far-field model, the porosity and permeability distribution that has occurred within 12 meters of the excavation after 1,000 days is used. It is assumed that this distribution does not change with time, the pores remain saturated, and the physical properties of both the salt and the brine remain constant. In the near-field model, the permeability for radial distances greater than 12 meters is set to zero. In the far-field model, the permeability for radial distances greater than 12 meters is set at 1.0 nanodarcy. The results predicted that a near-excavation source of brine inflow differs little in cumulative inflow or rates from a far-field model for the first 30 years following excavation. After 30 years, the curves diverge markedly. In the near-field model, the inflow decreases as the zone of disturbance, which is dewatering, ceases to develop further, whereas the far field continues to supply brine to the excavation. The volume of disturbed rock surrounding the excavation is a function of the square of the shaft radius. Therefore, repeating the exercise for a much smaller radius shaft (or drillhole) should minimize the contribution of brine from the DRZ in the case of the near-field model. It is expected that the predicted brine inflow for the two models should diverge sooner for holes or excavations smaller than the 1.8-meter-radius shaft considered during the present studies.

1.0 INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) is a Department of Energy (DOE) research and development facility established to demonstrate the safe disposal of radioactive wastes derived from the defense activities of the United States. The WIPP Project's mission consists of two parts. The first part is demonstrating the safe handling and disposal of transuranic (TRU) waste in bedded salt. The second part is creating a research facility for in situ examination of the technical issues related to the emplacement of defense-related radioactive waste in bedded salt.

The WIPP facility is located approximately 42 kilometers east of Carlsbad, New Mexico, in an area known as Los Medaños (Figure 1-1). The underground portion of the facility (Figure 1-2) is located at a depth of approximately 655 meters in an evaporite sequence over 1,000 meters thick (Figure 1-3). An extensive program of site characterization and validation has been conducted over the past twelve years (1976 to 1988). The results of these studies are summarized in the WIPP "Geological Site Characterization Report" (Powers and others, 1978) and the WIPP "Preliminary Design Validation Report" (Bechtel National, Inc., 1983). Additional site investigations are being conducted as part of an ongoing program to further refine the understanding of the site-specific geology. The hydrogeological activities of the Brine Sampling and Evaluation Program (BSEP), as outlined in the Brine Testing Program Plan (BTP) (Morse and Hassinger, 1985), are part of these investigations. Phase I BSEP activities were reported by Deal and Case (1987) and Phase II activities were reported in Deal and others (1987).

The purpose of the BSEP is investigating the origin, hydraulic characteristics, extent, and composition of brine occurrences in Salado Formation excavations at the WIPP repository horizon. Although the workings are considered dry, brine is observed to weep from exposed surfaces in the repository horizon and seep into drillholes in the underground excavations.

The data presented in this report are a continuation and update of studies that began in 1982 as part of the Site Validation Program (Black and others, 1983; TSC-D'Appolonia, Part II, 1983; Alcorn, 1983), were formalized by Morse and Hassinger (1985), and have been previously reported in the Brine Sampling and Evaluation Phase I Report (Deal and Case, 1987) and the Brine Sampling Evaluation Phase II Report (Deal and others, 1987). Users should consult those two reports for background information, detailed descriptions of

FIGURE 1-1 LOCATION MAP OF THE WIPP SITE

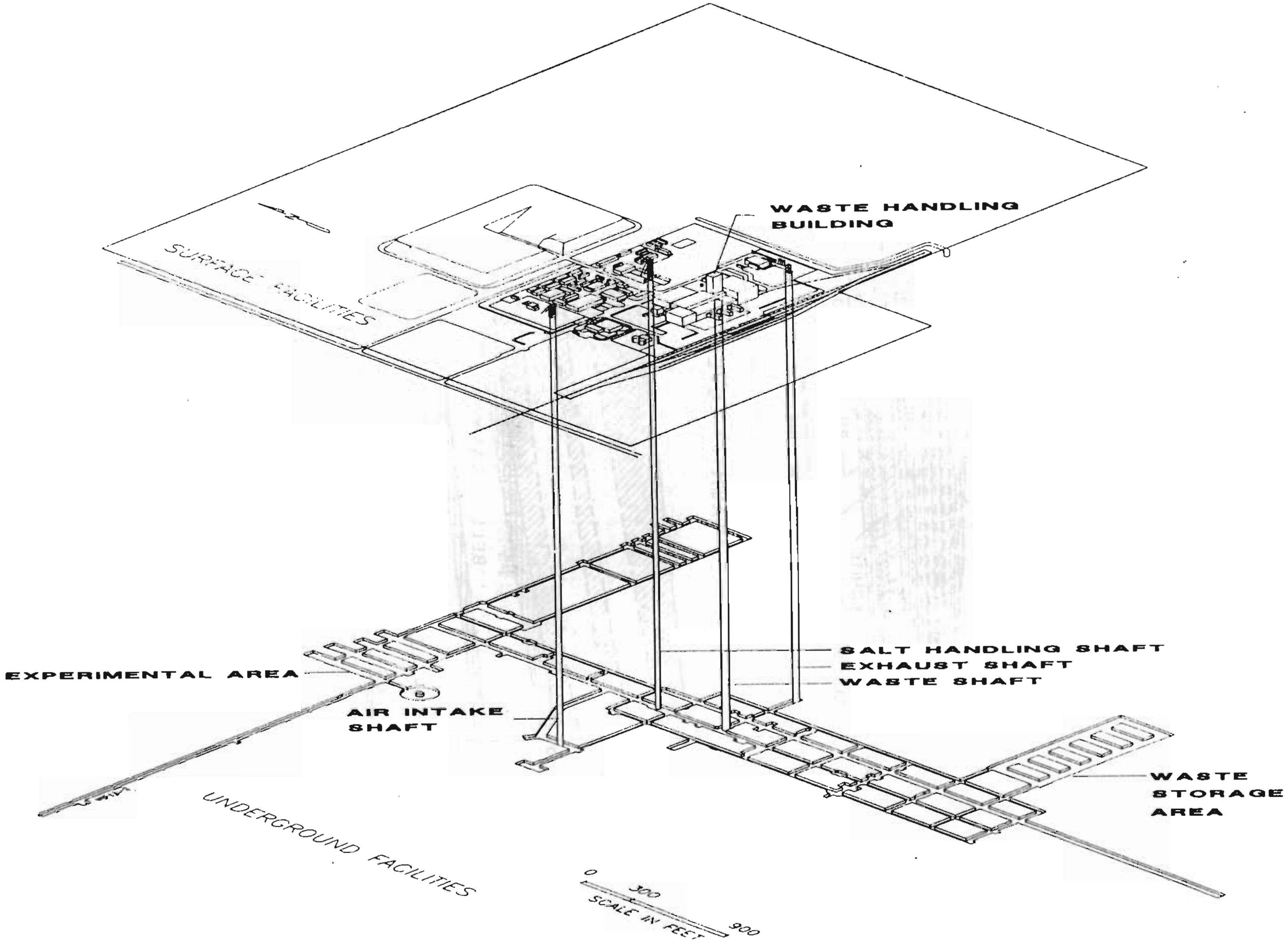

FIGURE 1-2 SURFACE AND UNDERGROUND LAYOUT OF THE WIPP FACILITY

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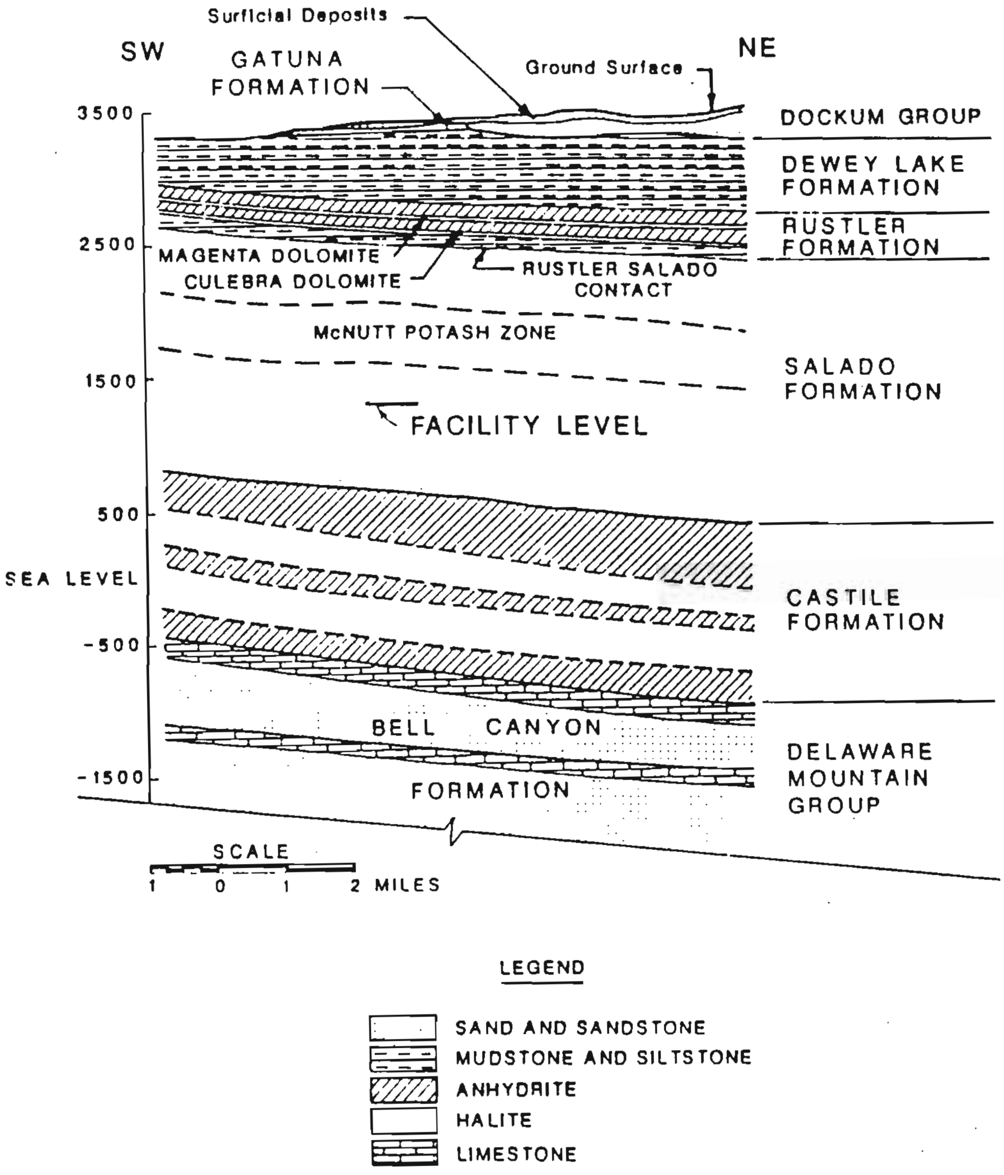


FIGURE 1-3 GENERALIZED STRATIGRAPHIC CROSS SECTION (MODIFIED FROM FIG. 1-2, DEAL AND CASE, 1987)

the data gathering and analytical procedures, and the cautions that should be exercised when using the data presented herein.

This report is limited to activities performed or initiated during the 1988 calendar year. These activities, which dealt primarily with the immediate environment of the underground excavations, were designed to provide information on the amount of brine that flows into the underground, the properties of the brine, the properties of the formation in which the brine resides, and modeling of the potential for brine inflow from the formation immediately surrounding the excavations.

Information on brine inflow comes from several sources. Most information was derived from measurements either of brine removed from holes drilled downward from the facility horizon or of brine seeping from holes drilled upward from the facility horizon. Some data were also collected from the brine weeps that form on exposed surfaces shortly after excavation. These inflow data are listed in Section 2.0 of this report.

Section 3.0 presents data regarding the properties of the brine. The geochemistry of the brine recovered from underground provides insight into its origin and subsequent modification. Newly improved analytical procedures increased the confidence in the geochemical analyses and allowed substantial progress to be made in modeling the data and understanding key elements of the chemical system of which the brine is a major part. As part of the characterization of the brine, a study was conducted to investigate brine and surface area microbiology in the underground excavations. Salt-tolerant bacteria were found in all brines, muck, and boreholes sampled within the workings. No human pathogens were found during this study.

Studies describing the properties of the formation containing the brines are presented in Section 4.0. The investigations included a characterization of the moisture content of the formation, measured by heating the samples taken from the surfaces of the drifts after they had been categorized by age of excavation, stratigraphic position, and geographic location. The electrical properties of the repository stratigraphy were determined in more than 20 boreholes from the repository horizon and correlated with the free brine content of the rocks using a borehole induction logging tool. The borehole video camera survey was also completed, and the final results are summarized in this chapter.

Modeling studies, which relate the deformation experienced by the rock immediately surrounding the underground workings to the potential for brine inflow, are presented in

Section 5.0. The general relationships between the effects of rock deformation, brine degassing, and depressurization of the rocks due to mining are developed in a rigorous fashion in Appendix J. Sections 5.4 through 5.10 present an actual application of this relationship to deformation around, and brine inflow to, a circular opening in the repository. This exercise is accomplished by using simplifying assumptions to allow the coupling of salt deformation and fluid flow computer codes to predict fluid behavior of a hydrologic system strongly affected by near-field deformational effects.

Quantification of the rate of brine inflow and evaluation of the total volume of brine that can inflow to the repository are important tasks from the standpoint of long-term repository performance. While the repository is open, much of the brine that enters the repository is removed by evaporation. After closure, however, this mechanism of removal will not be available. Evaluation of the effects of resaturation and repressurization of the facility following closure will require as much information as possible regarding these inflow rates and their cumulative results. Many long-term predictions are based upon the type of mechanism by which the brine is generated and moved. These preliminary modeling exercises compare the effects of differing brine inflow mechanisms.

2.0 MONITORING OF BRINE INFLOW PARAMETERS

2.1 INFLOW DATA

2.1.1 Introduction

Brine seepage into some underground locations at WIPP has been measured since January 1985. The data presented in this report cover the time period between August 1987 and December 1988 and are primarily an extension of the data presented in the BSEP Phase I Report (Deal and Case, 1987) and Phase II Report (Deal and others, 1987). Brine accumulation data are presented in Appendix A. Smoothed curves (11-point moving averages) of these data are presented in Appendix B.

The brine accumulations in holes drilled from the WIPP underground workings and the stratigraphy of the Salado Formation have been extensively discussed in previous reports (Deal and Case, 1987; Deal and others, 1987; Deal, 1988; Deal and Roggenthen, 1989). The locations of the BSEP observation holes referred to in this report are shown in Figure 2-1, which also shows the extent of the excavations that existed at the end of December 1988. A list of the underground locations where brine observations have been made as part of the BSEP is presented in Appendix A. The holes can be grouped as near-vertical downholes, near-vertical upholes, and nearly horizontal holes. The stratigraphy of the rocks close to the excavations is shown in Figure 2-2. The detailed stratigraphy from drilling logs for many of the drillholes is presented in Appendix H of this report, as part of the discussion on the results of observations made with a borehole camera.

2.1.2 Downholes

Table 2-1 summarizes the most important data obtained to date from the downholes. Additional information is contained in Appendix A. Figure 2-3 shows the relationship between the downholes and the stratigraphy.

Deal and Case (1987 - Table 3-1) discussed brine inflow into 13 downholes with observations beginning in late 1984 or early 1985 and extending through August 1986. After 1.5 years of observation, ten of those holes showed fairly steady inflow trends, two were decreasing, and one was increasing. As of July 1987 (Deal and others, 1987) after approximately 2.5 years of observation, five remained steady, five that had been steady were decreasing, the two that had been decreasing were still decreasing, and the one that had been increasing was decreasing. As of the end of December 1988 (Table 2-1), after approximately 4 years of observation, three 15-meter holes (two in the heated experimental

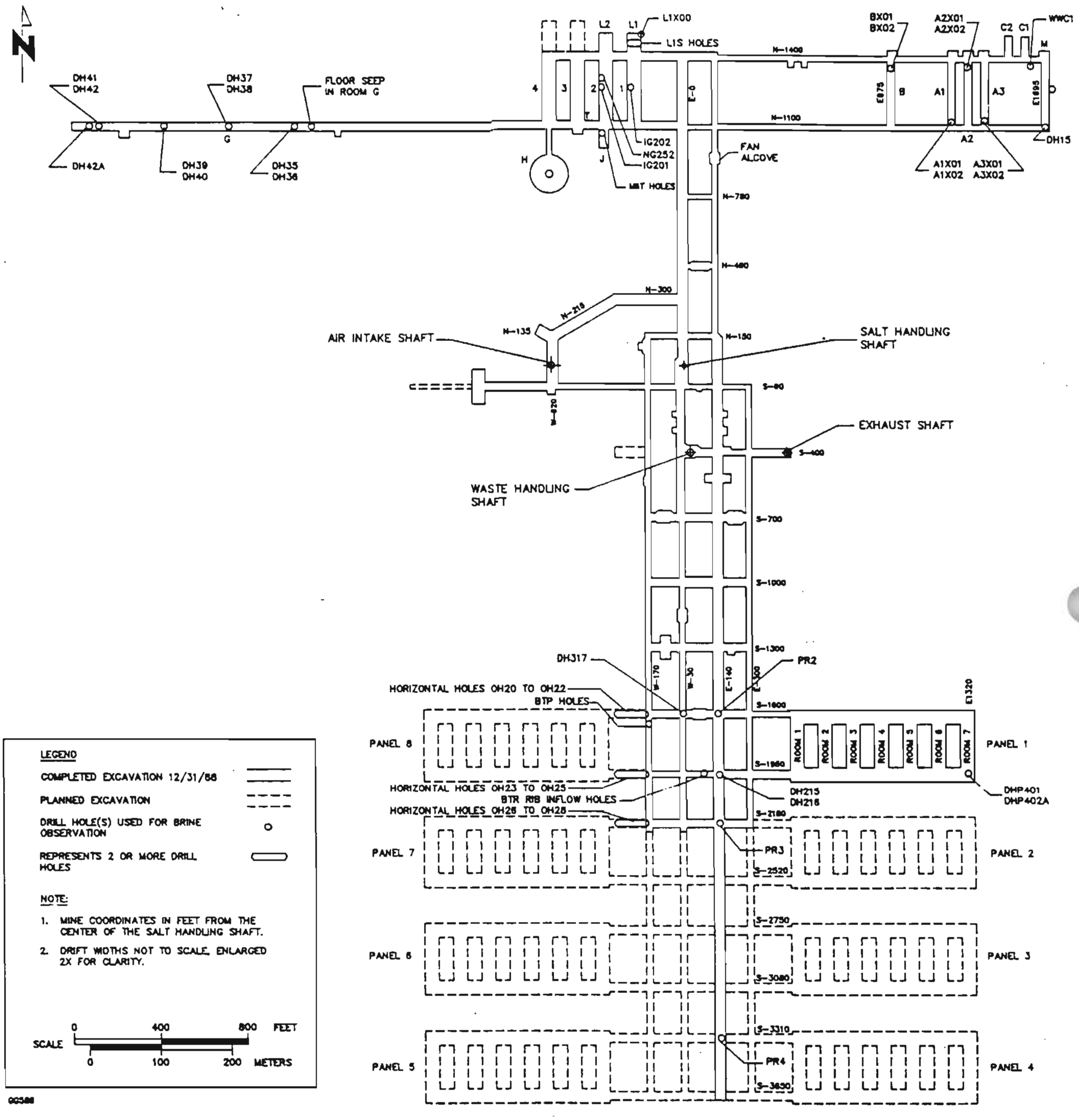
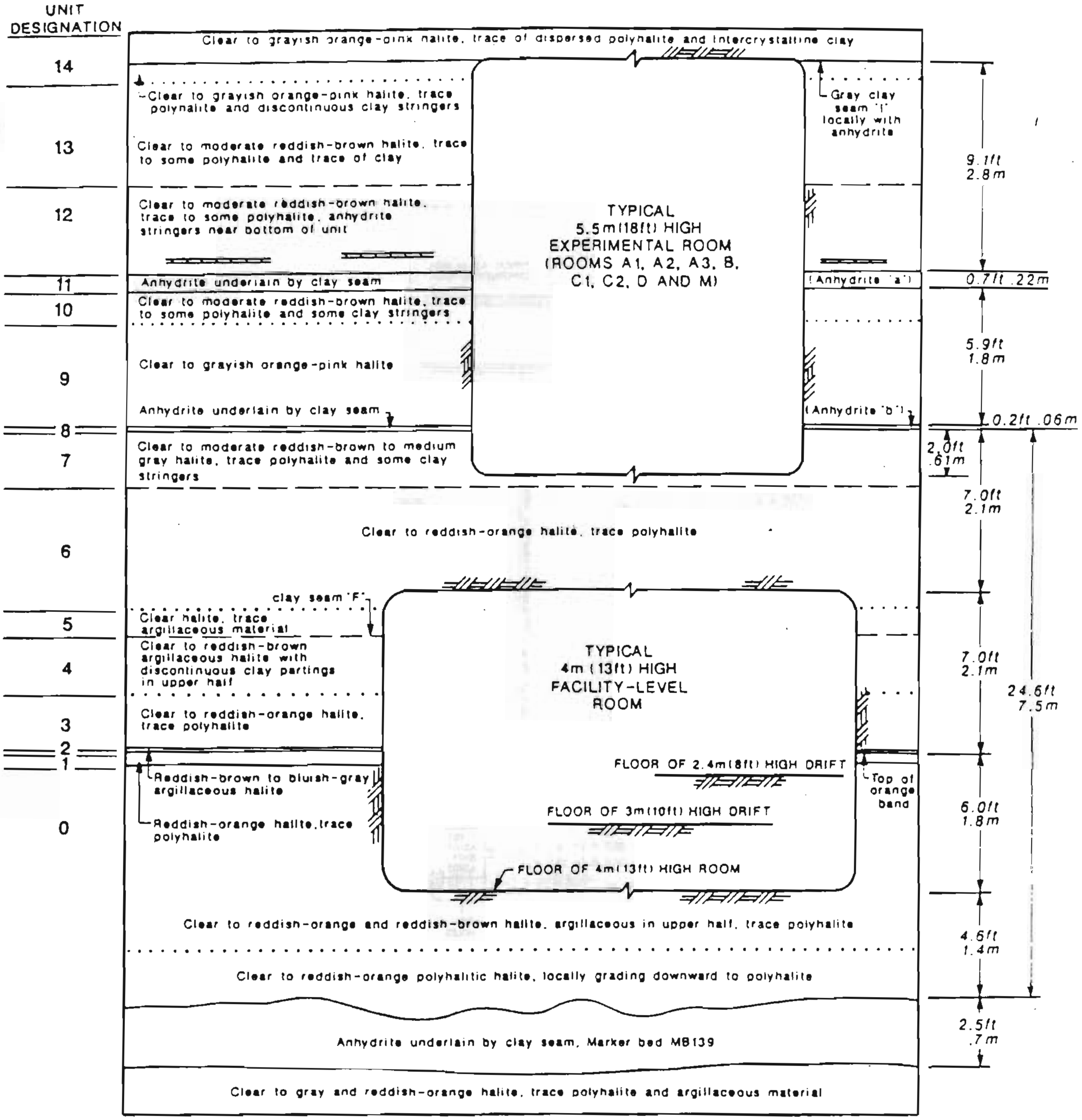


FIGURE 2-1 MAP OF WIPP UNDERGROUND WORKINGS SHOWING BSEP OBSERVATION LOCATIONS AS OF DECEMBER 31, 1988



NOTES:

1. *Dimensions and lithologic descriptions are derived primarily from corehole and geologic mapping data from the four test rooms and experimental area supplemented by geologic information from the remaining SPDV excavation.*
2. *Unit thickness are approximate and vary slightly.*
3. *Room dimensions have changed with time due to salt-creep closure.*

(after Deal and Case, 1987)

FIGURE 2-2 GEOLOGIC CROSS-SECTION OF THE FACILITY WITH UNIT NUMBER DESIGNATIONS

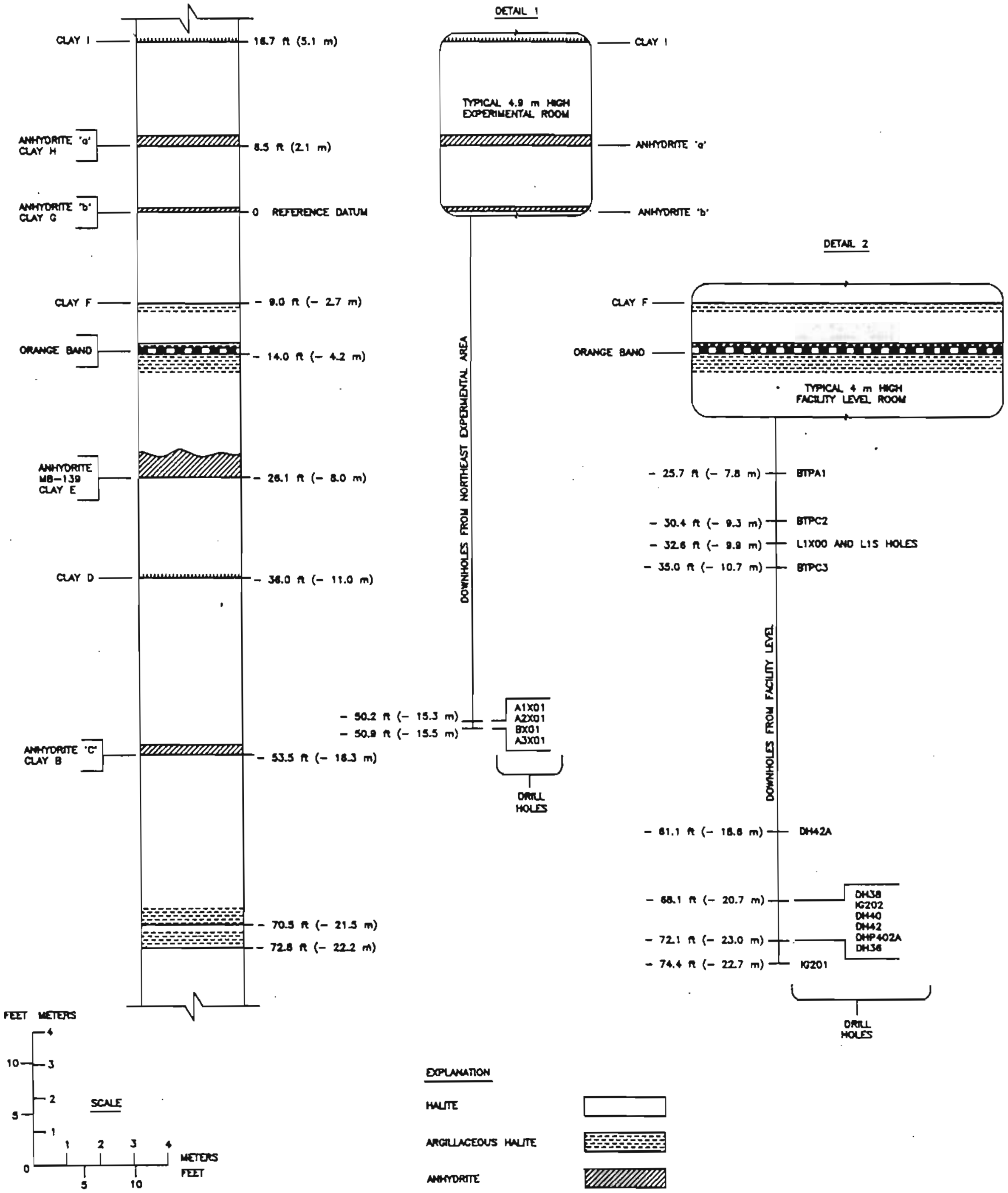


FIGURE 2-3 CORRELATION OF THE STRATIGRAPHY WITH DOWNHOLES IN THE NORTHERN PART OF THE FACILITY

TABLE 2-1

BRINE ACCUMULATION SUMMARY FOR DOWNHOLES

HOLE	ROOM OR LOCATION	DATE ROOM EXCAVATED	DATE HOLE DRILLED	DATE FIRST OBSERVED	APPROX. MAXIMUM INFLOW (ℓ/DAY)	APPROX. INFLOW 12/88 (ℓ/DAY)	INFLOW TREND 12/88 (I,S,D)*	APPROX. TOTAL VOL. REMOVED BY 12/88(ℓ)
A1X01	A1	10/84	2/85	3/85	0.05	0.026	S	38
A2X01	A2	07/84	2/85	2/85	0.12	0.020	D	37
A3X01	A3	11/84	1/85	2/85	0.03	0.022	S	32
BX01	B	06/84	1/85	1/85	0.12	0.03	D	66
DH36	G	12/84	1/85	1/85	0.28	0.14	D	272
DH38	G	12/84	1/85	1/85	0.18	0.045	S	73
DH40	G	12/84	1/85	1/85	0.04	0.002	S	7
DH42	G	12/84	1/85	1/85	0.05	0.02	S	38
DH42A	G	12/84	1/85	1/85	0.2	0.10	I	142
DHP402A	S1950/E1330	10/86	12/86	12/86	4	1.13	D	332
L1S25	L1	04/84	6/85	8/85	0.02	0.005	D	13
L1S26	L1	04/84	6/85	8/85	0.004	0.002	S	2
L1S27	L1	04/84	7/85	8/85	0.007	0.003	S	4
L1S28	L1	04/84	7/85	8/85	0.005	0.005	S	2
L1S29	L1	04/84	7/85	8/85	0.8	0.13	I	151
L1S30	L1	4/84	7/85	8/85	0.08	0.02	D	83
L1S31	L1	4/84	7/85	8/85	0.15	0.15	I	28
L1S32	L1	4/84	7/85	8/85	0.18	0.16	S	101
L1S33	L1	4/84	7/85	8/85	0.1	0.1	I	50
L1S34	L1	4/84	7/85	8/85	0	0	DRY	0
L1S35	L1	4/84	7/85	8/85	0	0	DRY	0.1
L1S36	L1	4/84	7/85	8/85	0.01	0	DRY	5
L1X00	L1	4/84	5/84	5/85	0.03	0.24	S	53
NG252	2	3/83	3/83	12/84	0.5	0.07	D	377

Data summarized and rounded from Appendices A and B.

* I = Increasing
S = Steady
D = Decreasing

room area, A1X01 and A3X01, and one in Room G, DH42), remained steady, each producing approximately 0.02 to 0.03 liter of brine per day. Two of the 15-meter holes that had remained steady through August 1987 (A2X01 in the heated experimental area and DH36 in Room G) were declining in the fall of 1988. Of the five 15-meter holes that had gone from steady to decreasing by August 1987, one was still decreasing (BX01 in the heated experimental area), two were leveled out and fairly steady (DH38 and DH40 in Room G), one (DH42A at the far western end of Room G) had turned around in August 1988 and was increasing, and one (IG202 in SPDV Room 2) had been closed by salt creep and could no longer be sampled. Of the two holes that had been decreasing steadily since before August 1986, both located in SPDV Room 2, one (NG252) continued to decrease and the other (IG201) was closed by salt creep and could no longer be sampled. The remaining hole, (L1X00 in Room L1) which had shown increasing inflow in August 1986 and decreased in July 1987, was fairly steady by December 1988.

2.1.2.1 Downholes in the Heated Experimental Area

The four downholes in the heated experimental area (A1X01, A2X01, A3X01, and BX01; Figure 2-1) penetrate a slightly different stratigraphy than do other 15-meter downholes (Figure 2-3), intersecting Marker Bed 139 approximately 7 meters beneath the floor. As described above, they are remarkably similar and steady, producing brine at approximately 0.02 to 0.03 liter per day.

2.1.2.2 Downholes in Room G

The four evenly-spaced 15-meter downholes in Room G (from east to west, DH36, DH38, DH40, and DH42; Figure 2-1) intersect Marker Bed 139 approximately 2 meters beneath the floor of the drift (Figure 2-3). The graphs of the seepage into them (Appendix B) show very similar patterns, but there is a difference of two orders of magnitude in the rate at which brine seeps into them (0.1, 0.04, 0.002, and 0.02 liter per day, respectively). The westernmost drillhole in the workings, DH42A, is only 2 meters west of DH42 (Deal and Case, 1987), only 12 meters deep, and continues a seepage inflow pattern (Appendix B) that is quite different from that of others discussed above. It showed a clear, increasing inflow trend in August 1988 and continues to produce brine four times faster than its deeper neighbor, DH42.

2.1.2.3 BTP Downholes at S1650/W170

The BTP downholes, drilled as part of the BSEP, just south of the intersection of the S1650 and W170 drifts, have been discussed in Deal and others (1987 - pp. 14-17), and inflow data are included in Appendix A of this report. Water has been spread in this area for dust control and chemical analysis of the brine removed from these holes shows that they contain components not characteristic of the Salado Formation (Section 3.1.1.3). Additionally, calculated seepage rates show sudden increases after water has been spread in the area. The data provided by these drillholes reflect construction activity more than a natural brine seepage phenomena. Therefore, these holes are no longer being surveyed as part of the BSEP; the data from them are not included in Table 2.1.

2.1.2.4 Downhole DHP402A at the East End of S1950 Drift

This downhole in the southeast corner of Waste Storage Panel 1, drilled in December 1986, had drilling brine spilled into it in July 1987, had been buried beneath a pile of muck from October 1987 through July 1988, and had collected a considerable amount of brine that was spread in August 1988 as part of a construction effort to reconstitute loose muck on the floor. The inflow rates calculated for this hole during the time period covered by this report strongly reflect these activities (Appendix A). Valuable chemical data have been obtained from the brine in this hole, demonstrating that the chemical "fingerprints" of the various waters encountered and utilized in the WIPP excavations can be identified. This knowledge can be used to approximate the amount of dilution that occurs to the naturally-occurring brines (Section 3.1.1.3 and Table 3-2). DHP402A continues to be included in the routine observations made as part of the BSEP.

2.1.2.5 Inclinometer Downholes in the SPDV Rooms

Inclinometer holes IG201 and IG202 were discussed at length in Deal and Case (1987 - Appendix D, Sections 3.1 and 3.2). Salt creep caused shear closure of the holes and they are no longer accessible. They were deleted from the BSEP.

2.1.2.6 Downholes in Room L1

Downholes L1X00 and L1S25 through L1S36 were discussed at length in Deal and others (1987 - Section 2.3.1.3). The L1S holes are a line of 12 downholes, spaced about 0.6 meters apart in two groups of six (Figure 2-4a). L1X00, observed since November 1984 as part of the BSEP, is located in the northeast corner of Room L1, approximately 4.4 meters north of the line of L1S holes. The data demonstrate the striking variation in seepage rates that can occur in closely spaced drillholes.

Similar variations in seepage measurements in closely spaced drillholes have been noted in other places in the WIPP excavations, most notably in the Materials Interface Interaction Test (MIIT) drillholes in Room J (Morse and Hassinger, 1985; and Deal and Case, 1987 -

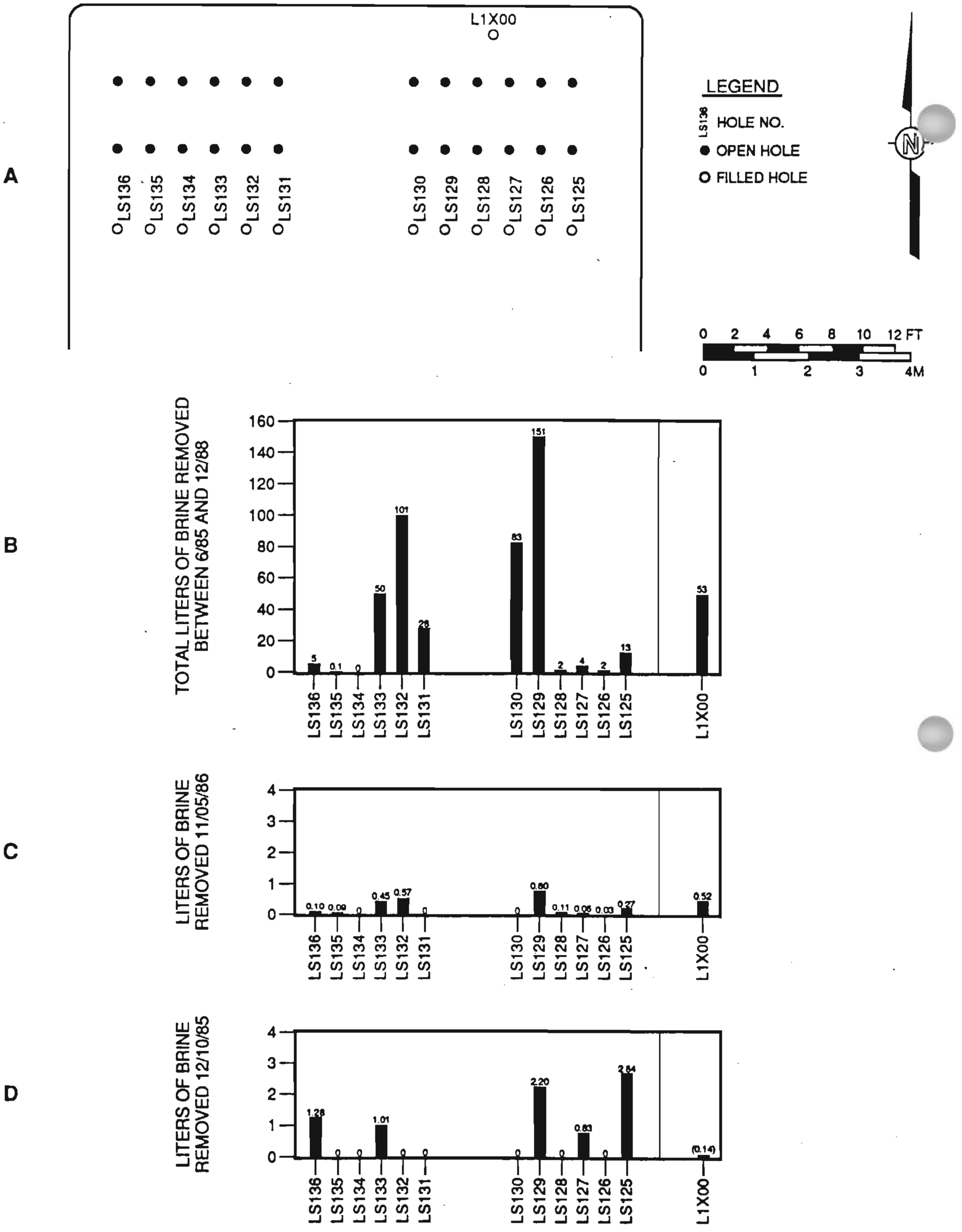


FIGURE 2-4 DRILLHOLES IN THE NORTH END OF ROOM L1

Appendix D, Section 3.5), and holes DH42 and DH42A in Room G (Section 2.1.2.2). These observations lead Deal and Case (1987) to remark that "the great variation in inflow characteristics between locations only a short distance (a few meters, or in some instances, less than a meter) apart make the discussion of 'averages' or 'typical occurrences' difficult or misleading."

Room L1 was excavated in April 1984. Downhole L1X00 was drilled in the northeast corner of the room (Figure 2-4a) in May 1984 and was one of the first holes observed as part of the BSEP (Deal and Case, 1987 - Appendix D, Section 3.6). The L1S array of 36 drillholes, each 10 centimeters in diameter and 3.6 meters deep, was drilled through Marker Bed 139 as part of the sealing and plugging experimental program at the WIPP. These downholes were drilled in three lines of 12 holes each, south of L1X00. The northern two lines were filled with grout as part of the experimental program, but the southern line, holes L1S25 through L1S36, was left open (Figure 2-4a). These 12 holes, drilled in June 1985, have been observed as part of the BSEP since that time.

Initial seepage rates observed in 1985, as illustrated by the data for December 1985 (Figure 2-4d) showed striking variations in seepage rates from hole to hole. Higher seepage rates tended to occur in the holes on the outside of the array, as might be expected for pressure-driven brine flow moving from regions of high confining stress under the adjacent ribs (creating pressures perhaps as high as 2000 psi) toward atmospheric pressures found in the drillholes, and the lower confining stress beneath the center of the excavated rooms.

By May 1986, seepage into the holes was more evenly distributed, but in the late summer and fall of 1986, a dramatic increase in seepage into holes near the center of the room began (Appendix A and B). This trend is evident in the data for November 1986 (Figure 2-4c), although it was initially interpreted simply as a decrease of seepage into the holes near the edges of the room (L1S25 and L1S36) in response to a lowering pressure gradient in the surrounding deforming salt. It is interesting to note that through that time period the two holes closest to the center of the room (L1S30 and L1S31) had exceedingly low seepage rates, perhaps because most of the brine moving toward the center of the room was intercepted by other drillholes. L1S31 was never observed to contain any brine until after March 1987.

The data for the L1S holes not only show variations from hole to hole, but also show a change in pattern with time. We feel the variations from hole to hole at any given point in time to be controlled by slight local variations in stratigraphy and fracturing and that the change of pattern with time is caused by the development of excavation-induced fracturing beneath the drifts. The development of this fracturing and the effect it may have on brine seepage into any given drillhole have been discussed by Deal and Case (1987 - Appendix D, Section 3.2.2; and Section 2.1.2.7 of this report).

2.1.2.7 Downhole NG252 in SPDV Room 2

Downhole NG252, a small-diameter (38-millimeter) drillhole in the floor of SPDV Room 2, was discussed at length by Deal and Case (1987 - Appendix D, Section 3.2.2). This hole behaved anomalously and produced relatively large amounts of brine from an excavation-induced fracture associated with Marker Bed 139. When initially measured in the spring of 1985, the seepage rate into this small hole was approximately 0.5 liter per day. Calculated seepage rates (Appendices A and B) showed a decline over 4 years, to a rate of about 0.1 liter per day at the end of 1988.

2.1.3 Upholes

Brine seepage into upholes has been discussed in Deal and Case (1987) and Deal and others (1987 - Section 2.3.2). The upholes characteristically produce less brine than the downholes and do so for shorter periods of time. Part of this can be attributed to the fact that it has been difficult to seal the upholes to prevent evaporation (Deal and Case, 1987) and loss of moisture by dispersion from the hole collar. Not only is loss of moisture by evaporation evident from the salt crust buildup in and around most of the upholes, but the chemical data (Section 3.1.3) also show compositional differences between the brines from upholes and downholes that can be explained by evaporation of some of the uphole brine. The stratigraphy exposed in the upholes (Figure 2-5) is slightly different from that exposed in the downholes. Summary data for selected upholes are presented in Table 2-2. Only two of the 17 upholes listed continue to produce any brine at all. Additional data are presented in Appendix A.

2.1.3.1 Upholes in the Heated Experimental Area

Four upholes, located in the heated test rooms (Rooms A1, A2, A3, and B), are, from east to west, A3X02, A2X02, A1X02, and BX02 (Figure 2-1). These holes cut a slightly different stratigraphy than do the upholes drilled from the facility level (Figures 2-5, H-3, H-5, H-7, and H-9), which includes anhydrite Marker Bed 138, six clay partings, and the

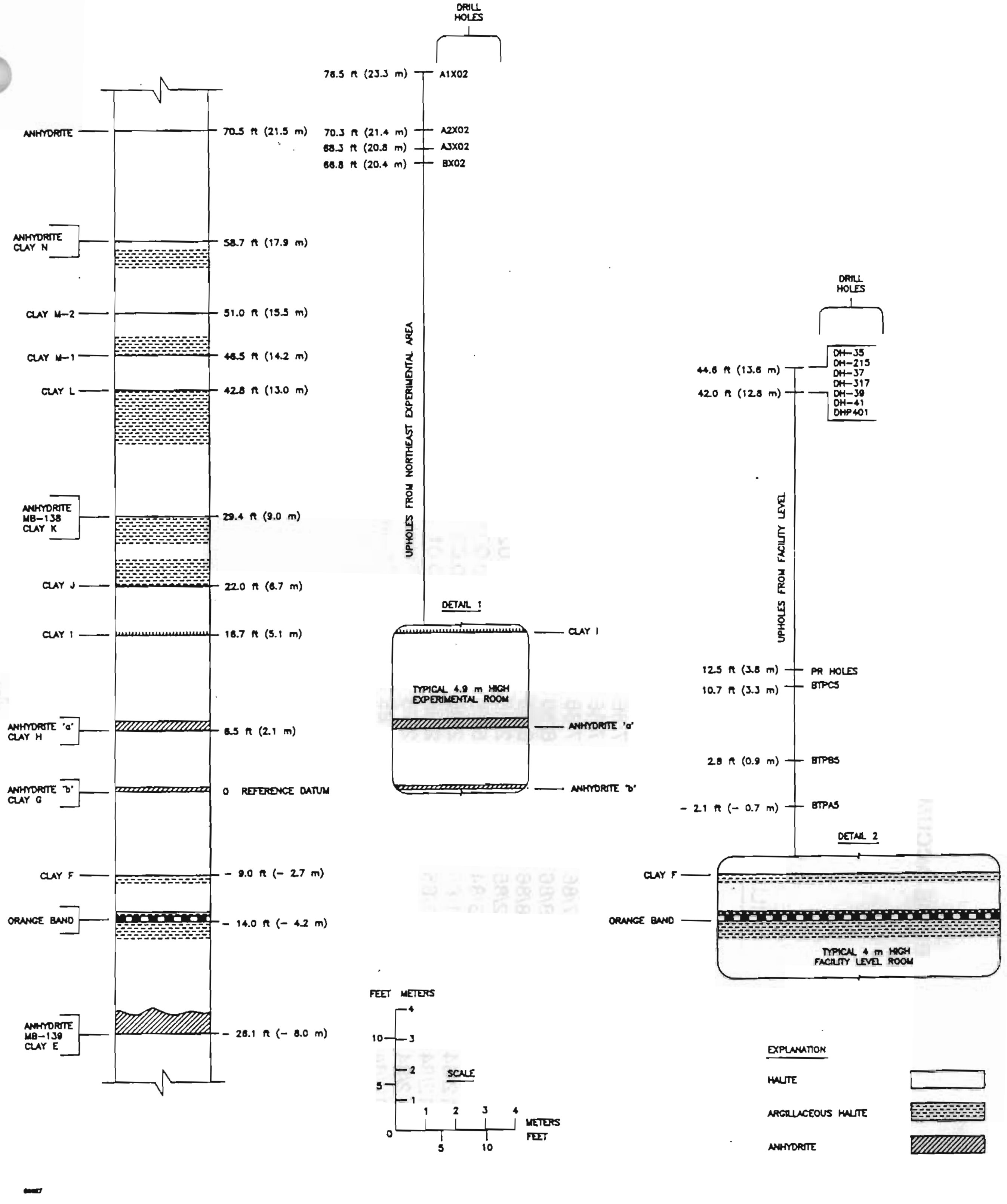


FIGURE 2-5 CORRELATION OF THE STRATIGRAPHY WITH UPHOLES IN THE NORTHERN PART OF THE FACILITY

TABLE 2-2

BRINE ACCUMULATION SUMMARY FOR UPHOLES

HOLE	ROOM OR LOCATION	DATE ROOM EXCAVATED	DATE HOLE DRILLED	DATE FIRST OBSERVED	APPROX. MAXIMUM INFLOW (*l*/DAY)	APPROX. INFLOW 12/88 (*l*/DAY)	INFLOW TREND 12/88 (I,S,D)*	APPROX. TOTAL VOL. REMOVED BY 12/88(*l*)
A1X02	A1	10/84	3/85	3/85	0.09	0.03	D	40
A2X02	A2	07/84	2/85	2/85	0.04	0	DRY	5
A3X02	A3	11/84	1/85	2/85	0.02	0	DRY	4
BTPA4	S1620/W170	09/85	7/86	7/86	0	0	DRY	0
BTPA5	S1620/W170	09/85	7/86	7/86	0	0	DRY	0
BTPB4	S1620/W170	09/85	7/86	7/86	0	0	DRY	0
BTPB5	S1620/W170	09/85	7/86	7/86	0	0	DRY	0
BTPC4	S1620/W170	09/85	8/86	8/86	0.03	0.003	D	5
BTPC5	S1620/W170	09/85	8/86	8/86	0	0	DRY	0
BX02	B	06/84	2/85	2/85	0.02	0	DRY	2
DH15	N1104/E1688	03/84	3/84	5/86	0.009	0	DRY	4
DH35	G	12/84	1/85	2/85	0.02	0	DRY	4
DH37	G	12/84	1/85	2/85	0.01	0	DRY	1
DH39	G	12/84	1/85	2/85	Trace	0	DRY	0
DH41	G	12/84	1/85	2/85	Trace	0	DRY	0
DH215	S1960/E153	01/83	2/83	4/84	0.09	0	DRY	18
DHP401	S1950/E1330	10/86	1/87	3/87	0.008	0	DRY	2

Data summarized and rounded from Appendices A and B.

* I = Increasing
S = Steady
D = Decreasing

anhydrite just above clay I. Three of the holes are 15-meters deep, but the one uphole with anomalous seepage behavior (A1X02) is 18-meters long and intersects an additional anhydrite interbed that is not intersected by any of the other observed upholes. All four of these upholes have been observed as part of the BSEP since they were drilled in early 1985. The heated experiments were energized in Room B on April 23, 1985 and in the A rooms on October 2, 1985. All four holes (Appendices A and B) showed a typical seepage rate peak a few weeks after drilling then began to decline. Seepage into BX02 and A3X02 decreased to zero fairly quickly, with the holes becoming essentially dry by October 1985, and February 1986, respectively.

Upholes A1X02 and A2X02 both exhibited an increased seepage rate in the summer of 1986, beginning in June, peaking in August, and declining back to May rates by October. The fact that the peak occurred in the summer is likely to be a coincidence. It is probable that the increased inflow is related to the time since excavation (~ 2 years) or the time since heating of the rooms began (~ 1 year). We suggest the phenomenon is most likely associated with excavation-induced parting along anhydrite Marker Bed 138 and underlying clay K, that may additionally be driven by thermal effects resulting from heating of the rooms. Seepage into A2X02 continued to drop off and the hole became dry by September 1987.

Seepage into A1X02 became difficult to measure in the fall of 1986 due to a blockage developing in the collecting device, which was completely plugged by December 1986. Repeated attempts to open the tubing were unsuccessful and the entire collecting system was replaced at the end of June 1987. The new system functioned properly and seepage rates increased during the winter of 1987 through 1988, reaching a maximum in March 1988. Seepage rates began to decline and were still doing so at the end of December 1988.

2.1.3.2 Upholes in Room G

Four 15-meter long upholes in Room G have been observed since they were drilled in January 1985. Very little moisture seeped into any of these holes, although moist areas and salt crusts occurred around each of them. A small amount of moisture accumulated in the collecting device attached to DH39 in March 1985, but otherwise the collecting container did not contain measurable amounts of brine. Detectable amounts of moisture stopped accumulating in DH41 in February 1986, in DH37 in July 1986, and in DH35 in September 1986.

2.1.3.3 BTP Upholes at S1620/W170

Six upholes were drilled in this location in July 1986 to evaluate relative variations in brine seepage from different horizons above the repository-level excavations. The shallow holes (BTPA4 and BTPA5) are open for the first 1.4 to 1.6 meters above the back and penetrate the halite units below anhydrite B, but not anhydrite "b" and clay G. Two holes of intermediate lengths (BTPB4 and BTPB5) are cased and grouted to approximately 2 meters and are open from there to approximately 3 meters, through the zone that contains anhydrite "b" and clay G. The deepest holes (BTPC4 and BTPC5) are cased and grouted through the anhydrite and clay zone and are open from approximately 4.2 to 5.5 meters in the clear halite between anhydrites A and B. All the holes were sealed at the collar; thus it is unlikely that evaporation into the repository atmosphere was significant in reducing apparent brine volumes accumulated by the collecting system.

All of the holes, except for one of the longest (BTPC4), were dry. BTPC4 started to produce some brine in August 1986, on the order of 0.02 liter per day, and declined to approximately 0.003 liter per day by October 1988 (Appendices A and B). In December 1986, the W170 drift was extended southward causing stress redistributions to occur around the intersection. A slight increase in brine seepage occurred, similar to the more obvious response that occurred in DH215 (Section 2.1.3.4). The BTP holes are no longer being observed as part of the BSEP.

2.1.3.4 Uphole DH215 at S1950/E153

This part of the E140 drift was mined in January 1983. Uphole DH215 was drilled at S1950 shortly after excavation. In the spring of 1984, brine was noticed dripping from the hole and the hole was fitted with a brine collection device in April 1984. In November 1985, the floor of the E140 drift was lowered and the S1950 cross drift was cut. Shortly thereafter, brine seepage into this uphole increased threefold. Deal and Case (1987) described the excavation and seepage history at this location and stated that the change in seepage rates "almost certainly reflect changes in the stress distribution in the disturbed zone in the immediate vicinity of the repository excavations."

Seepage into this hole has continued to be monitored (Appendices A and B). Inflow reached a maximum in January 1986 and then began to decline. By October and November of 1986, the seepage into the hole had almost completely ceased, but then began to pick up again in February and March 1987. Seepage rates then decreased over the summer of 1987. The last brine was collected at this location in September 1987. It remained dry throughout 1988.

2.1.3.5 Uphole DHP at the Southeast Corner of Panel 1

Uphole DHP401 is a 15-meter-long observation hole drilled in the southeast corner of Waste Storage Panel 1 at S1950/E1330. It was completed in January 1987. A small amount of brine seeped into the hole during 1987 (Appendix A), accumulating a total of 2.36 liters by March 1988. Due to construction activities, the collecting device was removed from the hole and not reinstalled until October 1988. No brine had accumulated by the end of 1988.

2.1.4 Horizontal Holes

An array of horizontal holes was drilled into the north rib of the S1950 drift at about E100. The holes were drilled as part of the BSEP to investigate any easily observed variability in seepage from different stratigraphic horizons exposed in the facility-level excavations. Figure 2-6 is a sketch showing the locations of the holes and their stratigraphic positions. The detailed stratigraphy of the facility level is shown in Figure 2-2. The holes, numbered BTR1 through BTR12, are inclined slightly downward so that the end of the hole is lower than the collar.

This segment of the drift was excavated on January 31, 1986. The holes were drilled on February 27, 1986, approximately 1 month after the drift surface was cut. Suction soil moisture collecting devices were placed in the holes the following day and the openings were sealed to prevent evaporation and the loss of brine.

The brine seepage data for these holes are included in Appendix A and summarized in Table 2-3. The shallow (~ 0.3 meters deep) holes have never produced brine. The deeper holes (~ 0.9 meters deep) show distinct differences related to the stratigraphy and time since excavation.

The holes (BTR11 and BTR12) in the lower unit of clear halite near the floor were the driest and did not produce measurable quantities of brine. The holes (BTR8 and BTR9) penetrating the orange band and the clay seam above it were the most moist, followed by holes (BTR2 and BTR3) drilled in a unit containing some clay and intersecting a small clay seam. The holes (BTR5 and BTR6) in slightly clayey halite produced only small amounts of brine. These observations corroborate those in other sections of this report that note a correlation of moisture content and brine inflow with the amount of clay present in the salt.

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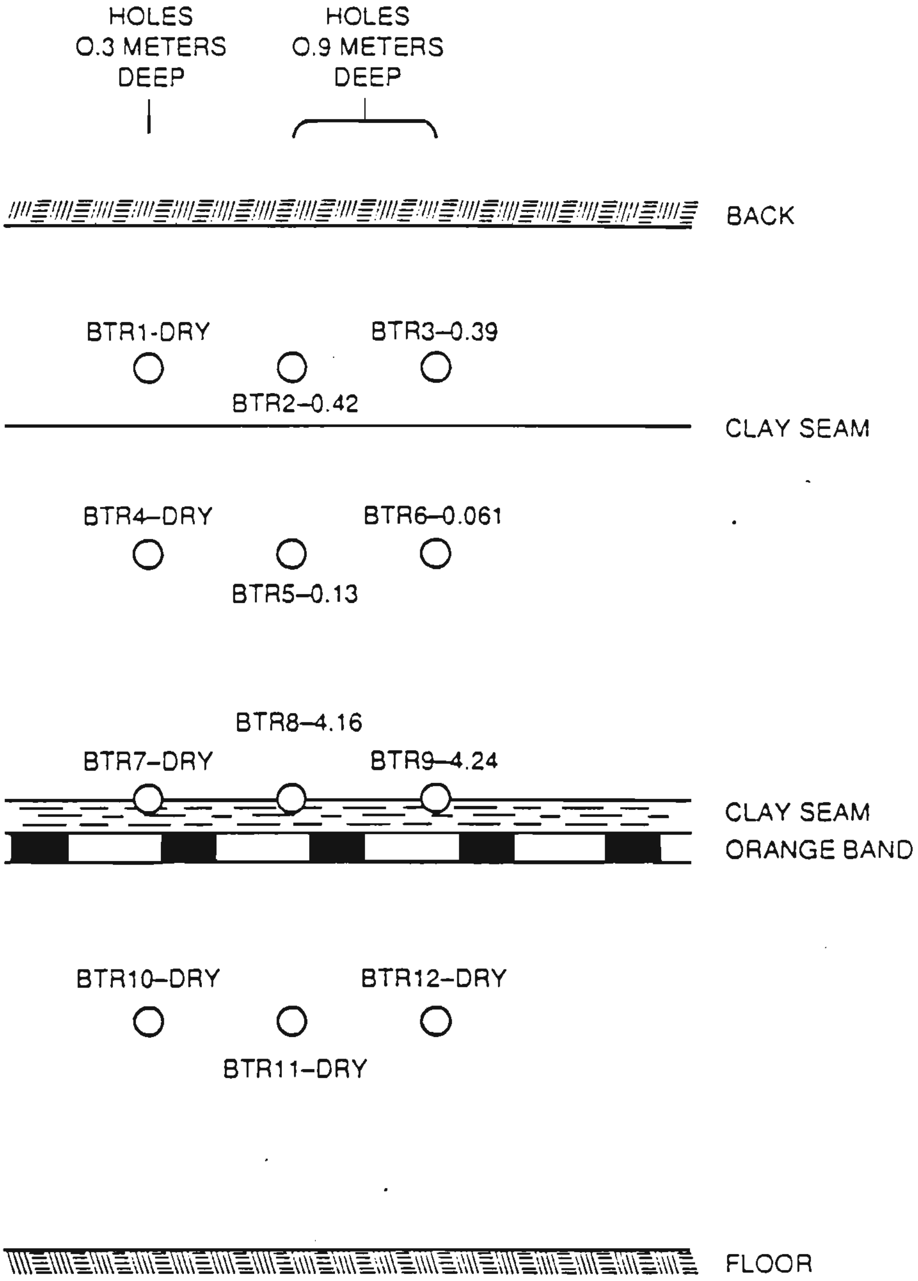

EXPLANATION

BTR12–DRY	HOLE NUMBER – LITERS OF BRINE 2/86 – 12/88
○	LOCATION OF HOLE

FIGURE 2-6 SKETCH OF THE NORTH RIB AT S1950/E100 SHOWING THE LOCATION OF THE BTR HOLES

TABLE 2-3

BRINE ACCUMULATION SUMMARY FOR HORIZONTAL HOLES AT S1950/E100

DRIFT EXCAVATED: 1/86
HOLES DRILLED: 2/86
HOLES FIRST OBSERVED: 3/86

HOLE	DEPTH OF HOLE (m)	APPROX. MAXIMUM INFLOW (*l*/DAY)	APPROX. INFLOW 12/88 (*l*/DAY)	INFLOW TREND 12/88 (I,S,D)*	DRY SINCE	APPROX. TOTAL VOL. REMOVED BY 12/88 (*l*)
BTR1	0.3	0	0	DRY	02/86	0
BTR2	1.0	0.015	0	DRY	10/88	0.42
BTR3	1.0	0.001	0	DRY	10/88	0.39
BTR4	0.3	0	0	DRY	02/86	0
BTR5	0.9	0.001	0	DRY	10/87	0.13
BTR6	0.9	0.001	0	DRY	11/86	0.06
BTR7	0.3	0	0	DRY	02/86	0
BTR8	0.9	0.04	0	DRY	02/88	4.16
BTR9	0.9	0.02	0	DRY	07/88	4.24
BTR10	0.4	0	0	DRY	02/86	0
BTR11	0.9	0.001	0	DRY	09/86	0.1
BTR12	0.9	0.0004	0	DRY	03/86	0.01

Data summarized and rounded from Appendices A and B.
Hole locations shown in Figure 2-6.
* I = Increasing
S = Steady
D = Decreasing

Maximum seepage in the rocks near the excavation surface seems to take place approximately 11 to 19 months after excavation (Appendix A). This can be seen best in the data for BTR8 and BTR9, during the time period from November 1986 through July 1987. The same seems to occur in BTR6. Maximum seepage into BTR2 appears to occur between December 1986 and March 1987 and into BTR3 between March 1987 and October 1987.

All of these holes have now stopped producing measurable quantities of brine. They are no longer monitored as part of the BSEP.

2.1.5 Damp or Wet Areas on Floors

Moist areas have been observed on the floor of the WIPP workings and have previously been discussed by Deal and Case (1987) and Deal and others (1987). Presently, there is only one sizeable, persistently, moist area.

Room G was excavated in November 1984. In August 1985, a small area of damp muck along N1100 was noticed on the floor at approximately E1140, adjacent to the south rib. In November 1985, the damp area had expanded in size to approximately 5 meters east-west and approximately 4 meters north-south on the floor of the drift. The bedrock salt floor at this location is covered with several inches of partially consolidated salt muck saturated with brine, which was evaporating into the repository air, forming a salt crust and cementing the surface of the muck. In November 1985 a small pit was excavated by hand through the salt muck down to the level of the bedrock. Brine inflow measurements were made by evacuating this small sump, but only partial dewatering of the saturated muck on the floor of the drift was achieved. As noted in Deal and others (1987), the resulting values calculated for seepage rates in terms of liters per day are quite irregular as a result of incomplete and inconsistent dewatering of the muck (Appendices A and B).

Additionally, it was realized that a reduction in the frequency of brine collection from every week or two to once a month in November 1986 resulted in seemingly reduced seepage rates. Approximately the same amount of brine was being collected each time, probably because that was the maximum amount of brine that could be collected with the existing techniques, regardless of whether collections took place every 2 weeks or every month. In July 1987, we returned to sampling every week or two, and the calculated seepage rates returned to the same values we had obtained earlier. It seems clear that the apparent reduction of inflow rates between November 1986 and July 1987 reflects changes in sampling technique rather than a change in the actual seepage rate.

To improve our ability to sample at this location, a small sump, approximately 45 centimeters deep and 45 centimeters in diameter, was drilled in the floor at this location. The idea was to provide a drain and collecting sump for the brine that saturated the muck on the floor, and not to drill a "well" to a brine-producing zone. The sump has worked quite well; brine can be seen slowly seeping into the sump at the muck-bedrock interface 2 or 3 centimeters below the floor. A generalization of the data is that the seep in Room G has been producing approximately 0.5 liter of brine per day from December 1985 through December 1988. Over 440 liters of brine have been collected and measured in that time and more brine is known to have evaporated into the repository air.

The chemical data for the brine collected from G Seep (Section 3.1.3) indicate differences from the brine obtained from uncontaminated downholes. Evaporation is obviously taking place at G Seep, but that alone is not sufficient to account for all the differences in the brine chemistry. In order to obtain better seepage numbers and brine chemistry that may be less altered by evaporation, the collecting sump was fitted with a cover made from brattice cloth in August 1988.

2.2 MEASUREMENT OF RIB WEEPS: QUANTITATIVE ESTIMATES OF SALT ENCRUSTATION WEIGHTS AND INFERRED BRINE VOLUMES

2.2.1 Introduction

Small encrustations of precipitated salt tend to develop on newly excavated portions of the underground workings at the WIPP facility. The encrustations, sometimes called salt efflorescences, result from the evaporation of brine draining from the adjacent salt and often take the form of "buttons" or larger masses, depending upon the amount of brine available.

The salt efflorescences on the ribs are quite noticeable, thus are often the subject of comment when the topic of brine inflow arises, but quantification of the brine required to form them had not been attempted prior to this program. In order to quantify the amount and distribution of the brine, the amounts of salt that developed as encrustations were measured on selected portions of the ribs. Based upon the measurements, the amounts of brine required to form those encrustations were estimated.

2.2.2 Methods

Three areas with well-developed encrustations were selected. These are: (1) Area R1S, located on the south rib of S1950/W120; (2) Area R2S, located on the south rib at the extreme west end of Room G (N1100); and (3) Area R3S located on the east rib of W170/S1750.

At each location a randomly chosen section of rib was gridded on 0.3 meter intervals using a Ramset gun, nails, and nylon string. A total of 3.1 meters horizontally and 2.4 meters vertically were gridded, yielding a measured area of 7.4 square meters in all three cases. The grid was centered vertically between the back and the floor of the drifts and the position of the orange band and other stratigraphic markers were noted on the field data sheets. The encrustations within each square-meter area were carefully collected by scraping the wall and allowing the loosened material to fall into a tray held beneath the square. In general, the encrustations were surprisingly easy to remove, particularly if they were relatively wet.

The material from each square-foot area was placed into individual plastic bags, labeled, and sealed to prevent moisture loss. Upon return to the surface, the material from each square was weighed and heated to 250°C until the weight stabilized as water was lost from the sample. The dry weight of each sample was determined and the water loss from each sample was calculated as a percentage of loss compared to the original weight of the sample.

2.2.3 Data

The two quantities, dry weight and percentage water loss, were ascribed to the center of the gridded square for the purposes of further interpretation. It is recognized that for any given square-meter area, it is possible that some encrustation could have resulted from brine that flowed down the vertical surface from above. Similarly, some brine that seeped to the surface within the area may have flowed downward to lower areas before crystallizing.

Some additional uncertainties exist in the gridded values obtained for each square foot due to the collection techniques. Although care was taken to completely scrape the ribs of all encrusting material, some halite was left behind due to the inability to completely remove it in areas where the encrustation was merely a thin film on the rock surface. This type of error yields an underestimation of the encrustation weight. Conversely, sometimes small amounts of clay and salt not associated with the encrustation were incorporated in the samples. Although these amounts were small, their effect would be to provide overestimates of the dry weights of the samples. Given the listed uncertainties, the estimated accuracy of the dry weights due to sampling error is ±5 percent. The summary of the rib encrustation data for each 7.4-square-meter area is given in Table 2-4.

2.2.4 Discussion

The calculation based on the dry salt-encrustation weight results in the amount of brine required to produce the salt encrustations measured in each area. If the assumption is made that the brine totally evaporates, then the true volume of brine required to produce the weep accumulations would be underestimated. Krumhansl and others (1987) noted that chemical analyses of weep encrustations are deficient in magnesium in relation to typical brine geochemistries. They ascribed this difference to the difficulty in precipitating the highly soluble magnesium salts by evaporation into facility air at ambient temperatures, and they proposed that there is a loss of magnesium-rich liquids from the weep vicinity, perhaps through small cracks and fissures within the ribs. These cracks and fissures developed due to the creep closure of the rooms.

Estimation of the amount of brine required to form the weeps, therefore, must be corrected to reflect the greater proportion of halite in the weeps in relation to the halite content of the brines, based on sodium and chlorine concentrations. The following minerals appear to be the most important in the system $Na\text{-}K\text{-}Cl\text{-}SO_4\text{-}H_2O$:

Carnallite	$KMgCl_3 \cdot 6H_2O$
Sylvite	KCl
Halite	$NaCl$
Bischofite	$MgCl_2 \cdot 6H_2O$
Kainite	$MgSO_4 \cdot KCl \cdot 3H_2O$
Keiserite	$MgSO_4 \cdot H_2O$
Bloedite	$Na_2Mg(SO_4)_2 \cdot 4H_2O$
Leonite	$K_2Mg(SO_4)_2 \cdot 4H_2O$
Glaserite	$KNa_3(SO_4)_2$
Lowewite	$Na_{12}Mg_7(SO_4)_{13} \cdot 15H_2O$

Krumhansl and others (1987) performed x-ray diffraction studies of the weep encrustations from Rooms J and B in the experimental area. They determined that only halite and sylvite were volumetrically important, with kainite and carnallite being present occasionally. Although other mineralogic phases may occur in the encrustations as well, they probably do not affect the overall, gross composition of the encrustations. Of the phases recognized in the encrustations, only halite contains sodium.

TABLE 2-4
RIB ENCRUSTATION DATA

Sample Area	Original Weight (gm)	Avg. Water Loss (%)	Dry Weight (gm)	Date Excavated	Time Since Excavation
R1S	1538.34	11.3	1364.65	(12/04/86)	502 days
R2S	798.98	3.7	771.12	(01/02/85)	1211 days
R3S	361.02	12.8	314.80	(12/15/86)	520 days

To estimate the amount of brine required to form the salt encrustations, the following assumptions were made:

- The salt encrustations are comprised of halite and minor sylvite, with trace occurrences of carnallite and kainite.
- The average composition of the J Room salt encrustations (derived from analyses by Krumhansl and others, 1987) is representative of the salt encrustations sampled for the present study.
- The composite brine reported in Table 3-5 (UNC Geotech data) is typical of the brine which evaporated to form the salt encrustations.
- The minerals halite and sylvite control the molar Na/K ratio in the brine, and this ratio can be estimated from the cotectic point in the system Na-K-Cl-H_2O.

Using these assumptions and the supporting analytical data on the salt encrustations and brine, two independent mass balance equations were set up to account for the molar ratio of sodium to potassium in the brine (at the cotectic point) and in the salt encrustations. These equations were solved simultaneously to calculate the moles of sodium and potassium removed from a liter of brine (e.g., the moles of sodium precipitated as halite). Using the moles of sodium removed from the brine and mole fraction data for sodium in the salt encrustations, the total molar mass removed from the brine was calculated. The moles removed from the brine for other principal constituents in the salt encrustations (i.e., potassium, magnesium, chlorine, and sulfate) were then calculated from the mole-fraction and the total-molar-mass values. All molar values were converted to grams to yield a calculated evaporative precipitate of 233 grams per liter (g/L) of brine.

Given these values, an estimate on the upper bound for the volume of brine required to form the salt encrustations can be set using the expression

$$V_b = \frac{W_s}{233\ \text{g/L}} \tag{2.1}$$

where

V_b = The volume of brine required to form the salt encrustations,
W_s = Total dry weight of salt encrustations taken from the rib, and
233 g/L = The grams of solid precipitated from a liter of brine.

Based upon this relationship, the inflow rates can be calculated (Table 2-5), assuming that only the ribs on the long sides of the room contribute to flow (rib area for a storage room is equal to 91.4m x 4.0m x 2 ribs, or 731 square meters) and that the flow is constant over the entire rib area through time.

The assumption that the flow is constant with time over the entire rib area is probably not warranted. After 2 to 3 years, the encrustations cease to grow and become dry. Several explanations for the cessation in activity may be envisioned: (1) a decrease in driving pressure for the brine; (2) dewatering of the near field through the opening of cracks within the ribs; (3) macrofracturing, which cuts off the source of the brine; or (4) a combination of two or more of these factors. Comparing the 0.3-meter grid squares that have higher dry weight and greater water loss with the mapped geology at each location strongly suggests that encrustation development is a function of stratigraphy. Encrustations are best developed in the vicinity of this orange marker band (Map Unit 1, Figure 2-2) and clay F (just below Map Unit 5, Figure 2-2), and are least developed in the clear halite units.

There is a lateral variation along any given stratigraphic horizon that suggests the main development of encrustations appears to come from point sources that sometimes coalesce if the flow is sufficiently great. Field examination of the sources of encrustations confirms that the source seems to have a point origin in many cases.

These three sampling locations were revisited 1 year after the initial sampling and only very small amounts of encrustations had reestablished themselves. This is consistent with the observation (Deal and Case, 1987; Deal and others, 1987) that the encrustations cease to grow a few years after initial excavation.

TABLE 2-5

ESTIMATED BRINE FLUX TO 7.4 m^2 AND 731 m^2 RIB AREAS

Sample Area	Estimated Rib Flow in 7.4 m^2	Estimated Rib Flow in 731 m^2	Estimated Annual Rib Flow Rate Over The Total Time the Salt Encrustations Were Accumulating
R1S	5.9 liter	571 liter	415 liter/year
R2S	3.3 liter	323 liter	97 liter/year
R3S	1.4 liter	132 liter	93 liter/year

3.0 GEOCHEMICAL AND BACTERIOLOGICAL PROPERTIES OF THE BRINE

3.1 BRINE GEOCHEMISTRY

3.1.1 Introduction

A major objective of the BSEP has been to characterize the composition of brine collected from drillholes in the Salado Formation at the facility horizon. Characterized brines will be used to estimate the chemistry of a composite brine that may develop after closure of the repository (Deal and Case, 1987).

The BSEP has been hindered by difficulties (addressed below) encountered in the sampling and analysis of brines. Recently, quantitative data utilizing state-of-the-art analytical techniques for brine chemistry have become available and over 160 brine samples, from 25 drillholes in the Salado Formation at the WIPP, have been analyzed by two independent laboratories, UNC Geotech in Grand Junction, Colorado and IT-Export in Pittsburgh, Pennsylvania for up to 25 chemical parameters. Two laboratories are used to provide an independent check on data precision and accuracy. The results obtained from the two laboratories may be slightly different for a given constituent, primarily due to the use of different analytical techniques (see Section 3.1.2). UNC Geotech has been used as the principal laboratory for analyses, and several samples with a limited quantity of brine were exclusively analyzed by UNC Geotech. A complete listing of the drillhole number, analytical lab, date, and analytical parameters for each analysis is presented in Appendix C.

3.1.1.1 Sampling Problems

Brine sampling procedures and problems have been documented in the BSEP Phase I report (Deal and Case, 1987). The most notable observations and problems are:

- The inflow rates appear to depend on the number of thin clay and anhydrite beds or open fractures intersected by drillholes,
- The chemistry of some samples has been altered by exposure to mine ventilation air during the collection and sampling process,
- The difficulty in collecting all downhole brine due to salt crystals and waste rock from mining activities interfering with check-valve seating and bailing techniques,
- The difficulty of placing airtight seals around uphole collars to prevent brine evaporation,

- The difficulty in recovering a sufficient sample volume from soil moisture sampling devices placed in horizontal holes, and
- The presence of organic solvents and fluids associated with mining activities that have contaminated some sampling holes.

These observations and problems affect the collection and analytical results of BSEP brines. Variable and low-inflow rates of brine to the drillholes preclude following the sampling and protocol procedures established by the U.S. Environmental Protection Agency (National Water Well Association/U.S. Environmental Protection Agency, 1986). Additionally, a sufficient volume of brine for analysis (e.g., ~ 1 liter) may take a week to several months to accumulate; thus, brine samples recovered for analysis are exposed to mine ventilation air for some period of time.

Collection of limited volumes of sample from upholes (drillholes placed into the back of the drift) and horizontal holes (drillholes placed into the ribs of the drift) has resulted in very few analyses for these holes, relative to downholes (drillholes placed into the floor of the drift). The chemistry of uphole samples has usually been modified by evaporation of water and precipitation of halite.

Analytical data obtained from collected brines must be interpreted cautiously. For instance, Eh and total inorganic carbon (TIC) measurements obtained from collected brine may reflect equilibration with atmospheric gases. Furthermore, long sample-accumulation periods increase the probability of evaporation and possible contamination by fluids from mining activities and/or spreading of brine on the drift floors for dust control.

3.1.1.2 Analytical Problems

Most routine analytical techniques used on aqueous solutions with low total dissolved solids (TDS), such as atomic-absorption spectroscopy (AAS) and inductively coupled-argon-plasma (ICAP) spectrometry, are difficult to apply to brine without some modification or substitution of an alternative technique. Some of the most frequent problems associated with the analysis of brines are:

- High TDS will plug the nebulizer (AAS and ICAP) and severely disturb the flame (AAS) or plasma (ICAP), resulting in high backgrounds. Therefore, the sample is diluted prior to analysis, which results in poor precision for trace elements.

- Solutions with high TDS commonly encounter matrix enhancements, resulting in higher apparent concentrations for some major and trace elements. High concentrations of sodium and potassium in solution commonly cause this type of enhancement.

- High concentrations of alkaline earth metals (e.g., calcium and magnesium) can cause elemental interferences with many trace elements of interest using AAS and ICAP. Unless properly corrected, erroneous results will be reported.

- Unusually high ratios of elements within a group, such as the halogens, can cause large errors in specific ion-electrode determinations (e.g., chlorine masking fluorine when measured by an LaF electrode). Procedures utilizing specific ion electrodes have to be modified to include standard addition techniques to eliminate possible interferences.

The UNC Geotech and IT-Export laboratories have interacted closely to identify areas of concern for the analysis of brines. For some types of analyses, existing methods were modified or alternate methods were used (e.g., iodine by ion chromatography [UNC Geotech] and silica by flow-injection analysis [IT-Export]). Table 3-1 summarizes the analytical techniques used by the laboratories.

3.1.1.3 Contamination of BTP and DHP402A Holes

All BTP samples and DHP402A samples collected on August 22, 1988, display aberrant results compared to the majority of brine samples analyzed. BTP samples have high pH, calcium and strontium values, and low bromine and boron concentrations when compared to a typical BSEP brine (DH36, Table 3-2). DHP402A samples (collected August 22, 1988) have element concentrations which lie between representative BSEP brines and water present in the air intake shaft (AIS) sump (Table 3-2). Samples appearing in Appendix C with the BTP prefix and DHP402A (downholes) are considered contaminated for the following reasons:

- Some of the BTP holes have been grouted during completion activities and leaching of the grout material could be occurring if the brines are in contact with the grout (e.g., high pH and calcium values and multiple inflection points on alkalinity titration curves [Figure 3-1], probably from organic acids in the grout).

- Water present in the AIS sump, mostly Culebra water modified by dissolution of salts in the AIS and variable amounts of construction brine (B & E brine in Table 3-2), is collected and spread underground to minimize dust in the mine. An effort has been made to restrict spreading in areas where BSEP holes occur, but spreading has occurred in the area of BTP and DHP402A holes.

TABLE 3-1

ANALYTICAL METHODS USED IN THE ANALYSIS OF BSEP BRINES

PARAMETER MEASURED	ANALYTICAL METHOD	
	UNC GEOTECH	IT-EXPORT
SG & TDS	Gravimetric	Gravimetric
pH	Electrometric	Electrometric
Alkalinity	Titrimetric	Titrimetric
Br	Ion chromatography	Spectrophotometric
Cl	Mohr's titration	Titrimetric
F	Ion chromatography	Potentiometric
I	Ion chromatography	Titrimetric
NH_4^+	Spectrophotometric	Titimetric
NO_3^-	Ion chromatography	Ion flow injection
PO_4^{-3}	Ion chromatography	Was not determined
SO_4^{-2}	Ion chromatography	Spectrophotometric
TIC	Coulometric titration	Coulometric titration
TOC	Coulometric titration	Was not determined
Al	AAS, furnace	ICAP
As	AAS, flameless	AAS, furnace
B	ICAP	ICAP
Ba	ICAP	ICAP
Ca	ICAP	ICAP
Fe	ICAP	ICAP
K	AAS, flame	ICAP
Mg	ICAP	ICAP
Mn	ICAP	ICAP
Na	AAS, flame	ICAP
Si	ICAP	Ion flow injection
Sr	ICAP	AAS, flame

AAS = Atomic-absorption spectroscopy.
ICAP = Inductively-coupled-argon-plasma spectroscopy.

TABLE 3-2

ANALYSES OF AIR INTAKE SHAFT (AIS) SUMP, B & E, BTP-C1, CULEBRA, DH36, AND DHP402A WATERS⁽¹⁾

	pH	EAlk mg/L	Br mg/L	Cl mg/L	SO_4^{-2} mg/L	B mg/L	Ca mg/L	Mg mg/L	K mg/L	Na mg/L	Sr mg/L
S	7.1	122	42	188000	6170	13	953	1040	1720	118000	31
& E		195		189000	4063		1840	72		122000	
P-C1	8.0	348	358	192000	11600	116	554	6630	9690	106000	51
lebra*	7.9	99	22	20500	5650	30	1000	515	410	12500	12
H 36	6.0	831	1450	195000	16300	1490	340	18300	18200	87200	1
HP402A	6.2	451	95	192000	14800	640	469	12900	10700	93200	20

BTP-C1 mean values calculated from data in Appendix C. B & E drilling brine from Deal (written communication). S, DH36 and DHP402A (August analyses) are averages taken from Appendix D (UNC Geotech values). Extended kalinity (EAlk) as HCO_3^-.

nalysis taken from Culebra water entering air intake shaft (Lyon, 1989).

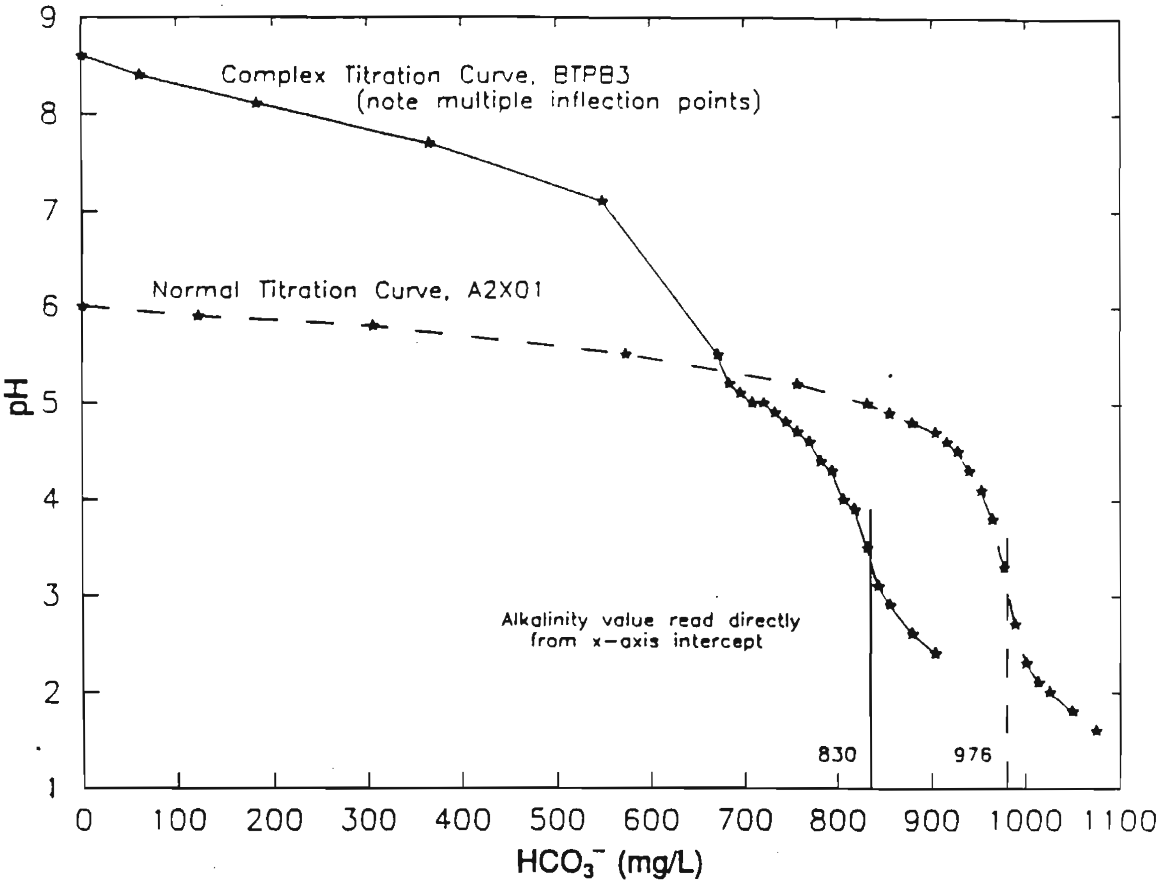

FIGURE 3-1 EXTENDED–ALKALINITY–TITRATION PLOT FOR HOLES BTPB3 AND A2X01 (SAMPLES 212 AND 214, APPENDIX C)

- Organic solvent vapors are frequently noted during sampling of BTP holes (see total organic carbon [TOC] values in Table 3-3), indicating contamination of these holes.

BTP and DHP402A (August analyses) brines may contain a component from AIS water because most of their parameter values lie between those representing AIS and typical BSEP brine (DH-36, Table 3-2). However, simple mixing of AIS and DH-36 brines cannot account for BTP and DHP402A brine compositions, reflecting the uncertainty in knowing the true composition of the AIS water on the date it was spread and the amount of dissolution and sorption that may have occurred as the spread water passed through salt on the drift floors.

Based on the evidence outlined above, BTP and DHP402A analyses do not represent true BSEP brine compositions and have not been considered in statistical calculations and further discussions. DHP402A results from the September 27, 1988, sampling round show less contamination than results for August 22, 1988 (Appendix C), suggesting typical BSEP brine may be recovered from this hole in future sampling rounds. There is no chemical evidence to suggest that the remaining BSEP brines contain components derived from carbonate waters in the overlying Rustler Formation or brines from the underlying Castile Formation.

3.1.2 Analytical Results

BSEP brines were analyzed for 25 parameters (Table 3-1) that were chosen for the following reasons:

- Seventeen are important seawater components (sodium, magnesium, calcium, potassium, chlorine, bicarbonate, sulfate, boron, silicon, strontium, manganese, fluorine, iodine, barium, phosphate, ammonium, nitrate) and, because BSEP brines are thought to represent seawater that has been evaporated to halite facies deposition, their concentrations must be measured to evaluate brine evolution models.

- Silicon, aluminum, and iron concentrations are useful parameters for evaluating clay diagenesis.

- TIC and TOC were measured to determine their contributions to the alkalinity values.

- Specific gravity and TDS are physical parameters that characterize the gravimetric properties of the brines, and are required in aqueous-speciation models to calculate molal concentrations (moles/kg H_2O) from data reported as milligrams per liter (mg/L).

TABLE 3-3

RESULTS (mg/L) FOR TOTAL INORGANIC CARBON (TIC), TOTAL ORGANIC CARBON (TOC), ALCOHOL, PHENOL, AND MONOCARBOXYLIC ACIDS

SAMPLE	#HOLE	TIC[1]	TOC[1]	METHANOL	ETHANOL	2-PROPANOL	1-PROPANOL	PHENOL	ACETIC ACID	PROPIONIC ACID	ISOBUTYRIC ACID	BUTYRIC ACID	ISOVALERIC ACID	VALERIC ACID
245-C	BTP B1	102		<5	<5	<5	<5	<1	<5	<5	<5	<5	<5	<5
245-D	BTP B1		472					<1						
247-C	BTP C1	91		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
247-D	BTP C1		406					<1						
254-C	DH-42A	3.6		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
254-D	DH-42A		15.7					<1						
260-C	DH-38	4.6		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
260-D	DH-38		12.7					<1						
265-C	DH-36	3.6		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
266-D	DH-36		4.1					<1						
275-C	G-SEEP	2.0		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
276-D	G-SEEP		7.1					<1						
281-C	G-SEEP	2.0		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
282-D	G-SEEP		12.2					<1						
293-C	BX-01	6.1		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
293-D	BX-01		22.4					<1						
294-C	BX-01	5.6		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
294-D	BX-01		25.4					<1						
301-C	A1X02	1.5		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
302-D	A1X02		6.6					<1						
309-C	NG252	6.6		<5	<5	<5	<5		<5	<5	<5	<5	<5	<5
310-D	NG252		2.5	<5	<5	<5	<5	<1	<5	<5	<5	<5	<5	<5

Analyses by Battelle. C and D represent, respectively, unacidified and acidified samples. Less than sign (<) indicates below detection limit.

[1] Reported as equivalent HCO_3

- Arsenic was determined to investigate its usefulness as a redox couple, whereas barium concentrations are needed to investigate solid-solution behavior with celestite and possible substitution into anhydrite.

Brine analyses are listed in Appendix C and statistical calculations of the mean and standard deviation appear in Appendix D. The data in Appendix C represent sampling and analyses carried out over the periods April 1987 through September 1988 for UNC Geotech, and November 1987 through July 1988 for IT-Export. Four of the 17 uncontamiated holes (see Figure 2-1 for their locations) have yielded a single analysis (A2X02, BTR8, BTR9, DH15, and DH40), and 13 have two or more analyses each (A1X01, A1X02, A2X01, A3X01, BX01, DHP401, DH36, DH38, DH42, DH42A, GSEEP, L1X00, and NG252). Holes with a single analysis were not used in statistical calculations and are not discussed below. Ranges in values for the mean and standard deviation were calculated for the 13 holes listed above. Minimum and maximum standard deviation and mean values reported in the text are followed by identification of the analytical laboratory that provided the results.

Each of the analytical groups (IT-Export and UNC Geotech) has been treated separately in the data reduction to evaluate variations in brine chemistry resulting from different procedures and techniques within laboratories. A relative measure of these differences is the range of minimum and maximum values for the mean and standard deviation (Table 3-4). Differences in the number of significant figures reported for a given analyte (Table 3-4) result from variation in the analytical techniques of the laboratories (Table 3-1) and dilution factors. Tables 3-1 and 3-4 should be referred to when the presentation of results cites analytical methods and/or range values.

To simplify presentation and discussion of the statistical results in Appendix D, the parameters in the data base have been divided into four sets, distinguished by the physical and chemical properties of mass, element complexes, halogens, and metals. The members of each set are as follows:

- Set One: Specific gravity and TDS,
- Set Two: Alkalinity (titrated to endpoint pH = 4.5), extended alkalinity (titrated to endpoint pH = 2.5), TIC, TOC, nitrogen (ammonium and nitrate), phosphate, and sulfate,
- Set Three: Bromine, chlorine, fluorine, and iodine, and

TABLE 3-4

RANGE OF MEAN (X) AND STANDARD DEVIATION (S) VALUES FOR BSEP BRINES FROM THE WIPP REPOSITORY HORIZON

IT Export (7 holes)

	SG g/cc	TDS mg/L	pH mg/L	EAlk mg/L	Alk[a] mg/L	Br mg/L	Cl mg/L	F mg/L	I[b] mg/L	NH_4^+ mg/L	NO_3^-[c] mg/L	SO_4^{-2} mg/L	TIC[d] mg/L
X min	1.21	330000	5.7	693		1280	173000	5	21	108	0.03	15200	5
X max	1.23	350000	6.1	925		2000	199000	8	22	150	0.70	33100	5
S min	<0.01	2000	0.0	9		40	3000	1	1	9	0.01	600	0
S max	0.02	11000	0.2	88		270	11000	2	2	20	1.01	2200	0

	Al[e] mg/L	As mg/L	B mg/L	Ba[e] mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr
X min		0.006	1480		260	2	16100	16400	0.8	67500	0.4	1.0
X max		0.020	1860		330	4	20800	32500	5.1	98700	0.8	6.9
S min		0.001	40		5	0	300	400	0.0	900	0.1	0.1
S max		0.010	160		39	1	2100	1800	0.2	10600	0.2	0.3

UNC Geotech (13 holes)

	SG g/cc	TDS mg/L	pH	EAlk mg/L	Alk[d] mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NH_4^+ mg/L	NO_3^-[f] mg/L	SO_4^{-2} mg/L	TIC mg/L
X min	1.22	368000	5.6	818	783	1340	187000	4.9	12.2	145	3	16000	2.8
X max	1.25	402000	6.4	1253	911	2410	202000	10.9	17.9	205	10	31800	95.1
S min	<0.01	3000	0.1	13	11	20	1000	0.8	0.7	5	1	700	1.2
S max	0.01	39000	0.6	265	66	510	9000	2.3	8.3	40	11	3700	94.5

	Al[g] mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe[g] mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr
X min	0.109	0.001	1420	0.015	270	0.25	15100	16200	0.67	50800	1.22	0.87
X max	0.989	0.012	1880	0.074	381	15.60	22700	44300	7.99	94700	5.14	5.89
S min	0.080	0.000	80	0.002	11	0.02	300	900	0.03	400	0.14	0.06
S max	0.833	0.006	240	0.057	65	15.50	2700	3000	0.66	4800	2.60	0.77

Reported ranges taken from the results of simple statistic calculations appearing in Appendix D. Abbreviations as follows: TDS = Total dissolved solids; EAlk = extended alkalinity (titrated to endpoint pH of 2.5); Alk = alkalinity (titrated to endpoint pH of 4.5); TIC = total organic carbon. EAlk, Alk, and TIC reported as equivalent HCO_3.

Key:

[a] Analyses not available.
[d] Analyses available for 5 holes.
[g] Analyses available for 12 holes.
[b] Analyses available for 3 holes.
[e] Below detection limit.
[c] Analyses available for 6 holes.
[f] Analyses available for 10 holes.

- Set Four: Aluminum, arsenic, barium, boron, calcium, iron, magnesium, manganese, potassium, silicon, sodium, and strontium.

3.1.2.1 Set One Parameters

3.1.2.1.1 Specific Gravity (SG)

Mean values for SG range from 1.21 to 1.23 (IT-Export) and 1.22 to 1.25 (UNC Geotech) grams per cubic centimeter (g/cc), with standard deviations less than 0.02 g/cc (Table 3-4). There is excellent agreement between laboratories on all samples.

3.1.2.1.2 Total Dissolved Solids (TDS)

TDS mean values show a range of 330,000 to 350,000 (IT-Export) and 368,000 to 402,000 (UNC Geotech) mg/L and standard deviations of 2,000 (IT-Export) to 39,000 (UNC Geotech) mg/L (Table 3-4). For identical splits of a sample, the IT-Export mean values are 30,000 to 40,000 mg/L lower than the UNC Geotech values. This difference probably results from IT-Export drying the precipitates at 180°C, which could result in dehydration of complex salts (e.g., $MgCl_2{:}6H_2O$ and $MgSO_4{:}7H_2O$), versus 105°C for UNC Geotech. To substantiate this hypothesis, UNC Geotech redetermined TDS on two NG252 samples (102 and 103, Appendix C; TDS = 377,000 mg/L at 105°C) at a temperature of 230°C and was able to obtain values within the range reported by IT-Export for NG252 (TDS = 328,000 to 347,000 mg/L, Appendix C).

3.1.2.2 Set Two Parameters

To facilitate comparison of results for alkalinity, extended alkalinity, TIC and TOC, these parameters are reported as equivalent bicarbonate (HCO_3^-).

3.1.2.2.1 Alkalinity and Extended Alkalinity

Results for alkalinity and extended alkalinity are reported as equivalent bicarbonate. Alkalinity (titrated to endpoint pH = 4.5) measurements were replaced by extended alkalinity (titrated to endpoint pH = 2.5) determinations in November 1988. The purpose of this extended titration is to identify any organic or weak inorganic acids that may be present and contributing to the alkalinity. As a result of this change, no alkalinity measurements are available for IT-Export results (i.e., no reported results prior to November 1988), and a limited number of holes (DH36, DH38, DH42A, GSEEP, NG252) analyzed by UNC Geotech prior to November 1988 have alkalinity and extended alkalinity measurements. UNC Geotech samples analyzed for alkalinity and extended alkalinity have extended alkalinity values 26 to 41 mg/L greater than alkalinity values. These differences may arise from low concentrations of TOC in BSEP brines (see Table 3-3) or protonation of weak acid species (e.g., $HB_4O_7^- + H^+ \rightarrow H_2B_4O_7$) during titration to a lower pH.

Extended alkalinity mean values range from 693 to 925 (IT-Export) and 818 to 1,253 (UNC Geotech) mg/L (Table 3-4). UNC Geotech results are 16 to 250 mg/L greater than results reported by IT-Export on similar holes. Differences greater than 60 mg/L are statistically significant and may arise from variations in the handling, storage, and hold times of the samples prior to analysis.

3.1.2.2.2 Total Inorganic Carbon (TIC)

TIC (reported as bicarbonate) was not determined on samples collected prior to February 1988. Samples analyzed by IT-Export were at or below the analytical detection limit of 5 mg/L. UNC mean values range from 2.8 to 95.1 mg/L and have standard deviations of 1.2 to 94.5 mg/L. Large standard deviations exist for BX01, DH36, and DH42 because of large increases in TIC concentrations reported for samples collected in November 1987, July 1988, and August 1988 (see Appendix C); thus mean values for these holes are anomalously high. Temporal and spatial variations within individual holes and among holes may be due to absorption of atmospheric carbon dioxide (CO_2) by the samples during collection, handling, and holding time prior to analysis. Variation is probably not related to analytical techniques, as determination of TIC is not known to have any interferences due to high TDS in solution.

The maximum TIC concentration (95.1 mg/L HCO_3^-) cannot account for the lowest extended alkalinity value (693 mg/L HCO_3^-), implying additional aqueous species must contribute to the alkalinity. Possible contributors to the alkalinity values observed in BSEP brines are organic acids (Section 3.1.2.2.3) and weak inorganic acids of ammonia (Section 3.1.2.2.4.), boron, silicon (both in Section 3.1.2.4.4), and aluminum (Section 3.1.2.4.2). However, only boron concentrations are sufficiently high to significantly contribute to the alkalinity values observed in BSEP brines (Section 3.1.3.2).

3.1.2.2.3 Total Organic Carbon (TOC)

To investigate whether organic carbon was contributing to the alkalinity, BSEP brine samples were sent to Battelle Memorial Institute-Columbus Division to be analyzed for TIC, TOC, short-chain alcohols and phenol, and short-chain aliphatic acid anions. The results are given in Table 3-3. TIC and TOC values (reported as equivalent bicarbonate) are generally very low, with the exception of two BTP holes contaminated by grout. Alcohol, phenol, and monocarboxylic acid contents were below the detection limit of the analytical method (<5 mg/L). The data in Table 3-3 confirm that neither organic acids nor TIC is responsible for the high alkalinity values. Weak inorganic acid ions of boron, ammonia, silica, and alumina could be contributing to the alkalinity. Of these, boron is the only parameter of sufficient concentration to account for the alkalinity (see Section 3.1.3.2).

3.1.2.2.4 Nitrate (NO_3^-) and Ammonium (NH_4^+)

The concentration of nitrate in the brines is low, generally below the detection limit of the IT-Export (0.02 to 0.04 mg/L) and UNC Geotech (3 to 10 mg/L) techniques. Six holes have multiple data reported above the detection limit. For these holes, the nitrate mean ranges from 0.03 to 0.70 (IT-Export) and 3 to 10 (UNC Geotech) mg/L (Table 3-4). Holes BX01, DH36, GSEEP and NG252 have data available from both analytical groups; the UNC Geotech mean is 3 to 10 mg/L greater than the IT-Export mean, probably due to different analytical techniques (see Table 3-1). It is difficult to place a high level of confidence in any of the nitrate concentrations because all values are near analytical detection limits.

Ammonium mean values range from 108 to 150 mg/L for IT-Export and 145 to 205 mg/L for UNC Geotech (Table 3-4). For identical holes, IT-Export values are 37 to 55 mg/L lower than those of UNC Geotech because their ammonium values represent nitrogen reported as ammonia (NH_3). A mass conversion was not performed on the IT-Export data due to a delay in receiving confirmation on their analytical method.

Concentrations of ammonium are one to three orders of magnitude larger than nitrate values, suggesting a redox state below +400 mv at pH = 6. This value should be considered an upper bound, due to the probable introduction of atmospheric oxygen, the low rates of equilibration of the redox couple, and the semivolatile nature of ammonia (Section 3.1.3.1). Ammonia is not stable in solutions with pH below 11 (Pourbaix, 1974) and, therefore, is deficient in BSEP brines (pH = 6).

3.1.2.2.5 Phosphate (PO_4^{-3})

IT-Export has not analyzed for phosphate in BSEP brines. UNC Geotech phosphate concentrations are below the detection limit (<1 mg/L) of the ion-chromatographic method, because BSEP brine samples must be diluted by a factor of 40 to keep the sulfate peak sharp on the elution pattern. However, quantitative phosphate values are necessary to assess the role of microorganisms in the performance of the repository. Therefore, alternative analytical techniques to obtain quantitative phosphate values are currently being investigated in cooperation with UNC Geotech.

3.1.2.2.6 Sulfate (SO_4^{-2})

The sulfate mean values range from 15,200 to 33,100 (IT-Export) and 16,000 to 31,800 (UNC Geotech) mg/L, with standard deviations of 600 (IT-Export) to 3,700 (UNC Geotech) mg/L (Table 3-4). Results from both laboratories on individual holes agree well. Mean sulfate concentrations for A1X02, L1X00, and GSEEP are 5,000 to 18,000 mg/L higher than for all other holes. This discrepancy can be satisfactorily accounted for in A1X02 and L1X00 by evaporation, because bromine, boron, and magnesium have higher concentrations and sodium a lower concentration (probably due to halite precipitation) relative to other holes. However, evaporation alone cannot explain the chemistry of the GSEEP samples because of the relative depletion of chlorine and magnesium and the high sodium concentrations. The anomalous composition of GSEEP is further addressed in Section 3.1.3.3.3.

3.1.2.3 Set Three Parameters

3.1.2.3.1 Bromine (Br) and Chlorine (Cl)

The ranges for bromine and chlorine mean values are, respectively, 1,280 to 2,000 (IT-Export) and 1,340 to 2,410 (UNC Geotech) mg/L, and 173,000 to 199,000 (IT-Export) and 187,000 to 202,000 (UNC Geotech) mg/L (Table 3-4). IT-Export values for Cl are 6,000 to 20,000 mg/L lower than UNC Geotech values and for bromine 50 to 500 mg/L lower, resulting in large positive charge balances in some IT-Export samples (see samples 423, 425, and 427, in Appendix C). This discrepancy between the laboratories may result from the slightly different titration method used for chlorine and the different analytical techniques used for bromine (Table 3-1).

3.1.2.3.2 Fluorine (F) and Iodine (I)

Mean values for fluorine range from 4.9 to 10.9 mg/L for UNC Geotech results and 5 to 8 mg/L for IT-Export determinations. IT-Export values were determined by an ion-specific LaF electrode and are generally 1 to 2 mg/L lower than values measured by ion chromatography at UNC Geotech. However, large standard deviations in the data of both analytical groups result in considerable overlap.

Not all samples were analyzed for iodine, and most IT-Export analyses are below their detection limit of 20 mg/L. The mean values for UNC Geotech determinations have a range of 12.2 to 17.9 mg/L. This range is typical of brines derived from seawater evaporation and probably represents a concentration factor from precipitation of salts and the breakdown of organic material (Hem, 1970).

3.1.2.4 Set Four Parameters

3.1.2.4.1 pH

The range in mean values for pH is 5.7 to 6.1 (IT-Export) and 5.6 to 6.4 (UNC Geotech) and, for identical holes analyzed by both analytical laboratories, they are commensurate within the standard deviation of either analytical group's mean. IT-Export values are typically 0.1 to 0.3 pH units below the UNC Geotech values. It is difficult to evaluate this discrepancy rigorously because of possible differences in travel time to the laboratories, temperature variation during transport, and holding time of the samples at the laboratories.

Field measurement of pH was conducted on BSEP brines sampled in September 1987. Laboratory pH measurements obtained on the same samples were 0.1 to 0.4 pH units lower than field measurements. However, these differences are not significant because they fall within the pH standard deviation of most holes. Additionally, low inflow rates of brine necessitated the recovery of samples that have resided in drillholes for 2 to 3 months. Thus, any change in pH will probably have occurred prior to sample collection and field measurements. For these reasons, field measurement of pH is no longer required. Further evaluation of the pH of BSEP brine is addressed in Section 3.1.3.1.

3.1.2.4.2 Aluminum (Al), Arsenic (As), Barium (Ba), and Iron (Fe)

Results for aluminum, arsenic, barium and iron are inconclusive for the following reasons:

- Low concentrations in brines,
- Analytical problems associated with higher detection limits as a result of dilution factors,
- Possible iron contamination from instruments placed in sampled drillholes, and
- Large standard deviations (generally greater than 50 percent of the mean value) among all samples.

3.1.2.4.3 Calcium (Ca), Potassium (K), Magnesium (Mg), and Sodium (Na)

Ranges for the mean values of major cations in BSEP brines are: sodium, 67,500 to 98,700 (IT-Export) and 50,800 to 94,700 (UNC Geotech) mg/L; magnesium, 16,400 to 32,500 (IT-Export) and 16,200 to 44,300 (UNC Geotech) mg/L; potassium, 16,100 to 20,800 (IT-Export) and 15,100 to 22,700 (UNC Geotech) mg/L; and calcium, 260 to 330 (IT-Export) and 270 to 381 (UNC Geotech) mg/L (Table 3-4). Standard deviations are generally less than 5 percent of the mean for sodium, magnesium, potassium, and calcium, but approach 10 percent on measurements from upholes.

Drillholes with multiple rounds of sample analyses (e.g., BX01, DH36, and NG252) display a complex temporal trend for magnesium and, to a lesser extent, for sodium. Over the 16-month sampling period, magnesium concentrations have a tendency to decrease as sodium concentrations increase. Upon closer inspection, these trends show discontinuities (increase in magnesium and decrease in sodium) during the September 1987 to November 1987 period. These temporal trends are addressed in more detail in Section 3.1.3.3.1.

3.1.2.4.4 Boron (B) and Silicon (Si)

Ranges for the mean boron and silicon values in BSEP brines are, respectively, 1,480 to 1,860 (IT-Export) and 1,420 to 1,880 (UNC Geotech) mg/L, and 0.4 to 0.8 (IT-Export) and 1.22 to 5.14 (UNC Geotech) mg/L (Table 3-4). Standard deviations for boron are less than 10 percent of the mean for downholes and approach 20 percent for upholes, while silicon standard deviations are 10 to 40 percent of the mean value. Silicon values reported by IT-Export are three to seven times lower than those reported by UNC Geotech. This difference is statistically significant and probably results from differences in the analytical methods used by each laboratory (Table 3-1).

The high boron concentrations and near neutral pH of the brines suggest boron is present as the aqueous species $HB_4O_7^-$ and H_3BO_3 (Pourbaix, 1974). $HB_4O_7^-$ probably contributes to the large alkalinity values in excess of TIC (see Section 3.1.3.2). Silicon most likely forms the aqueous species SiO_2 and H_4SiO_4 or $H_3SiO_4^-$ (Pourbaix, 1974). The latter silicon specie does not play a significant role in the high alkalinity values because of low silicon concentrations.

3.1.2.4.5 Manganese (Mn) and Strontium (Sr)

Ranges for the mean concentration levels of the trace elements manganese and strontium are, respectively, 0.8 to 5.1 (IT-Export) and 0.67 to 7.99 (UNC Geotech) mg/L and 1.0 to 6.9 (IT-Export) and 0.87 to 5.89 (UNC Geotech) and mg/L (Table 3-4). Standard deviations are 5 to 40 percent of the mean, with higher values for manganese relative to strontium. In general, UNC Geotech samples have lower standard deviations than identical IT-Export samples. The manganese concentrations are two to three orders of magnitude higher than seawater and strontium concentrations are equal to or an order of magnitude lower than seawater (Hem, 1970). These trends toward manganese enrichment and strontium depletion, relative to seawater, are addressed in Section 3.1.3.4.

3.1.2.5 Composite Brine Chemistry

The Statistical Analysis Software package (SAS Institute, Inc., 1985) and simple statistics were used to characterize an average composition for brine that might develop at the repository horizon. Multivariate-analysis-of-variance calculations (Walpole and Myers, 1985) were carried out on analytical results obtained during the period November 1987 through August 1988. Input parameters to the statistical programs were pH, bromine, chlorine, sulfate, ammonium, boron, calcium, potassium, magnesium, sodium, silicon, and strontium. Alkalinity, extended alkalinity, fluorine, iodine, nitrate, TIC, aluminum, arsenic, barium and iron were omitted from the calculations due to an insufficient number of analyses, results that were at or below the detection limit of the analytical technique, and/or contamination of brines by in-hole instrumentation.

A model was developed to test (at the 95-percent confidence level) for significant differences in the parameter mean values among individual holes. Application of a multiple-range test (which determines if mean values can be grouped into one or more populations) grouped those holes which did not have significantly different means. Each analytical group was modeled separately, because IT-Export analyses consistently showed excess positive charge balance (i.e., greater than 2 percent) relative to UNC Geotech. Results of the modeling and simple statistical calculations are given in Appendix D; the IT-Export and UNC Geotech composite brines are listed in Table 3-5. For parameters entered into the statistical program, composite brine values represent averages derived from the mean values of holes grouped by the multiple-range test (Appendix D). The composite brine values for parameters that were not entered into the statistical program were calculated by averaging the mean values on holes that were consistently grouped as similar by the

TABLE 3-5

COMPOSITE BRINE CHEMISTRY FOR IT-EXPORT AND UNC GEOTECH ANALYTICAL GROUPS

	SG g/cc	TDS mg/L	ph	EAlk mg/L	Alk mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NH4$^+$ mg/L	N03$^-$ mg/L	S04^{-2} mg/L	TIC mg/L	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L
<u>IT</u>																									
N	5/5	5/5	6/7	5/5	*	6/7	5/7	5/5	2/5	5/7	5/5	5/7	4/5	5/5	5/5	6/7	5/5	3/7	5/5	3/7	3/7	4/7	5/7	4/7	4/7
X	1.21	340000	6.1	818	*	1370	183000	6	22	116	0.23	16200	5	BDL	0.016	1540	BDL	327	3	20100	18400	1.2	84800	0.6	1.4
<u>UNC</u>																									
N	6/6	6/6	13/13	6/6	6/6	9/13	8/13	6/6	6/6	9/13	6/6	9/13	6/6	6/6	6/6	10/13	6/6	9/13	6/6	5/13	5/13	5/13	6/13	11/13	8/13
X	1.22	375000	6.1	881	817	1380	194000	6.1	15.0	158	6	17000	37	0.397	0.005	1480	0.031	328	2.44	18100	18200	1.07	85400	2.25	1.29

All available holes (IT =7, UNC = 13) were utilized in multivariate-analysis-of-variance (MANOVA) calculations. Alkalinity (Alk), F, I, NO_3, total inorganic carbon (TIC), Al, As, Ba and Fe were not used in MANOVA calculations because data were limited for these parameters. Extended alkalinity (EAlk), specific gravity (SG) and total dissolved solids (TDS) were not input to MANOVA calculations because data lines were limited to 60 columns. Averages calculated for the excluded parameters (using simple-statistic mean values in Appendix D) were obtained from holes which were consistently grouped as similar by Duncan's multiple-range test (carried out with MANOVA calculations). For IT-Export, these holes were BX01, DH36, DH38, DH42A and NG252. Simple averages for UNC Geotech were calculated from the same five holes utilized for IT-Export averages and additionally DH42. EAlk, Alk and TIC reported as equivalent HCO_3.

*Analyses not available for IT-Export.
BDL = Below Detection Limit
N = Number of samples used/total number of samples.
X = Sample mean (based on number of samples used)

multiple-range test (i.e., BX01, DH36, DH38, DH42A, and NG252). Holes A1X02, DHP402A, GSEEP and L1X00 were consistently rejected by the multiple-range test and have not been used in calculating the composite brine chemistry.

The upholes (A1X02 and DHP401) were rejected because their brine chemistry was modified by evaporation, as evidenced by the formation of halite stalactites around uphole collars (Deal and Case, 1987). GSEEP (described in Section 2.1.5) is located some distance downdip from an active experimental area (Room J) where grouting, artificial brines, and fresh water have been introduced. Excavation-induced fracturing (subparallel to drift floor) may have opened flow paths in Marker Bed 139 extending from Room J to GSEEP (Figures 2-1 and 2-2). Therefore, contamination of GSEEP cannot be ruled out (Section 3.1.3.3.3). There are a large number of grouted test holes close to hole L1X00; brine analyses from this hole may also reflect contamination from grout.

Results presented in Table 3-5 show good agreement between the analytical laboratories except for the parameters TDS, extended alkalinity, chlorine, iodine, ammonium, nitrate, TIC, potassium, and silicon. These differences probably result from variations in holding times of samples, laboratory techniques, and analytical methods (see Table 3-1). Based on UNC Geotech's better charge-balance totals (usually -2 percent to 2 percent), we suggest their averages should be adopted as the best estimate for a composite-brine chemistry at this time. However, further studies dealing with the spatial frequency and volume percent of anomalous brines (i.e., brines rejected as part of the population based on the statistical evaluation) are needed to evaluate whether they contribute significantly to the composite chemistry.

3.1.3 Discussion

3.1.3.1 Evaluation of pH and Eh in Brines

Solution pH and Eh values are critical parameters to constrain in all solution-equilibrium models. Unfortunately, the high ionic strengths of BSEP brines (> 7) suggest an uncertainty may be introduced in the measurement of pH by standard glass-electrode techniques. This uncertainty was evaluated by investigating independent controls on the brine pH, such as mineral/brine equilibria as it pertains to magnesite ($MgCO_3$). Magnesite was chosen over other carbonate minerals because it is present as a minor phase in the repository horizon (Stein and Krumhansl, 1988).

Eh values for surface and ground waters frequently show disequilibrium between redox couples and platinum-electrode measurements (Lindberg and Runnells, 1984). However, isolated brines in the Permian Castile Formation (underlying the Salado Formation) show good agreement between measured Eh values and those obtained from sulfate/sulfide and ammonium/nitrate redox couples (Popielak and others, 1983 - Table C-2). Unfortunately, BSEP drillholes in the Salado Formation have very low brine-inflow rates (Deal and Case, 1987 - Table E-20) and atmospheric oxygen (O_2) probably diffuses into the brine prior to collection. Exposure of brine samples to air during the collection process introduces uncertainties to the field measurement of Eh and calculated redox-couple values. An Eh value for BSEP brine was calculated with the ammonium/nitrate couple, but this value represents an upper bound due to low rates of equilibration for this couple and/or atmospheric oxygen diffusing into the brine prior to and during sample collection.

An average BSEP brine composition (Table 3-5, UNC Geotech data) was entered into the EQ3NR code (Wolery, 1983; Jackson, 1988; Pitzer option with data 0, ver. 3245R54) and equilibrated with magnesite to calculate the solution pH at T = 27°C, P = 1 bar, and Eh = +409 mV (Eh constrained by ammonium/nitrate equilibria). A specific redox value is not critical to the pH calculation because of the assumption that pH is controlled by carbonate equilibria. This was demonstrated by running the model at Eh = -400 mV and obtaining results identical to those calculated at Eh = +409 mV. Model results for an Eh range of -400 to +409 mV indicate a calculated pH of 6.0, overlapping with the mean range observed for glass-electrode measurements of 5.9 to 6.4 (Appendix D).

Wolery (1983) estimated the uncertainty in calculating the saturation indices (SI) of a particular phase as ± 0.4 SI units based on overall quality of the thermodynamic data base. Therefore, magnesite would be considered saturated if its calculated SI value was in the range of -0.4 to 0.4, which corresponds to a pH range of about 5.4 to 6.3. The modeling results suggest the magnesite/brine equilibrium is consistent with the measured pH variation in BSEP brines. However, no inference is made that the modeled Eh and pH values, or measured pH values, necessarily represent the "true" Eh and pH values of BSEP brines.

3.1.3.2 Solution Alkalinity

A question raised by the extended alkalinity (Section 3.1.2.2.1) is whether alkalinity measurements are much greater than the sum of TOC and TIC (all reported as mg/L

HCO_3^-). This suggests a noncarbonate source for most of the measured alkalinity. Organic acid species (Table 3-3) and weak acids of aluminum and silicon (e.g., $H_3SiO_4^-$) cannot account for the alkalinity because of their very low concentrations. Concentrations reported in Appendix C suggest the most reasonable contributor to the alkalinity is boron.

To determine the effect of boron on alkalinity, sodium tetraborate ($Na_2B_4O_7$) was added to a L1X00 brine (sample number 200; Appendix C) diluted 1:1 with distilled water. Sodium tetraborate was added to the brine because tetraborate species were the expected boron species in the brines (see Section 3.1.2.4.4). Dilution was required to avoid oversaturating the brine with halite (NaCl) upon addition of sodium tetraborate. Prior to the extended-alkalinity titrations, initial pH values were 5.8 for undiluted brine, 6.7 for diluted brine, and 7.3 and 7.4, respectively, for diluted brine spiked with 500 and 1,000 mg/L boron. The pH increases are probably due to dilution of the original brine, which lowers the activity of the hydrogen ion, and addition of sodium tetraborate to the diluted brine, which dissociates and consumes hydrogen ions according to the reaction

$$H^+ + B_4O_7^{-2} \rightarrow HB_4O_7^- \qquad (3.1)$$

All samples were titrated to an endpoint pH between 2.5 and 2 with 1.6N H_2SO_4. Results for the experiment are illustrated in Figure 3-2. The undiluted brine contains 2,070 mg/L boron and has an extended-alkalinity value of 1,100 mg/L bicarbonate, values twice those of the 1:1 diluted brine. Two successive titrations were carried out on the diluted brine, each after the addition of 500 mg/L boron to the solution. An alkalinity increase of 1,530 mg/L bicarbonate was measured after each successive titration. Based on similar boron concentrations (i.e., approximately 1,050 mg/L) and dissimilar extended-alkalinity values for undiluted brine and diluted brine spiked with 1,000 mg/L boron (Figure 3-2), the dominant boron specie in each of these respective brines is probably H_3BO_3 and $HB_4O_7^-$.

Figure 3-3 plots boron concentration against pH for the system boron and water at 25°C (Pourbaix, 1974) and supports the contention that H_3BO_3 and $HB_4O_7^-$ are the dominant aqueous species in solutions with high boron concentrations and pH between 4 and 9. Results of the boron-extended-alkalinity experiment and a composite brine (Table 3-5, UNC Geotech values) are also shown in Figure 3-3. The unspiked brines (undiluted and diluted

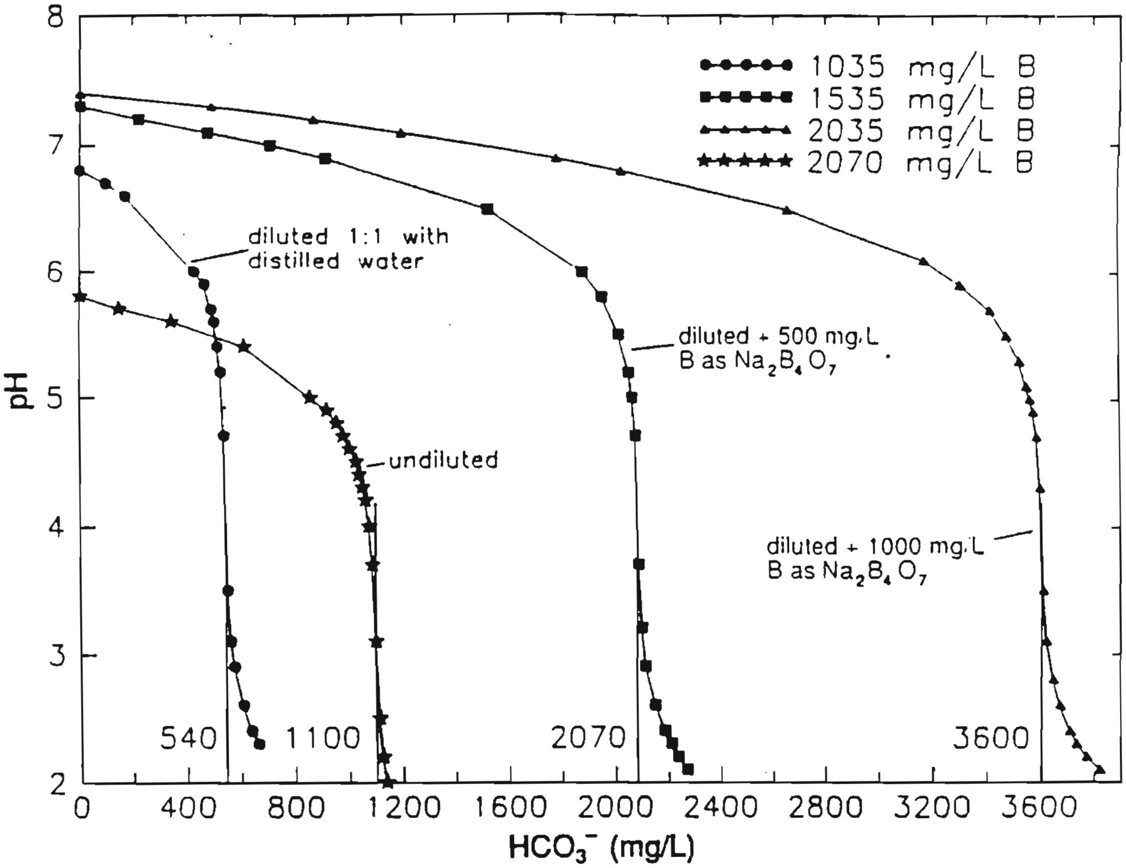

FIGURE 3-2 EXTENDED-ALKALINITY-TITRATION PLOT FOR L1X00 BRINE. INFLECTION POINTS INDICATED BY VERTICAL LINES. ALKALINITY READ DIRECTLY FROM X INTERCEPT

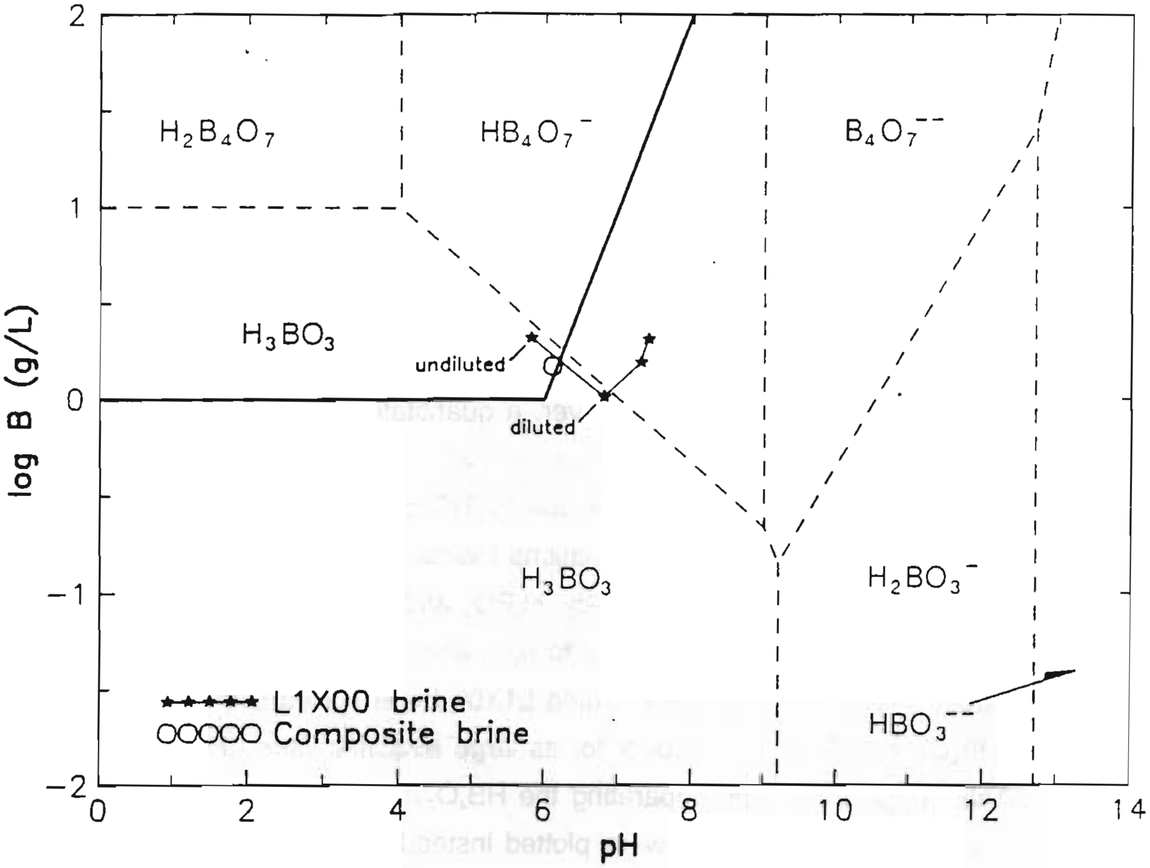

FIGURE 3-3 LOG OF BORON CONCENTRATION VERSUS pH FOR THE SYSTEM B–H_2O AT 25°C (AFTER POURBAIX, 1974). DILUTION OF L1X00 BRINE CAUSES COMPOSITION TO PARALLEL H_3BO_3/HB_4O_7 JOIN. ADDITION OF $Na_2B_4O_7$ TO DILUTED L1X00 BRINE DRIVES COMPOSITION INTO $HB_4O_7^-$ FIELD. SOLID LINE INDICATES EMPIRICAL SATURATION BOUNDARY FOR H_3BO_3.

L1X00 and composite from Table 3-5) lie near the $H_3BO_3/HB_4O_7^-$ line and the boron-spiked L1X00 brines lie within the $HB_4O_7^-$ field. It is important to reiterate that the pH shift in boron-spiked L1X00 brines, relative to undiluted L1X00 brines, places them in the $HB_4O_7^-$ field, which increases their capacity to buffer the titration and results in higher extended-alkalinity values for a given boron concentration (Figure 3-2). Undiluted brines lie above the empirical saturation boundary for boric acid; thus boric acid may be present in precipitated material found in some brine samples upon arrival at the analytical laboratories.

Unfortunately, there is a lack of thermodynamic data on aqueous boron species at high boron concentrations and evaluation of the $H_3BO_3/HB_4O_7^-$ ratio in the brines by speciation models (e.g., EQ3NR) is not possible. However, a quantitative assessment of the boron speciation in the brines can be made by assuming that boron species do not form metal complexes and all alkalinity in excess of that due to TIC can be accounted for by $HB_4O_7^-$ and $B_4O_7^{-2}$. Under these assumptions, calculations indicate the dominant species in unspiked and B-spiked brines are, respectively, H_3BO_3 and $HB_4O_7^-$ (Table 3-6). Unspiked brines have $H_3BO_3/HB_4O_7^-$ molar ratios of 5.8 to 6.7, whereas this ratio in boron-spiked brines is less than or equal to 0.2. The diluted L1X00 brine spiked with 1,000 mg/L boron must contain $HB_4O_7^-$ and $B_4O_7^{-2}$ to account for its large alkalinity value ($HB_4O_7^-/B_4O_7^{-2}$ = 2.9; Table 3-6). This suggests the line separating the $HB_4O_7^-/B_4O_7^{-2}$ fields (Figure 3-3) may lie at a lower pH value if boron activities were plotted instead of concentrations.

Alternatively, if hydrogen ions are consumed by association with chloride (Cl^- = 97,000 mg/L in diluted L1X00 brine) during the latter stages of titration (endpoint pH = 2.5 to 2), protonation of Cl^-, rather than $B_4O_7^{-2}$, may have occurred. This alternative hypothesis was tested by calculating (using the EQ3NR code) the activity product of HCl in the diluted brine and comparing this product to the equilibrium association constant at 25°C. This exercise led to the rejection of the alternative hypothesis because the activity product was an order of magnitude lower than the association constant. Therefore, a low concentration of $B_4O_7^{-2}$ probably contributes to the large alkalinity value in diluted brine spiked with 1,000 mg/L boron.

Figure 3-4 plots boron against extended alkalinity for all BSEP brines and the experimental results. Undiluted BSEP brines lie well above the trend defined by the diluted and spiked L1X00 brine because the former have lower pH values and, therefore, larger $H_3BO_3/HB_4O_7^-$ ratios. Very high alkalinity values in diluted and spiked L1X00 brine, relative to undiluted

TABLE 3-6

BORON SPECIE DISTRIBUTION COMPATIBLE WITH ALKALINITY VALUES IN COMPOSITE L1X00 BRINE AND DILUTED L1X00 BRINE SPIKED WITH $Na_2B_4O_7$

BRINE	EA-TIC mmol/L	B mmol/L	H_3BO_3 mmol/L	$HB_4O_7^-$ mmol/L	$B_4O_7^{-2}$ mmol/L	$H_3BO_3/HB_4O_7^-$	$HB_4O_7^-/B_4O_7^{-2}$
Composite	14	137	81	14	--	5.8	--
L1X00	18	191	119	18	--	6.6	--
Diluted L1X00	9	96	60	9	--	6.7	--
Diluted L1X00 + 11.6 mmol/l $Na_2B_4O_7$	34	142	6	34	--	0.2	--
Diluted L1X00 + 23.2 mmol/l $Na_2B_4O_7$	59	188	--	35	12	--	2.9

EA = Extended Alkalinity, TIC = Total Inorganic Carbon
EA - TIC is alkalinity (as HCO_3^-) in excess of that due to TIC
Proton equivalents required to neutralize excess alkalinity = EA - TIC = $HB_4O_7^-$ + (2 * $B_4O_7^{-2}$)

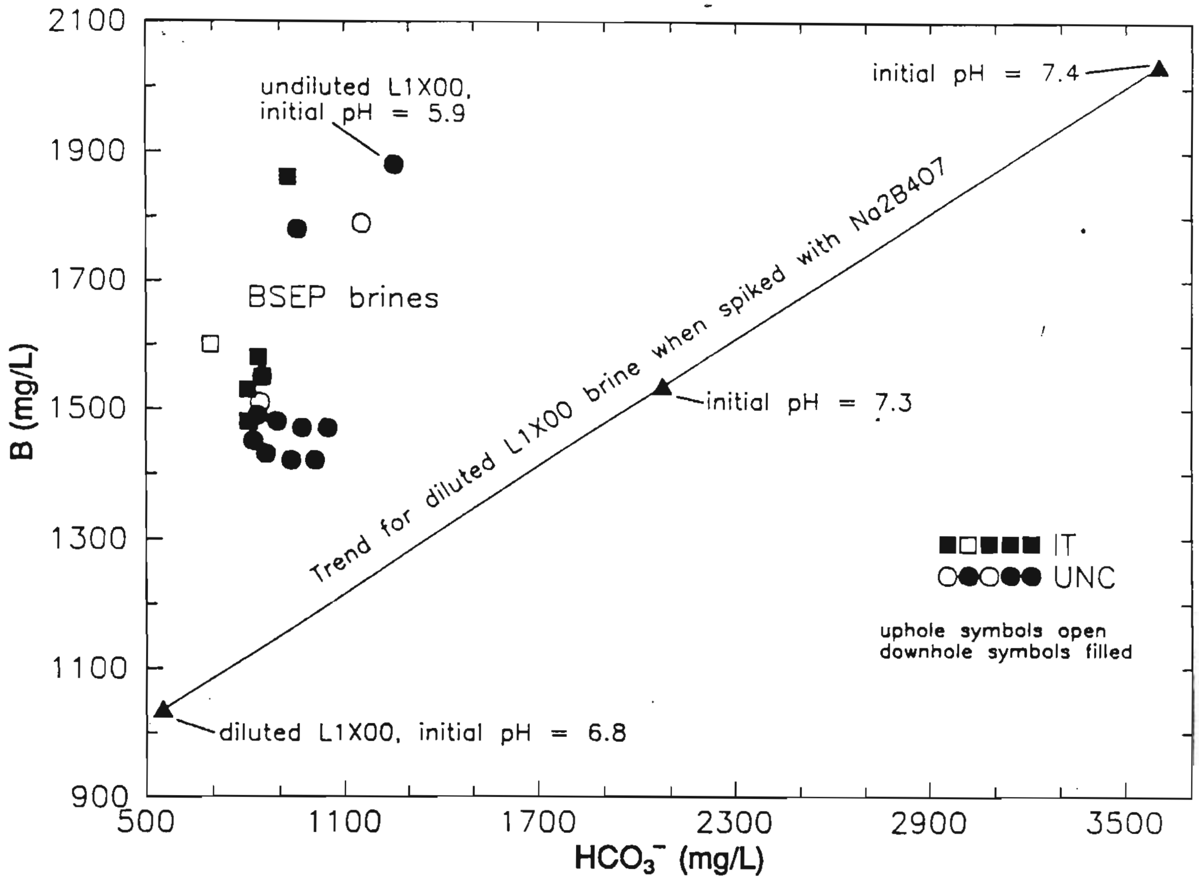

FIGURE 3-4 BORON VERSUS EXTENDED ALKALINITY FOR BSEP BRINES AND DILUTED L1X00 BRINE SPIKED WITH $Na_2B_4O_7$

BSEP brines which contain similar boron concentrations, are attributed to dissolution of $Na_2B_4O_7$ and subsequent protonation of $B_4O_7^{-2}$ to the $HB_4O_7^{-}$ specie.

3.1.3.3 Major Element Ratios

Insight into the origin of BSEP brines is provided by variation diagrams which utilize major-element ratios (by weight). Some of the most useful diagrams are Na/Cl versus K/Mg, Mg/Cl versus Br/Cl, and Na/Cl versus Ca/SO_4^{-2}. The first diagram allows a qualitative assessment of halite precipitation and diagenetic processes (Stein and Krumhansl, 1988), while the second plot evaluates the role of potash facies in decreasing magnesium and bromine concentrations (McCaffrey and others, 1987). Na/Cl versus Ca/SO_4^{-2} was chosen for the third diagram to evaluate anhydrite and halite facies deposition.

3.1.3.3.1 Na/Cl versus K/Mg

Figure 3-5 displays variation between Na/Cl and K/Mg mass ratios by utilizing the mean values of all holes. Upholes (excluding A2X02 and DHP401) have K/Mg values (0.3 to 0.5) similar to seawater in equilibrium with modern evaporites (Brantley and others, 1984), but are relatively depleted in Na/Cl (0.25 to 0.35). Lower Na/Cl mass ratios in upholes can be attributed to halite (NaCl) precipitation during evaporation, because fewer moles of sodium are initially present and halite precipitation will remove an equal number of moles of sodium and chlorine. Na/Cl mass ratios for downholes (0.35 to 0.57) are similar to brines in equilibrium with modern evaporites. However, the K/Mg mass ratios for downholes range from 0.5 to 1.2, well above the 0.4 value expected for surface brines found today. Higher K/Mg mass ratios suggest depletion of magnesium either by diagenetic reactions to form magnesite (Stein and Krumhansl, 1988) or exchange with clay minerals. Upholes with Na/Cl less than 0.4 do not reflect this magnesium enrichment, suggesting either substitution of potassium for sodium during halite precipitation (i.e., a sylvite component in halite) or subsequent depletion of potassium relative to magnesium during polyhalite formation. Two upholes (A2X02 and DHP401) plot within the downhole field. For A2X02 (UNC Geotech), this indicates a more successful endeavor in sealing off the hole and preventing evaporation. However, DHP401 (IT-Export) lies in the downhole field due to the low chlorine determinations (compare with UNC Geotech mean for DHP401). For identical holes, Na/Cl and K/Mg values are always greater for IT-Export determinations than for those of UNC Geotech. This trend results from IT-Export values on chlorine and potassium being, respectively, lower than and higher than those of UNC Geotech.

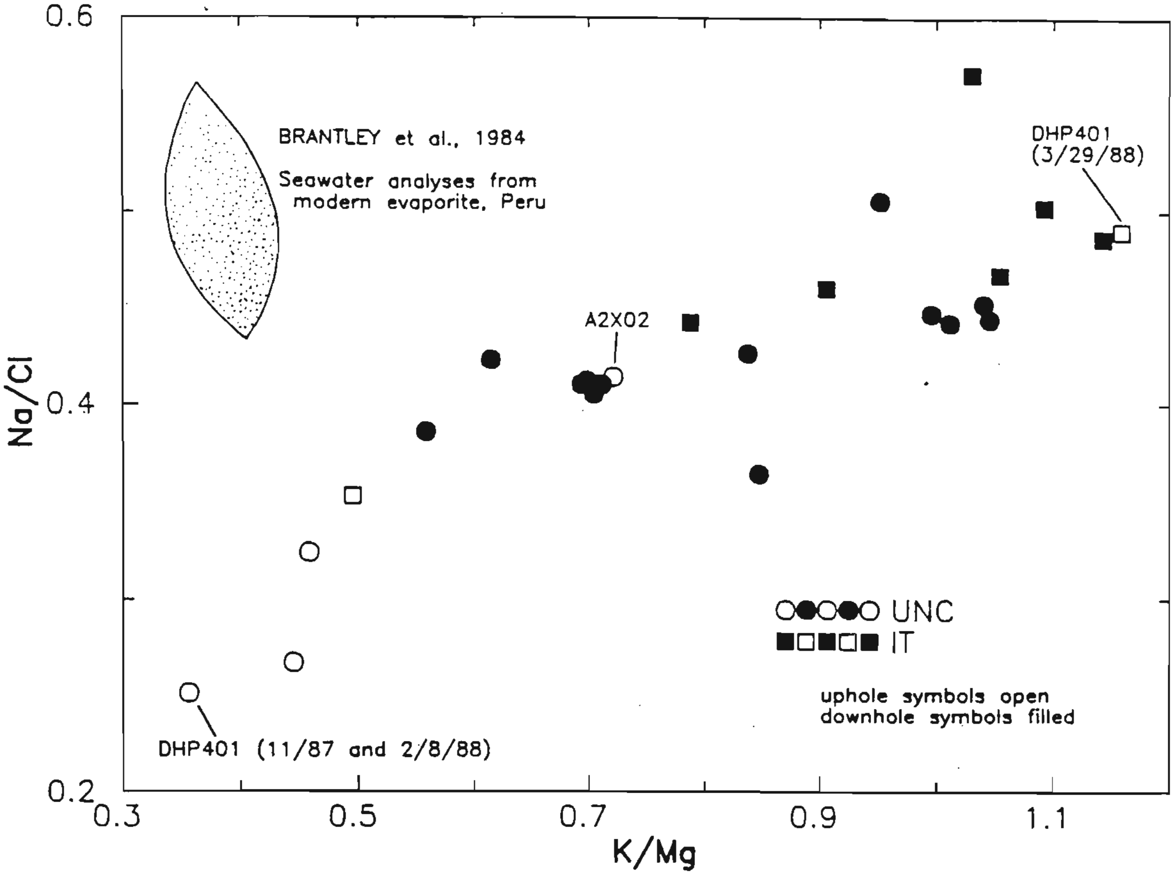

FIGURE 3-5 RATIOS (BY WEIGHT) OF Na/Cl VERSUS K/Mg FOR BSEP BRINES

Temporal variation of the K/Mg ratio and, to a lesser extent, the Na/Cl ratio are illustrated in Figures 3-6 and 3-7. Increases in the K/Mg ratio took place over the intervals of June 1987 through September 1987 and November 1987 through February 1988, while the September 1987 through November 1987 period was characterized by a decrease in the K/Mg value (Figure 3-6). The remaining sampling intervals are inconclusive because over any individual interval, K/Mg ratios decreased, increased, or remained the same. Na/Cl values remained constant or showed weak antithetic variation with K/Mg ratios (Figure 3-7). The sharp decrease in Na/Cl for IT-Export analyses over the November 1987 to February 1988 period is followed by a sharp increase for July 1988 analyses, probably reflecting analytical difficulty in the determination of chlorine concentrations (note large + and - charge balances for DH36 samples analyzed by IT-Export; Appendix C, Samples 262 and 425).

Although each hole has not been plotted in Figures 3-6 and 3-7, temporal variations exist in all holes (up and down), independent of the analytical laboratory and the duration of the period over which the sampling was conducted. It is difficult to ascribe the temporal trends to a single mechanism, because they most likely represent the complex interplay of evaporation, crystallization, diagenesis, dilution and analytical error. Additionally, the sampling holes may receive brines from a progressively greater rock volume as time proceeds. For instance, excavation-induced stress redistribution could cause a time-dependent increase in the permeability of clay and anhydrite seams in the Salado Formation (Deal and Case, 1987). Similar trends for other element ratios are being investigated to isolate specific mechanisms or analytical problems that may account for the temporal variation.

3.1.3.3.2 Mg/Cl versus Br/Cl

In the Mg/Cl versus Br/Cl plot (Figure 3-8), the trend for seawater during halite facies deposition (Holser, 1963) is broadly paralleled by upholes due to evaporation and crystallization of halite. Most downholes cluster between Mg/Cl mass values of 0.14 to 0.09 and Br/Cl mass values of 0.007 to 0.009 and exhibit a weak antithetic relationship between Mg/Cl and Br/Cl. All holes have lower Mg/Cl mass ratios relative to the halite facies trend (Figure 3-8), which is attributed to depletion of magnesium by diagenetic reactions (see Section 3.1.3.3.1). All of the sampled BSEP brines have Br/Cl mass ratios similar to those predicted by empirical (Holser, 1963) and experimental (McCaffrey and others, 1987) studies for halite facies deposition (Figure 3-8). Thus, the Br/Cl mass ratio

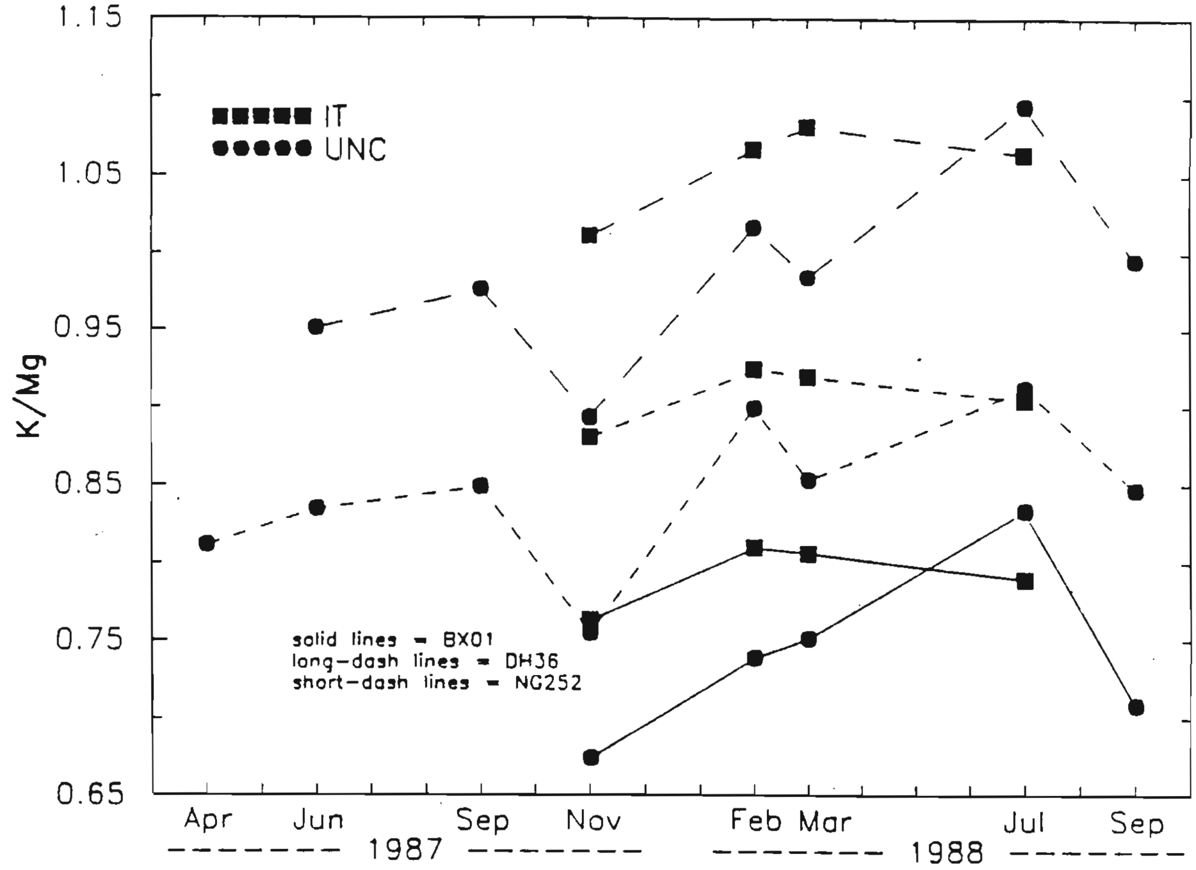

FIGURE 3-6 TEMPORAL VARIATION OF K/Mg FOR THREE BSEP BRINES

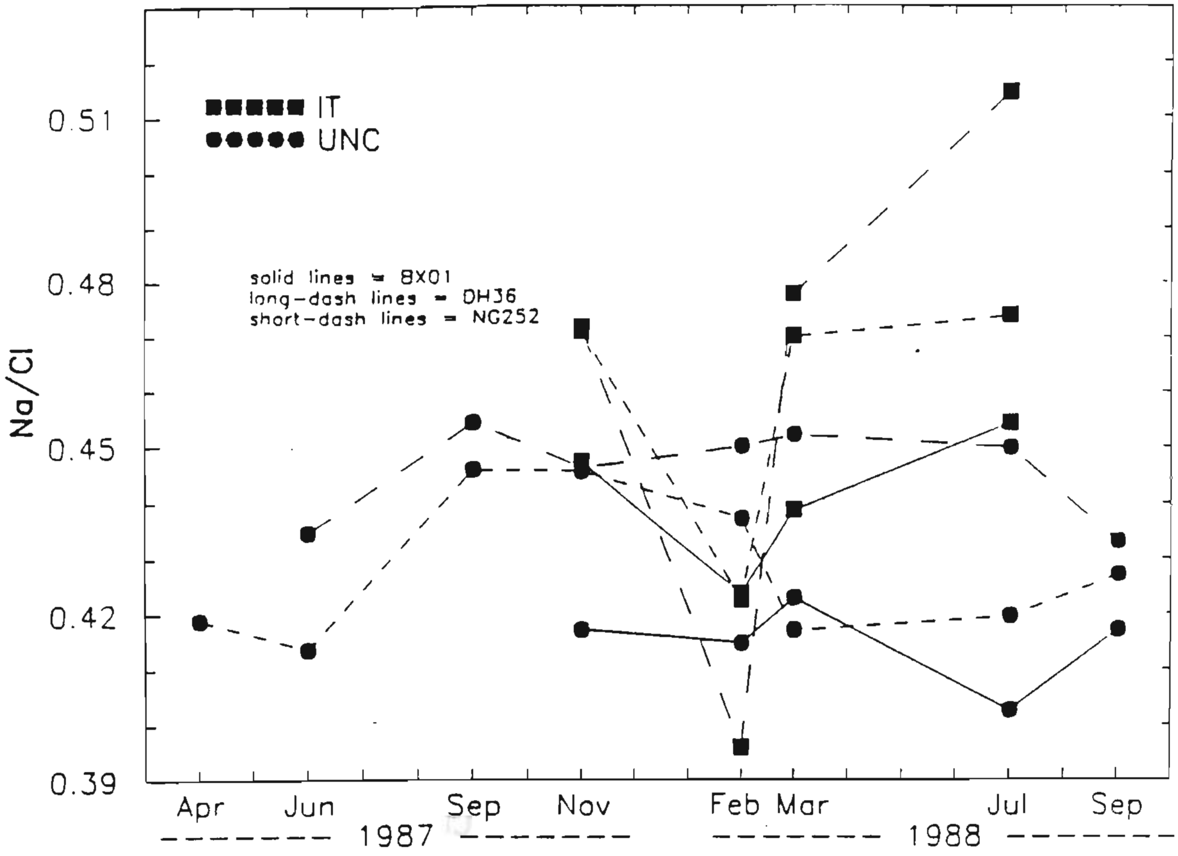

FIGURE 3-7 TEMPORAL VARIATION OF Na/Cl FOR THREE BSEP BRINES

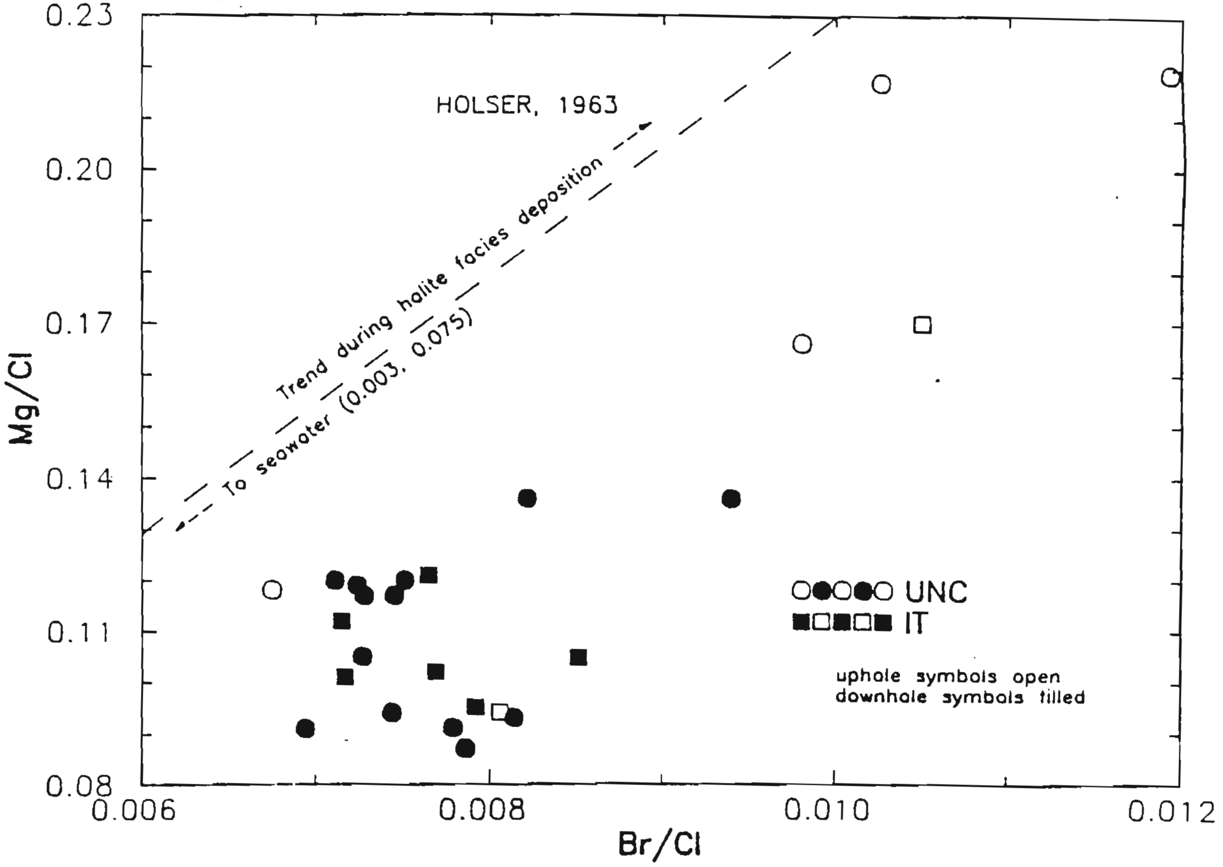

FIGURE 3-8 RATIOS (BY WEIGHT) OF Mg/Cl VERSUS Br/Cl FOR BSEP BRINES

for these brines implies that extreme evaporation characteristic of potash facies deposition was probably not reached. In contrast to the brine data, Stein and Krumhansl (1988) reported Br/Cl values consistent with potash facies deposition from a number of fluid inclusions recovered from recrystallized halite at the WIPP repository horizon. However, it is unlikely that primary brines are preserved in large quantities; the degree to which BSEP brines represent compositions modified by evaporation, crystallization, and diagenetic processes is still being investigated.

3.1.3.3.3 Na/Cl versus Ca/SO_4^{-2}

The variation of Na/Cl with Ca/SO_4^{-2} is illustrated in Figure 3-9. Excluding GSEEP, the samples exhibit a sympathetic trend which is probably controlled by precipitation of anhydrite (or gypsum) and halite (i.e., decreasing Na/Cl and Ca/SO_4^{-2} mass ratios in upholes). GSEEP samples have Na/Cl and Ca/SO_4^{-2} values very close to those for evaporated seawater prior to halite deposition (Na/Cl = 0.56 and Ca/SO_4^{-2} = 0.007; calculated from the data of Usiglio as reported by Krauskopf, 1967, p. 324). These mass ratios could imply that halite was not precipitated from GSEEP brines. However, contamination cannot be ruled out because GSEEP lies downdip from an active experimental area (Room J) where addition of artificial brine to an excavated pit has occurred.

The bottom of the GSEEP hole and the excavated pit in Room J are proximal to a fractured, thick (50-cm to 90-cm) anhydrite bed. Shortly after excavation of Room J, the anhydrite (MB 139) was observed yielding brine to the pit excavated in the floor (Deal and Case, 1987). Therefore, fractures beneath the floor of the excavations might serve as a common plumbing system for GSEEP and the excavated pit in Room J (Deal and others, 1987). The high Na/Cl values for GSEEP could indicate contamination from artificial brine (made with mined salt muck and fresh water) that migrated out of Room J along fractures. About 7,400 liters of artificial brine were introduced to the excavated pit in Room J in 1985 and an additional 7,000 to 8,000 liters of fresh water were added, a small amount at a time, over several years. Presumably, most of the artificial brine evaporated into the repository atmosphere, but some may have migrated out of the pit. It should be noted that the GSEEP chemistry is not observed in DH holes, one of which (DH36) is located 6 meters to the west of GSEEP. Contamination may not have occurred in DH holes because, relative to MB 139, they lie updip of GSEEP (Deal and others, 1987).

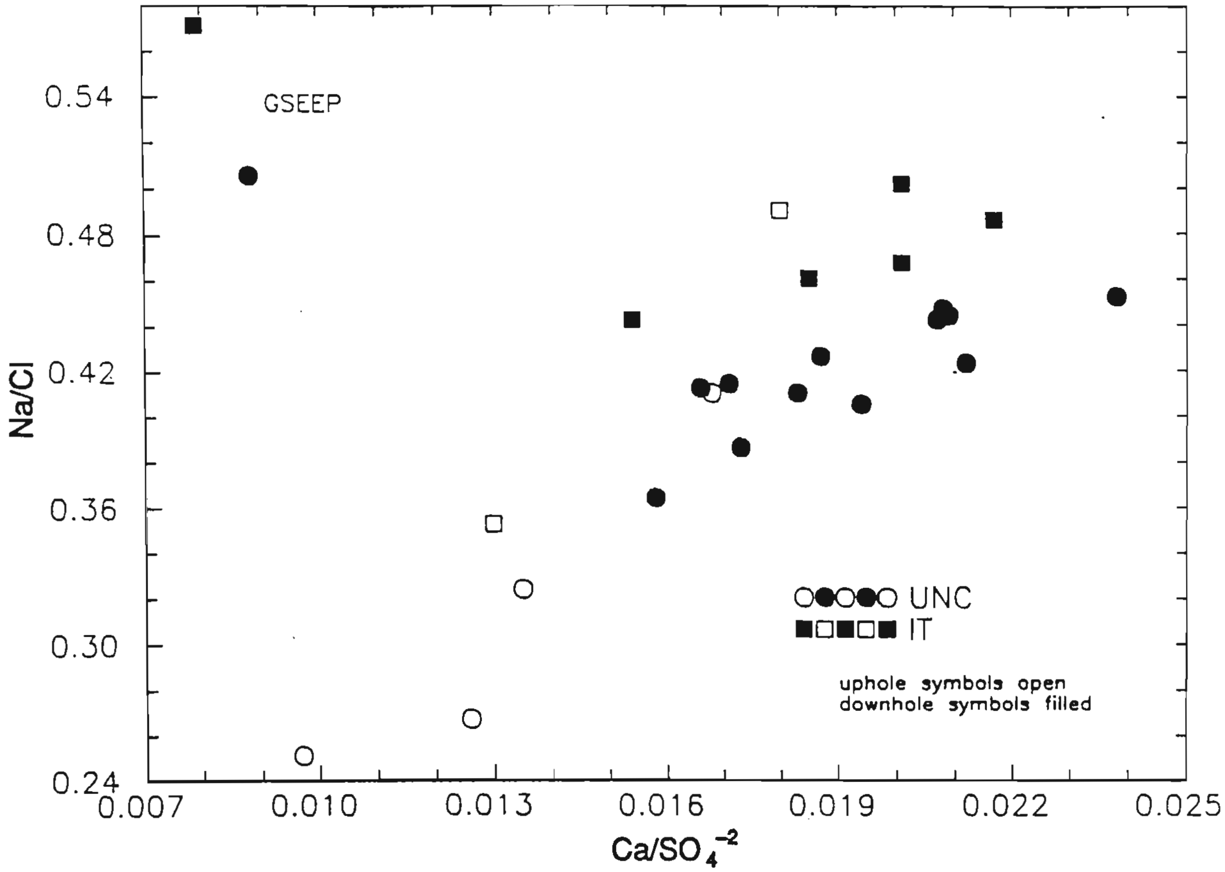

FIGURE 3-9 RATIOS (BY WEIGHT) OF Na/Cl VERSUS Ca/SO_4^{-2} FOR BSEP BRINES

The contamination hypothesis could be tested by sampling Room J artificial brine for the purpose of obtaining chemical analyses. Using the analytical results for artificial brine and typical BSEP brine, mixing models can be evaluated to determine if GSEEP chemistry is a mixture of the two end members.

3.1.3.4 Trace Elements

Interpretation of the concentrations of trace elements in BSEP brines must be approached cautiously because large dilution factors are required prior to analysis, introducing a greater degree of uncertainty in analytical results relative to undiluted waters with low TDS. For instance, fluorine and iodine show no significant difference in their concentrations between upholes and downholes, yet most upholes have experienced evaporation and should have higher fluorine and iodine concentrations relative to downholes (see also bromine concentrations of upholes and downholes). The dilution factors may also result in elevated detection limits for many elements (e.g., aluminum, boron, and iodine [IT-Export]; nitrate and phosphate [UNC Geotech]). Additionally, different analytical techniques may be utilized by the analytical laboratories on a specific element, which can result in order-of-magnitude differences in the reported element's concentration (e.g., Si). At this time, the most reliable trace elements for interpretation and discussion are manganese and strontium.

BSEP brines are depleted in strontium (0.9 to 6.7 mg/L) and enriched in manganese (0.7 to 8.0 mg/L), relative to seawater concentrations of strontium and manganese (7.9 and 0.002 mg/L, respectively; Hem, 1970, p. 11). The observed strontium concentrations are compatible with the partitioning of strontium into anhydrite (or gypsum) and/or precipitation of celestite ($SrSO_4$). The pH (5.6 to 6.4, Table 3-4) and Eh (less than 400 mV; Section 3.1.2.2.4) values of BSEP brine limit the oxidation state of manganese to +2. Therefore, manganese concentrations are not controlled by the solubility of MnO_2 and can be concentrated by evaporation.

These processes can be illustrated by plotting strontium and manganese against sulfate (Figure 3-10). Available barium data (UNC Geotech) has also been plotted in Figure 3-10 because barite ($BaSO_4$) forms a complete solid solution with celestite (Deer and others, 1966), and small amounts of barium can substitute for calcium in anhydrite. Anhydrite is not isostructural with barite and celestite because of the small size of the calcium ion relative to strontium and barium (Deer and others, 1966). Downholes, excluding L1X00 and GSEEP and upholes A1X02 and DHP401 define a sympathetic trend with respect to

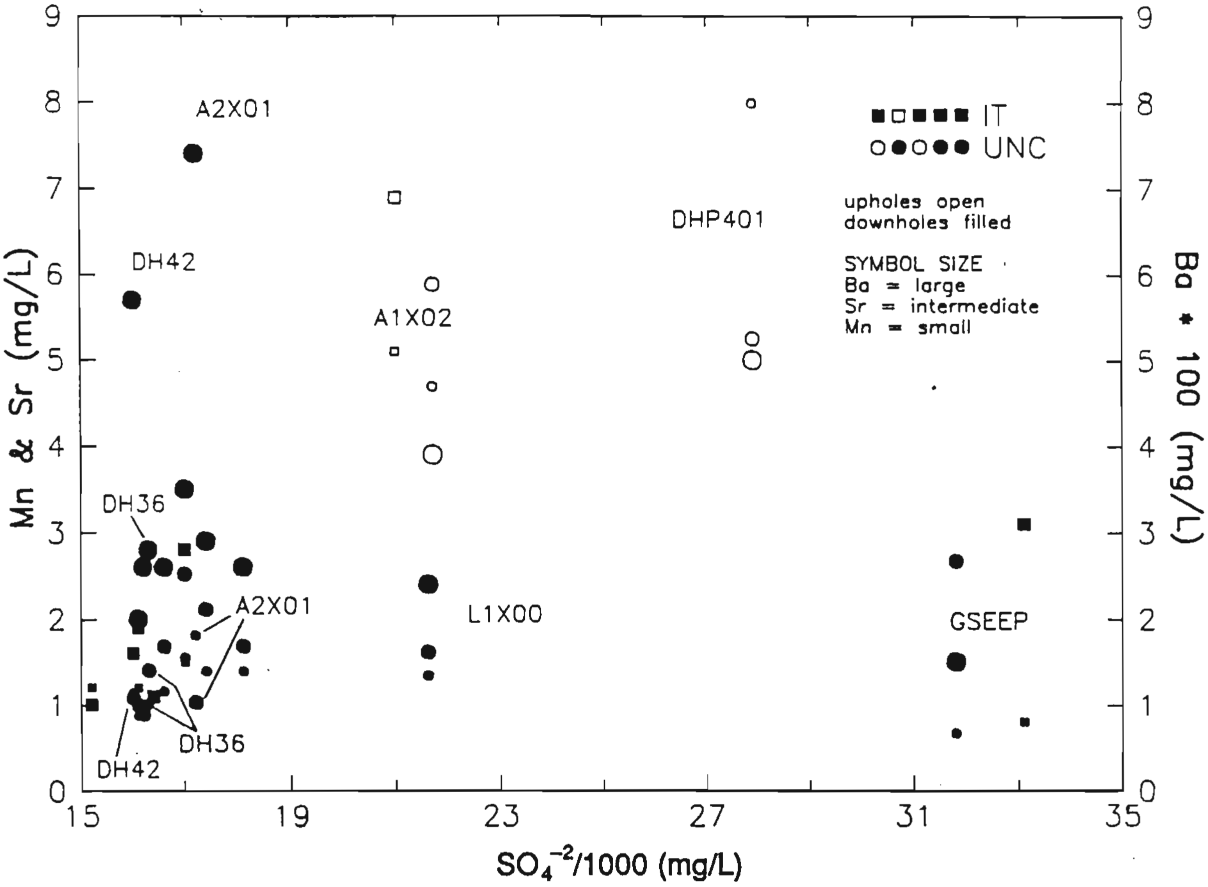

FIGURE 3-10 Mn, Sr, AND Ba VERSUS SO$_4^{-2}$ FOR BSEP BRINES

manganese and sulfate, indicating manganese and sulfate were concentrated in upholes by evaporation. However, these same holes show a more complex trend for strontium and barium versus sulfate, suggesting mineral solubilities may control these relationships. Relative to most downholes, L1X00 and GSEEP have similar trace-element concentrations, but greater sulfate values, while A2X01 and DH42 have anomalously high barium concentrations.

The solubility products of barite and celestite, and ion substitution in anhydrite, probably control the trace-element distribution of barium and strontium in BSEP brines. To test this hypothesis, the average compositions of six brines (A1X02, A2X01, DH36, DHP401, GSEEP, and L1X00; Appendix D, UNC Geotech values) were entered into the EQ3NR code (Pitzer option with data0 ver. 3245R54) to calculate the saturation indices (SI) of anhydrite, barite and celestite. The SI for these minerals are presented in Table 3-7. All brines tested are saturated with anhydrite and supersaturated with barite (except GSEEP, which is saturated with barite). A1X02, DHP401, and GSEEP are saturated and the remaining brines are unsaturated with celestite.

Strontium concentrations in downhole brines (excluding GSEEP) that are unsaturated with celestite may be controlled by the weak partitioning of strontium into anhydrite (D_{Sr} about 0.4 at 25°C; Kushnir, 1982) and/or diagenetic replacement of calcium by strontium in anhydrite, whereas the remaining brines (upholes and GSEEP) may have their strontium concentrations controlled by the celestite solubility product (Table 3-7).

The EQ3NR calculations of the ion-activity products for sodium and chloride (NaCl) and strontium and sulfate ($SrSO_4$) in brines saturated with celestite (Table 3-7) are in good agreement with the experimental results of Reardon and Armstrong (1987). Reardon and Armstrong (1987) conducted celestite solubility measurements in solutions to concentrations of 5.0 molal (mole/kg H_2O) NaCl at 25°C. Their results show a rapid rise in the celestite solubility product with increasing NaCl molality to a maximum of 5 millimolal (millimole/kg H_2O) $SrSO_4$ in a 3 molal NaCl solution. Further addition of NaCl to the solution caused a decrease in the celestite solubility product, to about 4 millimolal at 5 molal NaCl. Table 3-8 summarizes the modeled results for BSEP brines and shows a decrease in the ion-activity product of $SrSO_4$ from 4.8 to 3.8 millimolal as NaCl increases from 4.1 to 5.5 molal.

TABLE 3-7

SATURATION INDICES (SI) FOR ANHYDRITE ($CaSO_4$), BARITE ($BaSO_4$), AND CELESTITE ($SrSO_4$) IN SELECT BSEP BRINES

	$CaSO_4$		$BaSO_4$		$SrSO_4$	
BRINE	SI	STATE	SI	STATE	SI	STATE
A1X02	0.152	sat	0.728	ssat	0.012	sat
A2X01	0.133	sat	0.929	ssat	-0.793	usat
DH36	0.055	sat	0.438	ssat	-0.730	usat
DHP401	0.218	sat	0.927	ssat	-0.037	sat
GSEEP	0.186	sat	0.337	sat	-0.304	sat
LIX00	0.175	sat	0.437	ssat	-0.568	usat

Saturation indices (SI = log[ion-activity product/solubility product]) calculated with EQ3NR code by the ion-interaction method of Pitzer (1973), using the Pitzer thermodynamic data base. Input parameters taken from Appendix D (UNC values) with T = 27°C and Eh - 409mV. SI>0.4, supersaturated (ssat); 0.4>SI>-0.4, saturated (sat); SI<-0.4, undersaturated (usat).

TABLE 3-8

NaCl AND $SrSO_4$ ION-ACTIVITY PRODUCTS FOR A1X02, DHP401, AND GSEEP BRINES SATURATED WITH CELESTITE

BRINE	NaCl mol/kgH_2O	$SrSO_4$ mol/kgH_2O
A1X02	4.683	4.667 E-3
DHP401	4.102	4.845 E-3
GSEEP	5.470	3.759 E-3

Activity products calculated with EQ3NR code by the ion-interaction method of Pitzer (1973), using the Pitzer thermodynamic data base. Input parameters as in Table 3-2.

Brine ion-activity products for barium and sulfate ($BaSO_4$) indicate these solutions are saturated to supersaturated with barite. However, barite is not observed as a precipitate in supersaturated solutions. Presently, there is insufficient kinetic data on barite to evaluate the role of supersaturation in nucleation of barite crystals. Therefore, the calculated supersaturation of these brines may reflect an insufficient number of Pitzer interaction parameters for barium. The relatively high barium concentrations in brines A2X01 and DH42 are responsible for their large $BaSO_4$ ion-activity products. These brines have very large standard deviations for barium and high TIC values relative to other downholes (Appendix D), which may indicate some minor contamination has occurred to these drillholes.

3.1.3.5 Rock/Brine Equilibria

An objective of the BSEP is the characterization of rock/brine equilibria. To this end, preliminary modeling of the composite-brine chemistry (Table 3-5) with the solubility/speciation code EQ3NR (Wolery, 1983; Jackson, 1988; Pitzer option with data0 ver. 3245R54) has provided some insight. Runs of EQ3NR utilized both the Pitzer (1973) and Harvie-Moller-Weare (HMW) (Harvie and others, 1984) data bases, because all parameters cannot be input into a single data base. The Pitzer data base has thermodynamic parameters based on osmotic coefficients derived from isopiestic measurements, while the HMW data base is based on solubility measurements. Input for the Pitzer run consisted of values for pH, sodium, magnesium, potassium, calcium, chlorine, sulfate, strontium, manganese, ammonium, nitrate, bromine, fluorine, and iodine. Eh was determined by the ammonium/nitrate couple, which should be considered a bounding upper limit. For the HMW option, input consisted of values for pH, sodium, magnesium, potassium, calcium, chlorine, sulfate, and bicarbonate (as converted TIC). The Eh value was constrained by the ammonium/nitrate couple in the Pitzer run and the calculated value of +409 mV was entered into the HMW run.

Results of the EQ3NR modeling are given in Table 3-9. Minerals are listed with their SI values, which is the log of ion-activity product divided by the solubility product (log $[IAP/K_{sp}]$) for the mineral of interest. In general, undersaturation, saturation, and supersaturation of a solid phase are indicated by, respectively, negative, zero, and positive SI values. The precision of thermodynamic data is probably within ±0.4 SI units (Wolery, 1983); thus minerals are assumed to be saturated within the range of -0.4 to 0.4.

TABLE 3-9

RESULTS OF EQ3NR MODELING OF COMPOSITE BRINE

Pitzer data base

Input parameters: Br^-, Cl^-, F^-, I^-, SO_4^{-2}, NO_3^-, NH_4^+, Ca^{+2} K^+ Mg^{+2}, Mn^{+2} Na^+ Sr^{+2}

MINERAL	FORMULA	SI	STATE
Anhydrite	$CaSO_4$	0.001	sat
Bassanite	$CaSO_4 \cdot \frac{1}{2}H_20$	-0.698	usat
Celestite	$SrSO_4$	-0.802	usat
Fluorite	CaF_2	1.215	ssat
Glauberite	$Na_2Ca(SO_4)_2$	0.079	sat
Gypsum	$CaSO_4 \cdot 2H_2O$	-0.120	sat
Halite	$NaCl$	-0.018	sat
	MgF_2	0.792	ssat
Polyhalite	$K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O$	-0.246	sat
Sylvite	KCl	-0.584	usat
Syngenite	$K_2Ca(SO_4)_2 \cdot H_2O$	-0.392	usat
Thenardite	Na_2SO_4	-0.779	usat

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usat = undersaturated; sat = saturated; ssat = supersaturated

TABLE 3-9

RESULTS OF EQ3NR MODELING OF COMPOSITE BRINE
(CONTINUED)

Harvie-Moller-Weare database

Input Parameters: Cl^-, HCO_3^-, SO_4^{-2}, Ca^{+2}, K^+, Na^+, Mg^{+2}

MINERAL	FORMULA	SI	STATE
Anhydrite	$CaSO_4$	-0.112	sat
Bassanite	$CaSO_4 \cdot ½H_2O$	-0.810	usat
Dolomite-ord	$CaMg(CO_3)_2$	0.431	ssat
Dolomite		0.431	ssat
Glauberite	$Na_2Ca(SO_4)_2$	-0.146	sat
Gypsum	$CaSO_4 \cdot 2H_20$	-0.231	sat
Halite	NaCl	-0.055	sat
Magnesite	$MgCO_3$	0.178	sat
Polyhalite	$K_2Ca_2Mg(SO_4)_4 \cdot 2H_2O$	-0.900	usat
Sylvite	KCl	-0.688	usat
Syngenite	$K_2Ca(SO_4)_2H_2O$	-0.750	usat
Thenardite	Na_2SO_4	-0.891	usat

Saturation indices (SI=log[ion-activity product/solubility product]) were calculated by the ion-interaction method of Pitzer (1973) using the Pitzer and Harvie-Moller-Weare thermodynamic data bases. Minerals with SI values less than -0.4 are undersaturated, -0.4 to 0.4 saturated, and values greater than 0.4 supersaturated with respect to the solution. Only minerals with SI greater than -1.0 are listed. Solution speciation was evaluated at T = 27°C, density = 1.23 g/cc, total dissolved solids = 375 g/L, pH = 6.1 and Eh = 409 mv. Eh was constrained by the NH^+_4/NO_3^- couple using the Pitzer data base. Element parameters of each run are indicated.

usat = undersaturated; sat = saturated; ssat = supersaturated.

Results for the Pitzer run indicate that the composite brine is saturated with halite, anhydrite, gypsum, polyhalite, and glauberite, and supersaturated with fluorite and MgF_2 (Table 3-9). Utilizing the HMW data base, results of the EQ3NR run listed halite, anhydrite, gypsum, magnesite, and glauberite as the saturated phases and dolomite and ordered dolomite as supersaturated (Table 3-9). The EQ3NR runs produced different phase assemblages because each input file has a distinct set of elements (listed above). Thus celestite, fluorite, and MgF_2 are unique to the Pitzer run, whereas dolomite, ordered dolomite and magnesite appear in the HMW run. Phases that appear in both runs do not have identical SI values (e.g., polyhalite) because, the interaction parameters are based on isopiestic and solubility measurements in, respectively, the Pitzer and HMW data bases (Harvie and others, 1984). Additionally, the supersaturation of fluorite and MgF_2 may reflect an incomplete set of Pitzer interaction parameters for fluorine.

The joint modeling results are in good agreement with the observed mineralogy present at the WIPP repository horizon. At this level, Salado Formation mineralogy consists primarily of halite, with thin horizons of anhydrite, and trace amounts of quartz, polyhalite, gypsum, magnesite and clays (Stein and Krumhansl, 1988). The observed mineralogy and modeling results indicate BSEP brines have compositions consistent with rock/brine equilibria. Concentrations of barium, calcium, chlorine, sodium, strontium, and sulfate are probably controlled by halite, anhydrite (or gypsum), celestite, and barite (see Section 3.1.3.4 for barium and strontium results). Magnesite and polyhalite may constrain bicarbonate, potassium, and magnesium concentrations in BSEP brines, but modeling results are equivocal for these components.

Failure to achieve a perfect match between the observed phases and those calculated to be saturated in the brine reflect many complex factors, the most critical being:

- A lack of a complete set of interaction parameters for the variety of seawater species,
- A need to incorporate redox kinetics (inorganic and biologic) and crystal growth/dissolution kinetics into low-temperature solution equilibria models, and
- A need to refine the pH, trace-element, and TIC data of the brines.

There appears to be no immediate solution to the first two factors cited above, because extensive research will be required before a comprehensive treatment can be achieved. However, brines evaluated in this report have further constrained and refined a composite-brine chemistry (Table 3-5) that yields modeled saturated phases consistent with the hypothesis of rock/brine equilibria. As better quantitative, thermodynamic, and kinetic data become available for brines, the knowledge and understanding of rock/brine equilibria and solution models will evolve.

3.1.3.6 Future Work

To obtain further insight and knowledge on BSEP brines and rock/brine equilibria within the Salado Formation, future studies should be directed toward the following activities:

- Investigate the areal distribution and composition of brine along a north-south traverse between experimental rooms and waste panels.
- Obtain analyses of additional trace elements to evaluate contamination scenarios.
- Develop a composite-brine chemistry by statistical reduction of weighted means based on brine-inflow rates and areal distribution.
- Evaluate and model evaporation, precipitation, and diagenetic processes with additional major-element ratios and trace elements.
- Compare statistically derived, composite-brine chemistry with reaction-path modeling of seawater solutions evaporated to halite facies deposition.

The first two activities are required to assess the distribution of anomalous brine within the repository and develop a more rigorous statistical model for composite brine. Additional trace elements (e.g., lithium, rubidium, and cesium) can be utilized in contamination models to resolve the role of artificial brine in producing anomalous chemical signatures in some BSEP brines. Further speciation and reaction-path modeling will quantify evaporation, precipitation, and diagenetic processes and will lead to a more comprehensive understanding of the origin of BSEP brines.

3.1.4 Conclusions

Over 160 brine samples from 25 drillholes in the Salado Formation at the WIPP repository horizon have been analyzed by two independent groups for up to 25 chemical parameters. Holes with BTP prefixes and DHP402A were omitted in statistical reduction of the data and determination of the composite-brine chemistry, because their chemistries have been modified by grout placed in drillholes and/or air-intake-shaft water or construction water spread on drift floors for dust control. Multivariate statistical tests were utilized to derive a composite-brine chemistry that was incorporated into EQ3NR solubility/speciation models.

Excluding the BTP and DHP402A holes, there is no chemical evidence to suggest that WIPP brines contain a component derived from the carbonate-dominated Rustler Formation aquifer. No brine component from the underlying Castile Formation has been detected in WIPP brines. Furthermore, WIPP brines do not appear to chemically record extreme evaporation conditions characteristic of potash facies deposition present in the McNutt potash zone above the WIPP repository horizon.

Modeling of the composite chemistry with the EQ3NR code, utilizing the Pitzer and HMW data bases, revealed the brine to be saturated with respect to halite, anhydrite, gypsum, polyhalite, and magnesite; this finding is in agreement with the observed mineralogy in the Salado Formation at the repository horizon. WIPP brines have major-element compositions that suggest an origin from seawater that was evaporated to halite facies deposition and subsequently modified by both diagenetic reactions that formed gypsum, magnesite, and polyhalite and ion-exchange reactions with detrital clay minerals.

Analytical problems with trace elements preclude their rigorous application to the problems of brine equilibria. However, results for manganese and strontium concentrations in WIPP brines suggest that, relative to seawater, manganese was concentrated by evaporation and strontium was depleted by substitution for calcium in anhydrite and/or celestite formation. As more quantitative trace-element data become available, further insight will be gained into the composition and origin of BSEP brines.

3.2 BACTERIOLOGICAL STUDIES

3.2.1 Introduction

Between July 13 and August 1, 1988, during the construction of the Air Intake Shaft (AIS) at the WIPP, approximately 129,000 gallons of artificial brine (provided by an oil-field trucking company, B&E Inc.) were pumped into the shaft by the contractor in an effort to flush the upream bit cutterheads. This brine, along with inflows from the Rustler Formation, was collected in a sump constructed in the S-90 Drift. Some of this brine was later distributed in the underground workings during construction-related activities. On August 16 and 20, 1988, approximately 4,600 gallons of brine from the sump were spread on the floor of Panel 1 to assist in the reconstitution of the loose muck (salt cuttings) on the floor. Some of the brine in the AIS sump came from the Rustler Formation and some was an artificial brine used for construction purposes made by dissolving Salado Formation halite in fresh water. The portion of the underground impacted by this introduced AIS brine included the western end of the S-90 Drift and adjacent areas. Also, some of the brine from the AIS sump was distributed in parts of the underground workings for dust control (see discussion of chemistry of brine in hole DHP402A in Section 3.1.1.3). The introduction of this AIS brine raised concerns over the possible introduction and spread of bacteria into the WIPP underground. Therefore, an underground sampling was conducted for microbial analysis to investigate this possibility.

Although limited in scope, the objectives of this microbiological survey were to establish:

- Any potential immediate health threats to workers from human pathogens among the microbes introduced with AIS brine,
- The nature of the introduced organisms and the extent of their distribution in the underground, and
- The identifiable effects of these introduced microbes on the experiments to be conducted during the test phase.

Another objective of microbial characterization, not within the scope of this work but germane to the overall WIPP mission is to determine the potential effects of any native or introduced halophilic (or other) organisms on shaft sealing, long-term isolation of the waste, and performance assessment.

This study, in addition to addressing the concerns in the first three objectives, is a first step in identification of microbes already present in the underground workings. The data on microbiological functions within the WIPP during operation and after closure will need to be developed for, and examined as part of, performance assessment. The organisms isolated as a result of this study are relevant to concerns of the Performance Assessment Source-Term Group (Brush and Anderson, 1988).

3.2.2 Sampling Program

The basic plan was to examine introduced AIS brine, muck samples, rib surface samples, rib wall cores, and the brine being collected as part of the ongoing BSEP in the underground. Because there are other possible sources for microbial contamination (e.g., air circulated for ventilation, other human activities, and organisms native to the Salado Formation), samples were also taken in areas where inoculation by AIS brine was thought to be unlikely or impossible. All samples were collected in sterile 125-milliliter (ml)

Whirlpaks or 100-ml plastic containers, taking care not to cross-contaminate samples and using prescribed aseptic technique (APHA, 1985). Sample types and locations are given in Table 3-10 and shown in Figure 3-11.

3.2.2.1 Sampling Procedure

Brine was obtained from a number of underground locations (Figure 3-11 and Table 3-10). Samples of the introduced AIS brine were collected in Whirlpaks from the S-90 Drift on July 25, August 15, and September 8, 1988. Free-standing AIS brine was dipped from the floor sump directly into sterile Whirlpaks.

Brine was also obtained on September 8, 1988 from several boreholes in the floor and ceiling routinely sampled for the BSEP for an estimate of the extent of microbial contamination in the underground workings of the WIPP. Ceiling brine was obtained directly from the catch containers and placed into sterile Whirlpaks or plastic containers. Floor brines were sampled by lowering a sterile plastic container down the open borehole and carefully capping the container immediately upon retrieval. Some sample points had air pressure applied, forcing accumulated brine to exit through a sample line. These brine samples necessarily exhibit whatever contamination was carried to them by such means as prior samplings, airborne sources, human handling prior to our sampling, and water (AIS brine) applied for dust control in the drifts.

Samples of floor muck were taken by hand, scooping muck directly into open sterile Whirlpaks without the use of a tool. Sampling locations are shown in Figure 3-11.

Samples of the rock salt on the rib wall surface were scraped into sterile Whirlpaks using a stainless steel blade which had been flamed with a propane torch. These samples were taken at points on the rib located approximately 5 feet above the floor. Sample locations are shown in Figure 3-11.

Core samples (Figure 3-11) were taken adjacent to the rib surface samples and were obtained as follows. First, the undisturbed surface and the 2-inch coring tool were flamed with a propane torch. A rotary drill coring tool was used to obtain a 2-inch-deep core which was broken off and discarded. The tool and the borehole were then flamed again and another 2 inches of core were removed. This sterile core sample was dropped directly into a sterile Whirlpak.

TABLE 3-10
LOCATIONS OF SAMPLES TAKEN ON 9/8/88

LOCATION	BRINE	MUCK	RIB SURFACE	RIB CORE
N1420/E1000				Anhydrite.
N1420/E1005			Halite	
N1130/E1220	Roof			
N1100/W2025			Clay Seam	Halite
N1100/W2030			Wall Seep	
S90/W200	Brine Saturated Muck			
S1600/W170	Floor[1] Roof			
S1620/W170		Halite		
S1950/E1320	Floor	Halite	Clay Seam	Clay Seam
S2190/W30				Clay Seam
S2200/W30		Halite	Halite	
Muck Pile at Surface		Halite		
Air Intake Shaft	Floor			

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[1] Two floor brine samples were taken at this location.

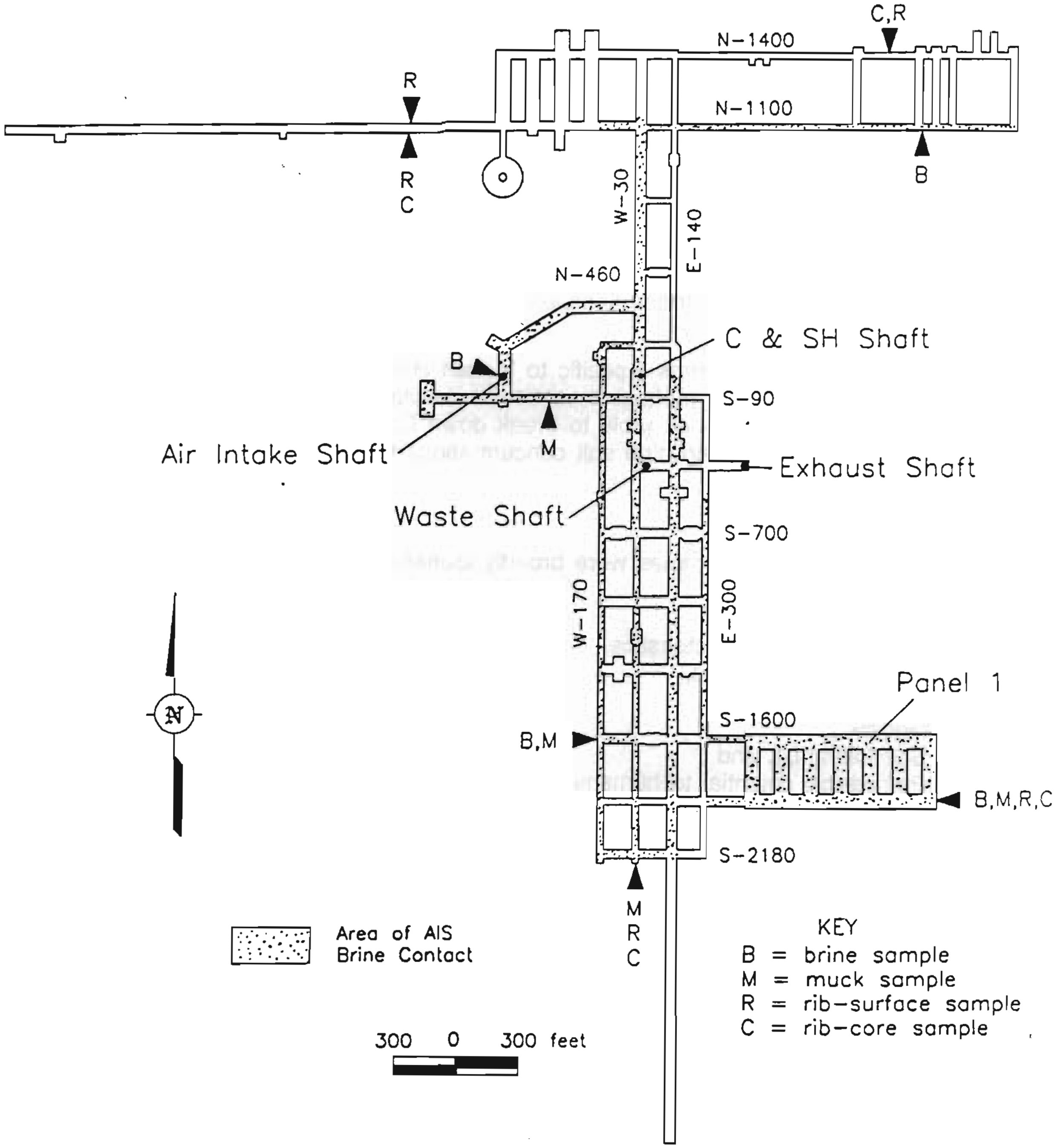

FIGURE 3-11 MAP OF THE WIPP UNDERGROUND WORKINGS SHOWING THE AREAS WHERE AIS BRINE WAS SPREAD AND SAMPLE LOCATIONS FOR THE BACTERIOLOGICAL STUDY.

3.2.2.2 Sample Preservation and Transportation

The samples were placed in sealed Ziplock bags on ice and transported to the Laboratory of Dr. Larry Jones at the University of Texas, El Paso (UTEP). Samples were transferred to a UTEP lab refrigerator and maintained until analysis could be initiated.

3.2.3 Culture Media and Procedures

The microbiological examination of these samples was selective for:

- Pathogens and coliforms (specific to human disease),
- Cellulolytic microbes (able to break down cellulose),
- Methylotrophic microbes (able to break down C_1 compounds),
- Halobacteria (requiring high salt concentrations for growth), and
- Yeasts and fungi.

Organisms cultured from these samples were broadly identified for:

- Morphological characteristics,
- Nutrient requirements,
- Staining responses,
- Motility,
- Salt tolerance, and
- Pathogenic potential to humans.

3.2.3.1 Special Culture Media

Because the task required identification of possible human pathogens as well as halotolerant and halophilic organisms, suitable culture media were employed for isolation of potential pathogens according to their reaction to the Gram's stain. Culture media for pathogens include:

- Blood agar for Gram positive (+) bacteria (Blair and others, 1970),
- MacConkey's agar for Gram negative (-) bacteria (Smith and others, 1985), and
- For specific pathogens:
  - Salmonella/Shigella Medium (Smith and others, 1985)
  - Staphylococcus 110 Medium (Difco Manual, 1984).

For coliforms, methylotrophs, cellulolytics, and yeasts and fungi, the culture media used were, respectively, eosine methylene blue agar (Difco Manual, 1984), 1090 marine methanol medium (Cote, 1984), trypticase soy agar supplemented with cellulose, 2 percent (Cote, 1984), and Sabouraud's dextrose agar (Smith and others, 1985).

3.2.3.2 High Salt Media

Four different hypersaline media described in Table 3-11 were employed for isolation of halotolerant/halophilic microbes:

- Medium 1176 (17 percent salt),
- Medium MORS (8 percent salt),
- Medium 974 (12 percent salt), and
- Medium 213 (25 percent salt).

3.2.3.3 Culture Procedures

Culture procedures followed for isolation and identification of human pathogens and halotolerant microbes are depicted in flow charts (Tables 3-12 through 3-14). Procedures approved by the American Public Health Association (1985) were followed (Cote, 1984). Isolates from liquid samples were prepared by centrifuging 100 ml of sample and resuspending the pellet in 0.85-percent sterile saline solution. Solid rock salt samples were dissolved in sterile saline solution prior to centrifugation. The sequence of these separations and plating regimes was designed to confirm halotolerant and/or pathogenic microbes utilizing appropriate nutrient media, culture methods, staining techniques, and microscopic examinations.

All samples were cultured on the halotolerant and the pathogenic media. Microbes growing on the pathogenic media regime (Table 3-12) were subjected to Gram's staining and further analyzed for pathogenicity. Microbes growing on the high salt media (Table 3-13) were subjected to Dussault's stain (Appendix E) for halophilic microbes and examined by microscope for gross morphology.

3.2.4 Results and Discussion

In all, 19 samples from all parts of the underground workings were submitted for microbiological evaluation (Table 3-10). A total of 48 organisms were isolated from these samples (Jones, 1988). All isolates came from either brine or muck samples. No organisms from rib surface or rib wall core samples grew on the media used in this study.

Characteristics of all 48 colonies isolated from samples in this study are summarized in Appendix F, which gives their description by microscopic appearance and gross morphology

TABLE 3-11
HYPERSALINE MEDIA

CONSTITUENT	GRAMS/LITER MEDIUM 1176	MEDIUM MORS	MEDIUM 974	MEDIUM 213
NaCl	156	80	125	250
$MgCl_2$	33	17	55	10
$CaCl_2$	1	0.5	0.2	0.2
KCl	4	2	---	5
K_2SO_4	---	---	5	---
$NaHCO_3$	0.2	0.1	---	---
Yeast Extract	5	5	5	10
Tryptone	---	---	5	2.5
Dextrose	1	1	---	---
Agar	20	20	20	20
Water	1000 ml	1000 ml	1000 ml	1000 ml
pH	7.0	7.0	6.8	7.2
% Salt	16	8	13	25

TABLE 3-12

FLOW CHART OF PROCEDURES FOR THE ISOLATION OF POSSIBLE PATHOGENS AND SPECIAL ORGANISMS

---

100 ml of sample

Centrifuge at 10,000 rpm for 10 min

Decant supernatant and resuspend pellet in 2 ml of 0.85% saline solution

Spread 0.1 ml of the resuspension on each of the following plates with an "L" rod

Blood agar
Tryptocase soy agar + 2% cellulose
Staphylococcus 110 agar
Eosine Methylene Blue agar
MacConkey's agar
Marine Methanol Medium agar
Salmonella/Shigella agar
Sabouraud Dextrose agar

Incubate at 37°C for 24-48 hrs

Identify and count similar colonies

Isolate pure colonies and transfer to fresh medium (Appendix F)

Perform gram reaction to determine the morphology (Appendix F)

Place on slants for further identification studies

TABLE 3-13

FLOW CHART OF PROCEDURES FOR THE ISOLATION OF HALOTOLERANT/HALOPHILIC ORGANISMS

100 ml of sample

Centrifuge at 10,000 rpm for 10 min

Decant supernatant and resuspend pellet in 2 ml of
15% saline solution

Spread 0.1 ml of the suspension on each of the
following plates with an "L" rod

Medium 1176 x 2	MORS Medium x 2	Medium 974 x 2	Medium 213 x 2

Incubate at 43°C until growth is observed

Identify and count colonies (Appendix F)

Isolate pure colonies and transfer to fresh media (Appendix F)

Gross morphology + Dussalt's stain + microscopic observations

(Appendix E)

TABLE 3-14

FLOW CHART OF PROCEDURES FOR THE PREPARATION OF SOLID SALT SAMPLES

15 g solid sample

Add 15 ml of 0.85% saline

Add 15 ml of 15% saline

Spread 0.1 ml of the suspension on each of the following plates with an "L" rod

Continue as shown in flow chart of procedures for the isolation of possible pathogens (Table 3-12).

Continue as shown in flow chart of procedures for the isolation of halotolerant/halophilic organisms (Table 3-13).

on agar plates. These colonies were further identified by plating on the high salt media (Table 3-11 and Appendix F), which provided viable counts on the various media for confirmation of pathogens. All 48 of the isolates are at least halotolerant. Some may even be true halophiles (requiring high salt concentrations for growth). All were isolated and maintained in aerobic conditions. Several anaerobic microbes, which initially grew in anaerobic jars, died after isolation due to the inability to maintain strict anoxic conditions without an anaerobic culture apparatus. These were strictly anaerobic halotolerant microbes. Some of the 48 aerobic halotolerant microbes may also be facultatively anaerobic (able to grow in the presence or absence of oxygen).

Gram's staining is important for indication of pathogenicity. Common human pathogens are usually Gram negative and sometimes form spores. Many of the isolates were Gram Intermediate (staining both Gram positive and Gram negative). Many did not stain well at all, turning black in response to the stain (not unusual for organisms isolated from the natural environment). Microbial characteristics, isolation media, stain reactions, and colony morphology of the potential pathogens and other specialized organisms are given in Appendix F. Potential pathogens were further evaluated by culture on agar slants for confirmation. Although some of these suspect organisms grew on media designed to select for human pathogens, no pathogens were found. Based on colony morphology, biochemical media screening, and Gram's staining, none of the 48 isolates were indicated as pathogenic to humans. The fact that some grew well on media designed to mimic human physiological fluids (blood agar, protein-enriched agar, etc.) may have been due to the complex nature of the media.

With regard to the distribution of the WIPP organisms, it is significant that most of the 48 isolates were found in samples of brine or floor muck that had come into contact with brine spread for dust control. Also, the samples taken from the surface muck (salt) pile were found to have viable organisms. No organisms from samples of rib surface or the rib wall cores grew on the media used in this study. This suggests that there are no organisms in the host rock that can be easily cultivated in the laboratory. This could be due to any of the following three reasons:

- The organisms in the native halite formation are either dormant or metabolize too slowly to be observed when incubated for only a few weeks on these media. Halophilic microbes are extremely small and grow at abnormally slow rates, (sometimes taking many weeks to show signs of visible growth), or

- The procedures and/or media were incorrect, or
- There are no native organisms in the formation.

Incubation was terminated after several weeks as there are no known halophilic human pathogens.

The absence of viable organisms in drift face and rib wall cores is significant for another important reason. Consistency of sampling procedures and quality control during sample acquisition is evident from the consistent absence of contaminants in these samples.

Populations of microbes indigenous to hypersaline environments are rather specialized organisms adapted to live in the strong brine and prefer, and sometimes require, the high salinity of their environment for growth and reproduction (Larson, 1980). Sodium and magnesium chlorides are the dominating salts of hypersaline environments throughout the world. Calcium chloride and calcium sulfate brines have also been found. These environments are mostly aerobic, but anoxic situations are also encountered. Acidities may differ considerably from one environment to another.

During a previous study, brine ponds near the WIPP site in Nash Draw were surveyed in a preliminary study of the bacterial ecology of surface environments (Turner, 1986). Pond conditions included measurements of seasonal changes. Temperatures ranged from 8°C to 30°C. Brine densities varied from 1.106 to 1.247 gm/cc. Potassium/sodium ratios varied from 2 to 0.5, with magnesium/calcium generally greater than 10 (Powers, 1989). The study provided information on the halotolerant and halophilic bacteria found in these ponds. Valuable experience was gained in the care and culture of these fragile and unaccommodating, yet highly adaptable, organisms.

Of the 48 isolates obtained during the present study, many were found to closely resemble the salt pond microbes found in Nash Draw (Jones, 1990). A final determination of these apparent similarities requires that all the organisms are identified (keyed to genus and species). Taxonomic keys have been developed for the halophiles (Vreeland and others, 1980). This can be done, but is beyond the scope of this initial study.

The muck pile at the WIPP probably maintains a saturated to partly saturated aqueous environment internally that is generally similar to the brine ponds in Nash Draw. Salado

Formation salt from shaft and facility horizon excavation yields potassium and magnesium, as do the tailings piles from the potash mines in the area. Although the chemistry of the tailings pile has not been studied, the solute chemistry is likely to be similar to that of the brine ponds which are fed partly from the runoff and seepage from tailings piles. The WIPP tailings pile has most likely been inoculated with airborne and/or avian-transported bacteria from these ponds (Powers, 1989).

Medium 213 was the halotolerant selective substrate of highest salt concentration tested (25 percent). A total of six organisms grew on this medium; two organisms (W-18 and W-47)[1] grew extremely well and may actually be true halophiles. Three additional organisms reacted positively to the Dussault's stain for halophiles (W-28, W-30, and W-43).

Samples obtained shortly after AIS brine introduction into the WIPP (July 25, 1988) showed a total of five organisms growing well on high salt media. When this brine was sampled again 21 days later (August 15, 1988), this number had increased to 17 organisms. When sampled again after another 24 days (September 8, 1988), there were 19 halotolerants and three of these had an affinity for the Medium 213 (either adaptive halophiles, which were introduced, or dormant native species, which revived in the saturated brine). Additionally, the 19 organisms bear little resemblance to the original populations in the earlier AIS brine samples collected in July and August. What seems to have occurred is that the original contaminating microbes either adapted to the new environment, exhibiting new nutrient requirements, or were replaced by a more successful community.

One sample of floor muck produced two halotolerants which were limited to that specific location (S1620/W170) and did not occur in any other samples. Another floor muck sample taken in a newly excavated drift (S2200/W30) produced only a single type of organism (W-29). A similar organism appeared at one other location (S90/W200) in an area that had been saturated with the AIS brine. As this organism did not occur in the original AIS brine samples, it may be native to the Salado Formation or could have been introduced via mine air. Also, its numbers were three times higher in the wet muck sample containing the AIS brine (S90/W200) than at the undisturbed area (S2200/W30). No dust control water had been applied in this new drift.

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[1] Organisms are numbered W-1 through W-48 in Appendix F.

A large range of organisms was isolated from the surface muck pile, including fungi. Of these, the single microbe which showed halotolerance was not found in the underground and may have come from the salt pond communities via avian transport.

Two floor brine samples known to be contaminated with AIS brine (DHP-402A and BTP-C1) showed very similar microbes, even though they are quite distant from each other. This seems to confirm the more or less common distribution of certain organisms via dust control operations (such as W-13, which occurs also in the AIS brine samples and in floor brine sample BTP-A2, also known to be contaminated with AIS brine).

The sole methanol-oxidizing organism isolated came from a roof brine (BTP-C4). This organism was not found in any of the AIS brine samples or in the surface muck pile. It is quite difficult to explain its existence here as a contaminant.

A most peculiar organism (W-16) was found in only two samples (BTP-C4 and A1X02). Both sample sites were roof brines located at opposite ends of the facility. It could be argued that some of the brine sources are connected and have unique microbial communities. Organisms W-15 and W-17, found in both floor and roof brine samples, may not be contaminants, as they were found nowhere else. Another explanation for the spatial distribution of microbes found in boreholes is that they were introduced with the numerous tools that were inserted for measurements (Roggenthen, 1988).

Colors of the colonies can be an important key to identification. Colonies isolated in this study were colored clear, white to gray, blue, yellow, brown, pink, and orange to bright red. (Red color is characteristic of some true halophiles which color local salt ponds during bacterial "blooms" and are responsible for the proverbial "red herring".) Several isolate pairs could not be separated from each other and are true symbionts (only able to live in the presence of one other). One isolate, found in floor brines DHP-402A and BTP-C1, liquefied agar. Eight possible cellulose degraders found in AIS brine, the surface muck pile, and one roof brine sample, were also isolated. This roof brine sample (BTP-C4) also contained the only microbe isolated in the study that grew on 1090 marine methanol agar. This organism is a true methylotroph (can break down C_1 compounds as a food source) and is able to utilize a total of six of the media tested in the study, indicating that it is most probably a facultative methylotroph. It is a highly adaptable microbe for this extreme environment and is very much out of place in relation to the other isolates.

Two samples (muck pile and AIS brine) were found to contain fungi. These organisms are aerobic and some degrade cellulose.

The methanogens are a specific group of strict anaerobes that are capable of utilizing CO_2, H_2, methanol, acetate, and a few other simple compounds in the production of methane. Some acetogenic bacteria are also obligate anaerobes that utilize CO_2 as a terminal electron acceptor in the production of acetate and formate, which are the substrates for the methanogens (Brock and Madigan, 1988). Although halophilic anaerobes were discovered in some of the samples, special equipment required for their culture and isolation was not available and the organisms were lost. Their existence in the WIPP could have significance to long-term waste degradation (U.S. Department of Energy, 1989, a and b).

The methanogens and acetogens are a potential source for gas generation. Due to the lack of an available anaerobic culture apparatus, these groups could not be addressed at the time of the study. However, isolates of the aerobic organisms are being maintained at UTEP by sequential transfer to fresh media for future reference. Even though all measures are taken to maintain such cultures, steady natural mortality in these cultures will reduce the number of viable strains available for additional study as time goes by.

Because of the existence of the organisms discovered to be actively metabolizing in the WIPP environment, future investigations can be made more meaningful by incorporation of the actual resident organisms into the experimental designs. The cultures being maintained at UTEP can provide the inocula for the tests and measurements described as key to objectives outlined for future testing (U.S. Department of Energy, 1989, a and b). The chemistry of the gas and waste budgets, waste degradation, radionuclide migration pathways, seal degradation, backfill interactions, changes in formation permeability due to biofilm formation, and overall repository performance depend on the ability to experimentally simulate the "realistic conditions" called for.

3.2.5 Conclusions

- The results of this study show that there were no human pathogens found in the WIPP underground.

- Both aerobic and anaerobic microbes inhabit the WIPP.

- A total of 48 aerobic microbes were isolated in this study from 21 samples (see Appendix F). All were at least halotolerant. Some show characteristics of the true halophiles.

- Several anaerobic organisms (some having potential as gas generators) were isolated but could not be studied due to lack of an anaerobic system at UTEP.

- Most of the isolated organism grew slowly on artificial media and total counts ranged up to 4,500 organisms per milliliter of brine or gram of salt. A few samples were too voluminous to count.

- A large portion of these organisms seem to have been distributed by applications of brine or water for dust control.

- Viable native organisms were not found in areas where the halite is dry (rib surface and rib cores), although some of the brine samples did contain unique organisms. These microbes exhibited qualities which suggest they may be native to the Salado Formation, although this could not be conclusively addressed in this study.

- Viable populations of microbes were found to exist in the surface muck pile. These may be remote members of the communities known to exist in the salt ponds in Nash Draw.

- The successive samplings of AIS brine gave increasing numbers of organisms, suggesting that this brine could be associated with the rapid increase in overall population numbers of halotolerant microbes. These have exhibited a dramatic proliferation and the development of diverse community structure over time.

- Microbes were isolated that are able to metabolize media containing cellulose, protein, and methanol. Some fungi were also found. These microbes are also potentially important gas generators.

3.2.6 Summary

During July 1988, brine was introduced into the AIS at the WIPP during construction operations. Some of this brine was spread in the underground workings for dust control and the question arose whether this created any impacts to worker health or WIPP scientific programs. As a result, a preliminary survey of the microbiology of the WIPP underground was performed in order to determine if any impacts had been introduced.

A sampling program was undertaken to provide an overview of the microbial populations actively metabolizing in the WIPP environment. The objectives were to determine the nature and extent of distribution of the microbes existing in the WIPP. Special attention was directed toward identifying any pathogenic organisms in the populations isolated that could impact worker health. This baseline survey would also establish the kinds of microbial metabolic effects that could be expected during operation and after closure of the repository. This information will be important to the Performance Assessment Source-Term Group. Samples of brine, muck, rib surfaces, and rib wall cores were taken for analysis. These samples were transported to the laboratories of Dr. Larry Jones at the UTEP, Biology Department. Culture methods were followed for isolation of microorganisms found in the samples. Special emphasis was placed on human pathogens, halotolerant and halophilic microbes, and special trophic types using standard methods.

Results showed that there are at least 48 halotolerant aerobic microbes living in the WIPP. No human pathogens were found. Also isolated were several anaerobic microbes, although specific nutritional requirements could not be determined. All isolates were found in brine. All were at least halotolerant and some may be true halophiles. It could not be conclusively determined whether there are any indigenous organisms in the Salado Formation, although some organisms exhibited that potential and some closely resemble the halophilic microbes indigenous to the nearby Nash Draw salt ponds. Several microbes have potential to produce significant quantities of gas.

Eleven conclusions were drawn that characterize the microbial populations by type and distribution in the underground. It is not recommended that further examination for pathogens be undertaken.

This study of microbial organisms is an important baseline, and it is recommended that the WIPP and environs should be further sampled to obtain information on distribution and populations of microbes. The specific cultures being maintained at UTEP and any new organisms isolated should be extensively characterized as part of the experiments to be performed to support performance assessment.

3.2.7 Recommendations

As no pathogenic microbes were found in either brine or rock salt samples, there appears to be no likelihood that pathogens will be of concern during operations. Therefore, a follow-up study focusing on pathogens is not recommended. However, additional sampling of the WIPP should be pursued as part of a continuing general study of microbial activity in the repository. Specifically, microbes that inhabit the WIPP are important to the experiments to be conducted for gas generation. The denitrifying (converting nitrates to nitrogen gas), sulfate-reducing (converting sulfates to hydrogen sulfide), and methanogenic microbes are especially important to gas and water budgets and gas-generation potential. The cultures isolated during this study should be maintained for further experimentation.

4.0 CHARACTERIZATION OF FORMATION PROPERTIES RELATED TO BRINE

4.1 MOISTURE CONTENT OF THE SALADO FORMATION AT THE WIPP

4.1.1 Introduction

The existence of moisture in the Salado Formation at the WIPP facility horizon has previously been discussed by Deal and Case (1987) and Deal and others (1987). They have shown that moisture occurs in the facility rocks principally in:

- Hydrous minerals (mostly gypsum and clay),
- Fluid inclusions in bedded salt,
- Intergranular porosity, and
- Open fractures.

The present study was designed to determine the measurable variations of the moisture content of rocks very near the excavations. Specifically, the tasks were to evaluate what areal or stratigraphic variation exists in the host rock and determine if there are distinct locations of brine sources.

Because areal and stratigraphic variations were anticipated to be the dominant parameters affecting moisture content, the sampling and testing program was designed to identify possible correlations. Representative samples from specific stratigraphic horizons were collected at each sampling location. The program characterized four distinct areas in the underground: (1) Area 1, the Panel 1 waste area; (2) Area 2, a newly excavated drift (Air Intake Shaft access drifts); (3) Area 3, an older northern drift excavation with some additional recent excavations for a booster fan installation (near N1100 and E140); and (4) Area 4, the northern experimental area excavated in the upper stratigraphic sequence. The areas were arbitrarily defined and are shown in Figure 4-1. Each area was sampled extensively on a stratigraphically controlled pattern. The specific sample locations for each area are shown in Figures 4-2 through 4-7.

4.1.2 Previous Studies

The BSEP Phase II Report (Deal and others, 1987) presented the background information on the previous studies and programs that evaluated the moisture content of the WIPP facility host rock. These studies investigated the brine content of the facility interval strata to address the WIPP site qualification criteria (Black and others, 1983). The conclusions of the previous studies will be summarized here.

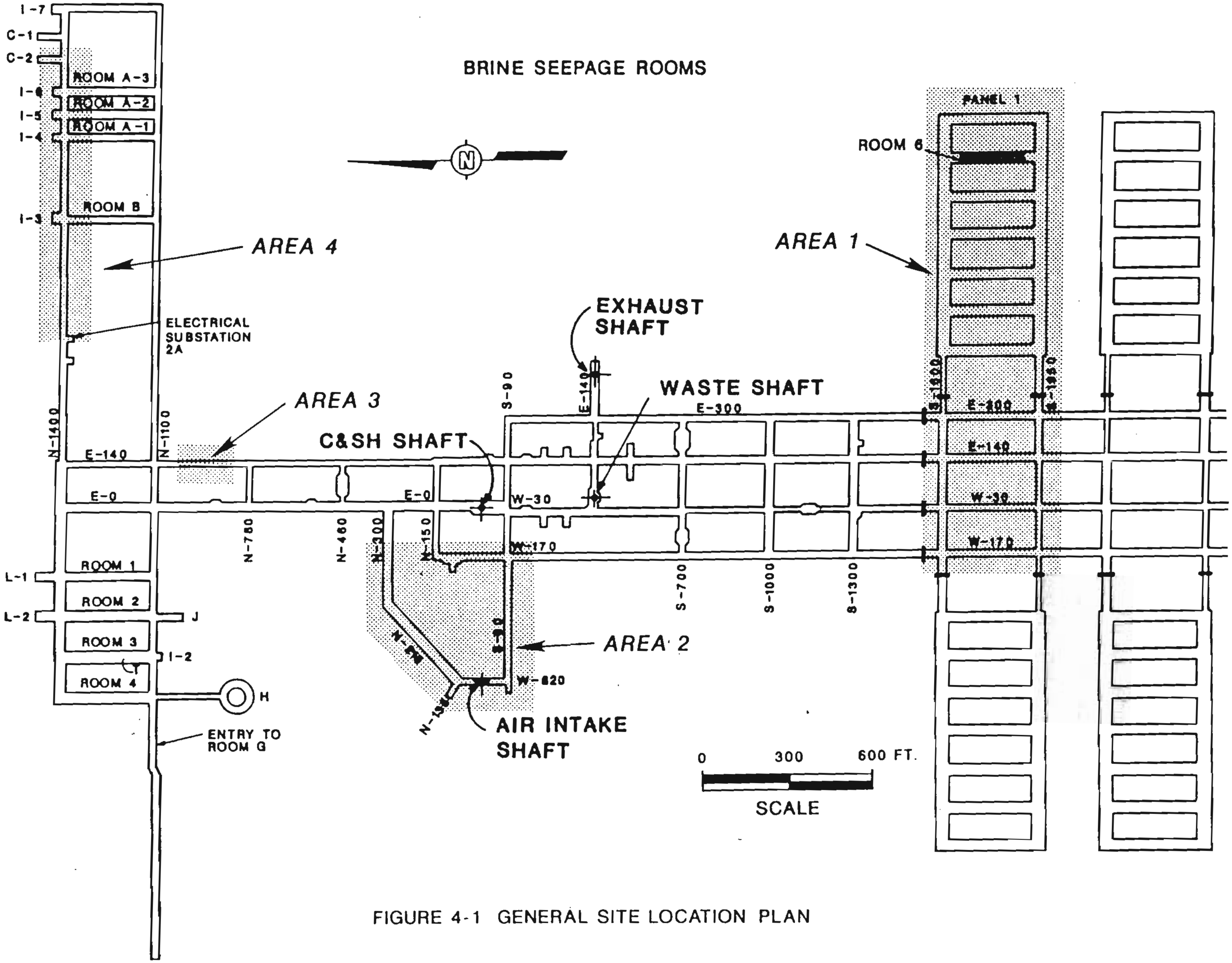

FIGURE 4-1 GENERAL SITE LOCATION PLAN

301407 03 01 A10

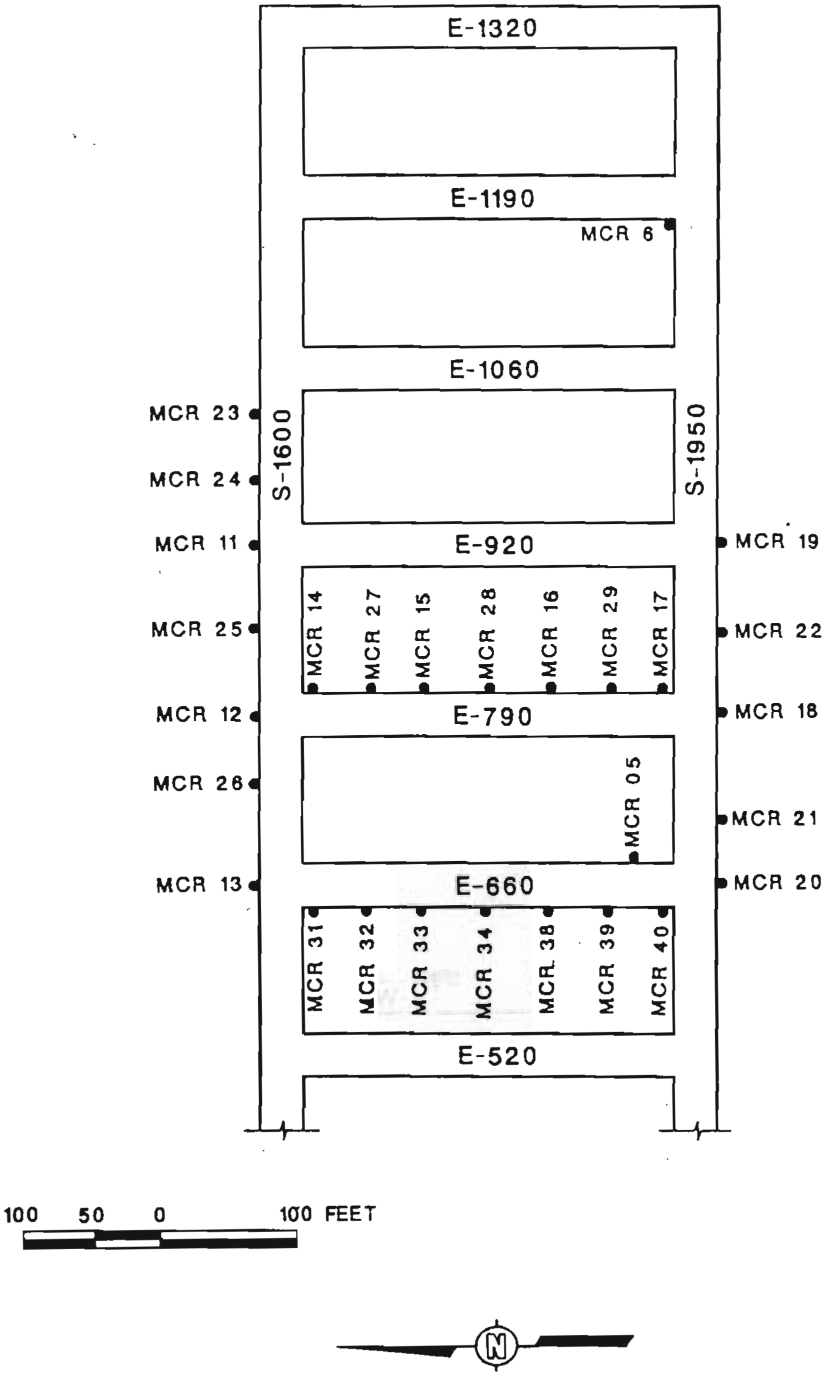

FIGURE 4-2 AREA 1 SAMPLING LOCATIONS

301001 89 08 02 A5

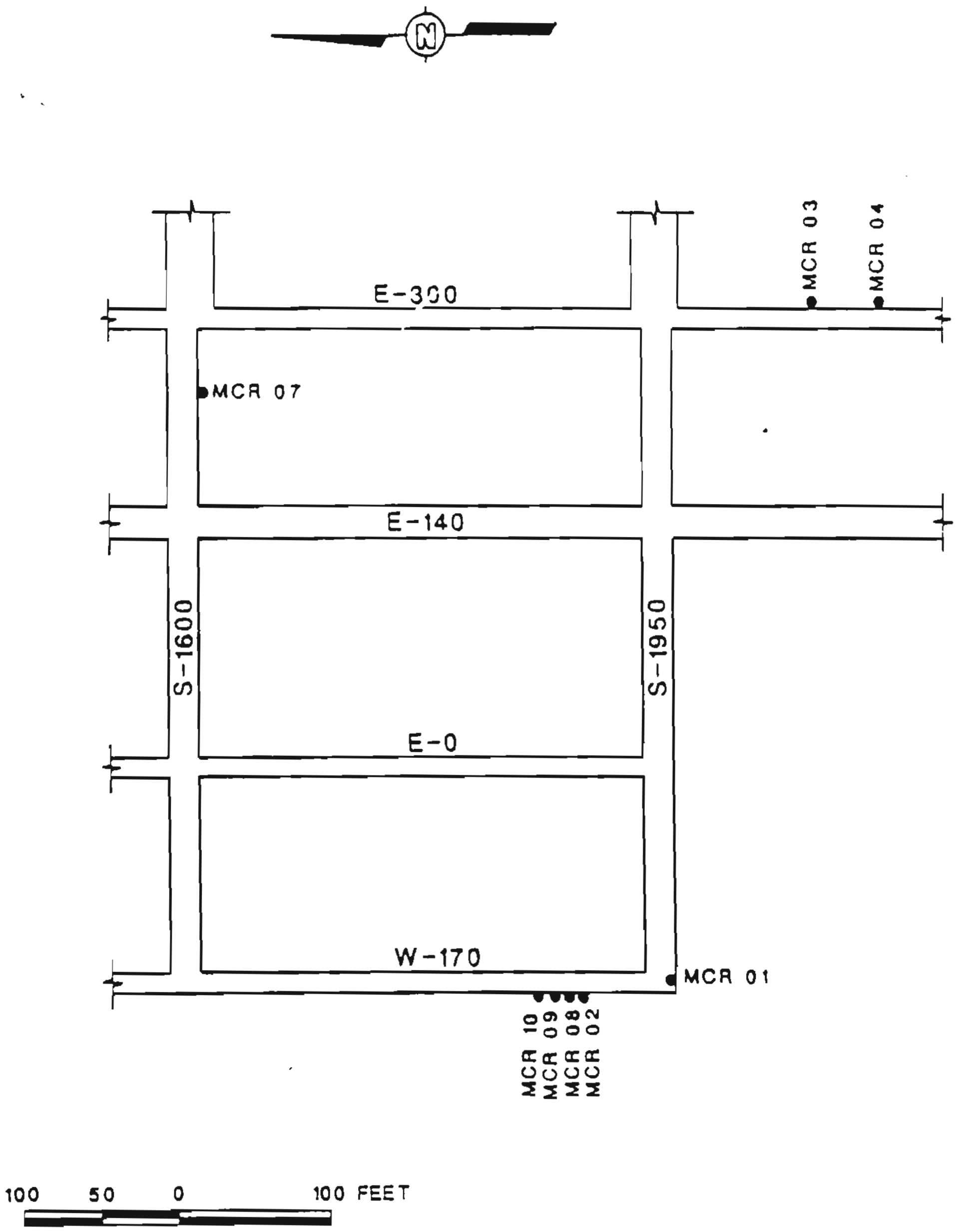

FIGURE 4-3 AREA 1 SAMPLING LOCATIONS (CONT'D)

301001 89 08 02 A6

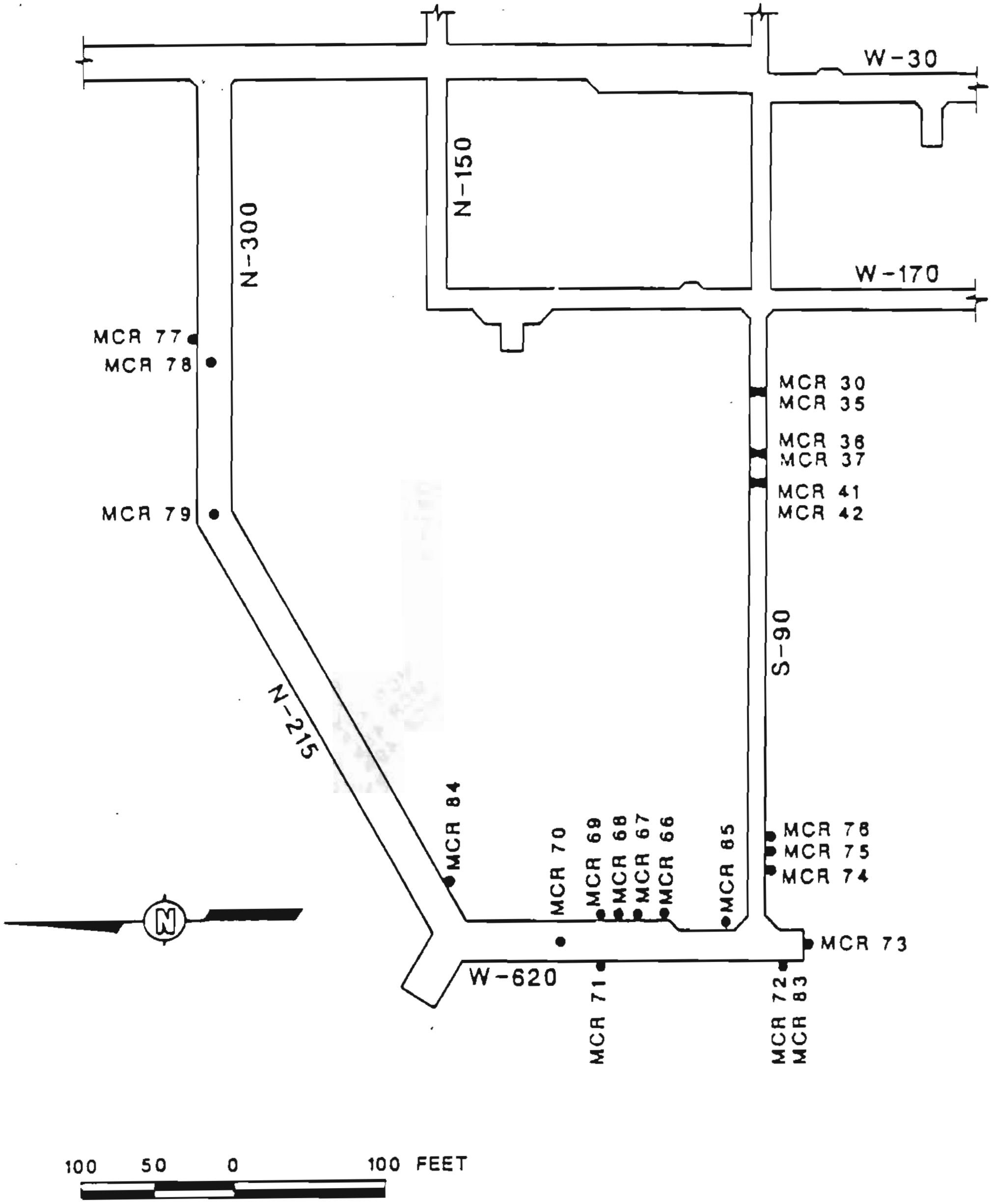

FIGURE 4-4 AREA 2 SAMPLING LOCATIONS

301407 03 01 A11

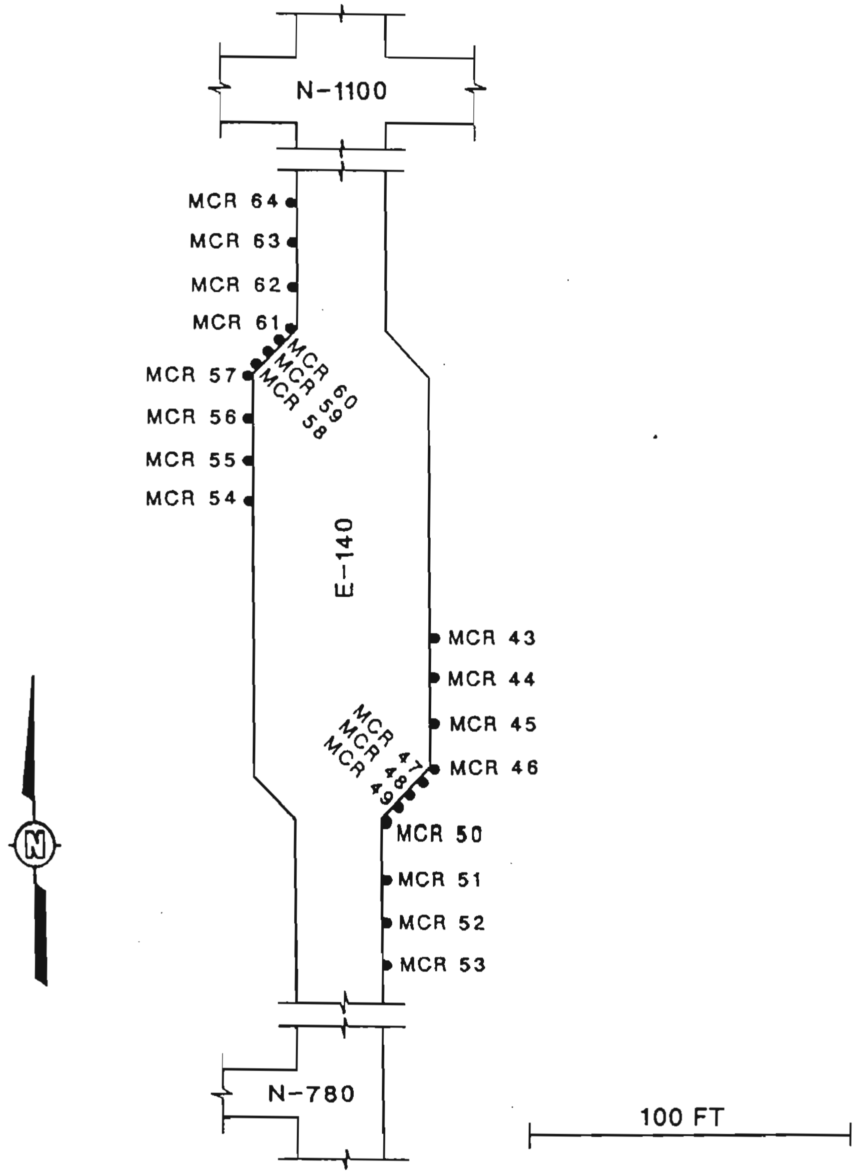

FIGURE 4-5 AREA 3 SAMPLING LOCATIONS

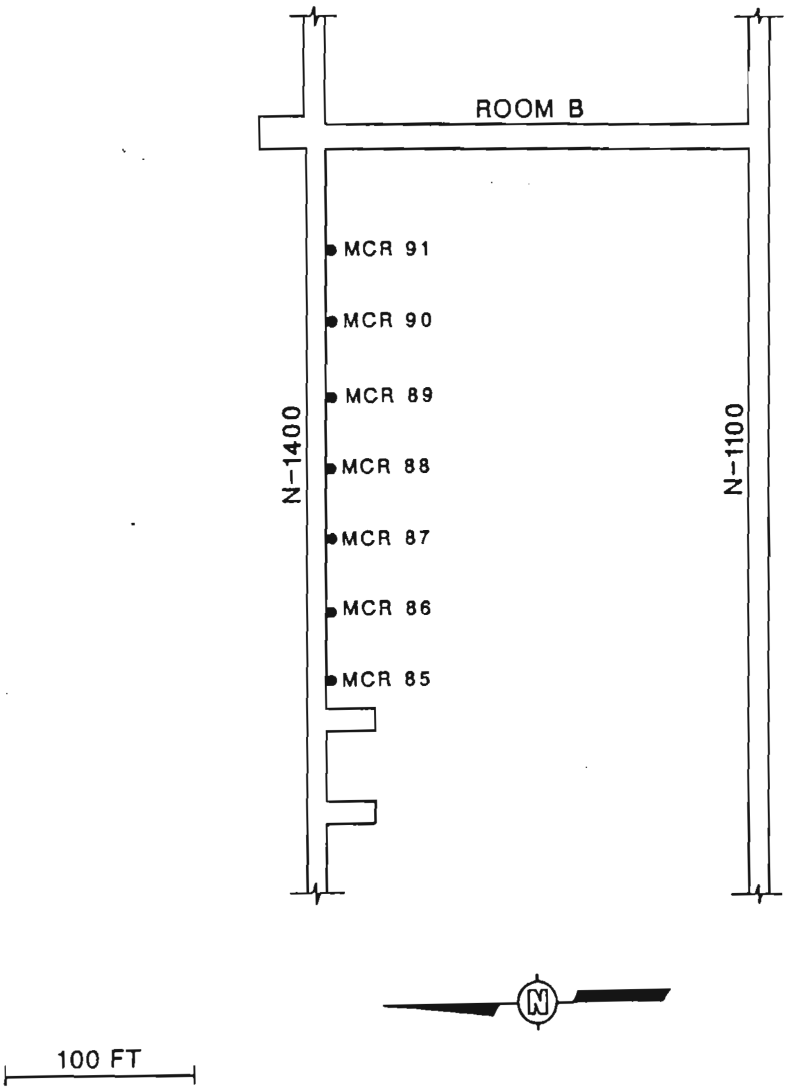

FIGURE 4-6 AREA 4 SAMPLING LOCATIONS

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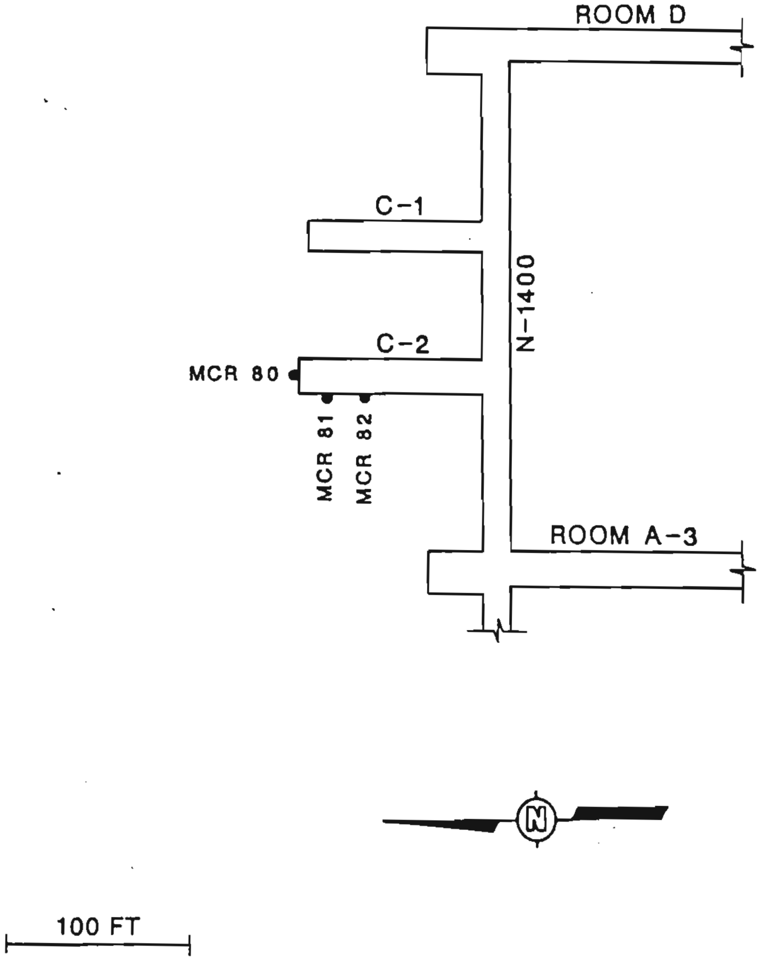

FIGURE 4-7 AREA 4 SAMPLING LOCATIONS (CONT'D)

The Geological Characterization Studies (Powers and others, 1978) included differential thermal analyses (DTA) and thermogravimetric analyses of samples ground to a small grain size. A number of different responses to heating were exhibited by the samples analyzed. Heating to 70°C was designed to measure absorbed water. Depending on sample constituents, moisture loss at 70°C ranged from 0 to 1.9 percent by weight, with values typically in the 0.20 to 0.30 percent range. The range of weight loss at 102°C ±5°C was from 0 to 3.5 percent by weight, with the majority of samples showing less than 0.5 percent weight loss. Most samples showed very little weight loss between 200°C and 300°C (Powers and others, 1978).

The Site Validation Program (SVP) was initiated, in part, to address the moisture content of the disposal stratum at the facility (Black and others, 1983). The thermogravimetric analysis of 24 samples in the SVP studies indicated that most of the free water was liberated from the rock salt in the range of 25°C to 250°C. Water released from the dehydration of polyhalite and illite occurred in the range of 250°C to 400°C. The authors (Black and others, 1983) concluded that the average weight loss for each of the temperature ranges was as follows:

- 25°C to 250°C: 0.10 percent,
- 250°C to 400°C: 0.12 percent, and
- 400°C to 500°C: 0.34 percent.

A study conducted by Hohlfelder (1981) on samples from the McNutt Potash Zone in the Upper Salado Formation indicated an average moisture loss of 0.51 percent by weight for samples weighing approximately 400 grams and heated to 424°C. These results were similar to another Hohlfelder study (1979) using much smaller samples (20 grams). Both studies indicated a mass loss of less than 0.08 percent for temperatures below 230°C. The U.S. Geological Survey (1974) also analyzed samples from the McNutt Potash Zone obtained from well AEC No. 8. The average moisture content for 30 core samples heated to 60°C was 2.2 percent.

These previous studies were used to direct the current activities and design a sampling and analysis scheme. The previous studies demonstrated that rock containing free and bound water will lose water at discrete temperatures, depending on how tightly bound the water is in the specimen. Free interstitial water will be lost at lower temperatures, whereas water of hydration will be lost at higher temperatures. The moisture content of the host rock in this current study was defined as the easily moved liquid at low-temperature ranges. A temperature range of 95°C to 150°C was selected to be representative of the free water in a sample that is easily driven off by heating.

4.1.3 Sampling Methodology

The sample collection phase of the program was conducted intermittently from January 1987 through January 1988. A total of 545 samples were collected, the majority of which were shallow core samples taken from the rib surface of the excavations. A small number of the samples were taken from vertical coreholes drilled from the facility horizon, and others were obtained as bulk samples immediately after mining.

Figures 4-2 through 4-7 are maps showing specific sampling locations. These figures indicate that the most extensive sample coverage was accomplished in Area 1, both because the underground excavation sequence allowed ready access and because Panel 1 was of particular interest as the first area proposed to receive waste at the facility.

In general, six core specimens were obtained at each of the sample locations at the facility horizon. The specimens were selected to represent the dominant lithologic types (Units 0 through 4 in Figure 2-2). In areas where excavation dimensions or stratigraphy differed, the number of core specimens was modified accordingly and additional units were sampled.

Samples from the shallow horizontal coreholes were obtained by dry drilling, without air circulation, using a single thin-walled diamond core barrel. The core barrel was advanced with a hand-held electric power drill. The final core dimension was 4.1 cm in diameter and approximately 15 cm long. Specimens were placed in moisture-tight containers until the laboratory analyses were conducted, as per WIPP sample procedures.

4.1.4 Laboratory Analysis

The moisture content determinations are based on the easily moved liquid in the low-temperature range (25°C to 250°C) defined in thermogravimetric studies (Powers and others, 1978; Black and others, 1983). The easily moved fluid, for purposes of this study, was defined as that fluid contained in the rock that can flow through interconnected pore spaces and existing fractures, is not bound chemically or as intragranular inclusions, and is easily driven off by heat. It is this easily moved fluid that is most likely to flow toward the excavation under mining-induced pressure gradients.

Samples analyzed for moisture content were obtained from the previously described coring process. The specimens were heated to temperatures of 95°C and 150°C, as per WIPP procedures. The temperature range evaluated was selected based on previous studies conducted and discussed in Section 4.1.2. This temperature range was considered to be within the range from which most intergranular free water is liberated, but well below the temperature causing decrepitation of the sample and rupture of intragranular fluid inclusions.

The fluid content of the specimen was calculated with the following formula:

$$F_c = (W_l / W_{SB}) \times 100 \text{ percent} \qquad (4.1)$$

where

F_c = fluid content by percent weight,
W_l = weight loss during drying, and
W_{SB} = weight of sample before drying.

This relationship provides the moisture content of the specimen as a percent of the total original weight of the specimen. Results for all specimens collected in this study are provided in Appendix G.

4.1.5 Results Evaluation

Analysis of the moisture content data developed to evaluate the areal and stratigraphic variations in the rock moisture content was accomplished with several appropriate statistical techniques and other qualitative graphical and numerical comparisons. The following sections discuss these approaches and provide an interpretation of the results. A frequency curve for all samples heated to 95°C is provided as Figure 4-8 for reference in this section.

4.1.5.1 Sample Size

The adequacy of the sample sizes was evaluated by applying the standard error of the mean method to the data. This method approximates the number of sample points required to satisfy a given bound on the error of estimation and confidence interval. The method, as discussed by Mendenhall (1975), requires knowledge of the standard deviation from previous sampling, an approximation of the value, or, as applied here, an exact value. An acceptable error of estimation for this application was arbitrarily chosen as 0.2 percent moisture. The empirical rule states that a 95 percent probability is expected at two standard deviations. A 95 percent probability (two standard deviations) was arbitrarily applied to the evaluation performed in this report.

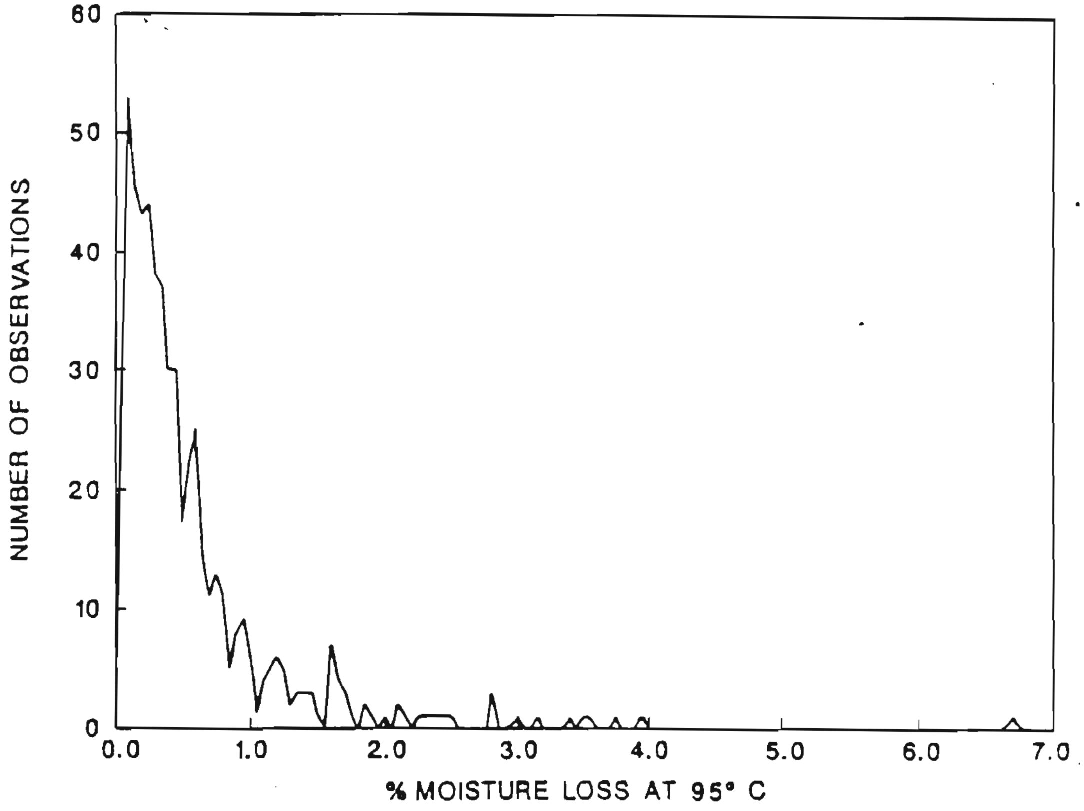

FIGURE 4-8 FREQUENCY CURVE FOR ALL SAMPLES AT 95° C

The sample size evaluation indicates that adequate sampling was obtained for Units 0 through 4 as a group and Units 0 through 4 individually. Some of the upper stratigraphic units were not adequately represented as determined by this approximation, due to the limited sampling effort in the upper sequence.

4.1.5.2 Spatial Comparisons

One of the primary intents of this study was to evaluate whether an areal variation in the host rock moisture content exists. To accomplish this, several statistical techniques were used to evaluate whether the sample sets for individual areas came from the same population. If all sample groups could be interpreted to have come from the same population, the probability of spatial differences would be low at a selected confidence level.

The Kolomogorov-Smirnov (KS) statistic is a technique that can be used to test the null hypothesis that two sample frequency distributions were drawn from populations having the same distribution (Miller and Kahn, 1962). This statistic is nonparametric; no assumptions need be made regarding the form of the distribution, nor is the test subject to very small sample size limitations. The technique is graphic and requires that the maximum separation between two cumulative frequency distributions be measured from the plotted curves of those distributions. The hypothesis that two distributions come from the same population is accepted if the measured maximum deviation of the sample pairs is less than what would be allowed for a selected confidence interval and known sample size, as determined from published graphs or formulas.

The KS statistic was applied to combinations of data representing similar stratigraphic intervals from Areas 1, 2, and 3 (Figure 4-1) to evaluate whether sample sets coming from distinctly different underground locations could be interpreted as being derived from the same population. This would imply that no areal variations exist in the sample sets. The spatial difference comparison for the first three sample sets was accomplished by comparing Area 1 versus Area 2, Area 1 versus Area 3, and Area 2 versus Area 3. Area 4 was not included in this analysis because it is comprised predominantly of samples from the upper stratigraphic sequence with different lithologic characteristics. The analysis was limited to the three sample sets representing similar stratigraphic intervals. Figure 4-9 presents the cumulative frequency curves for the three areas analyzed. In all cases, the

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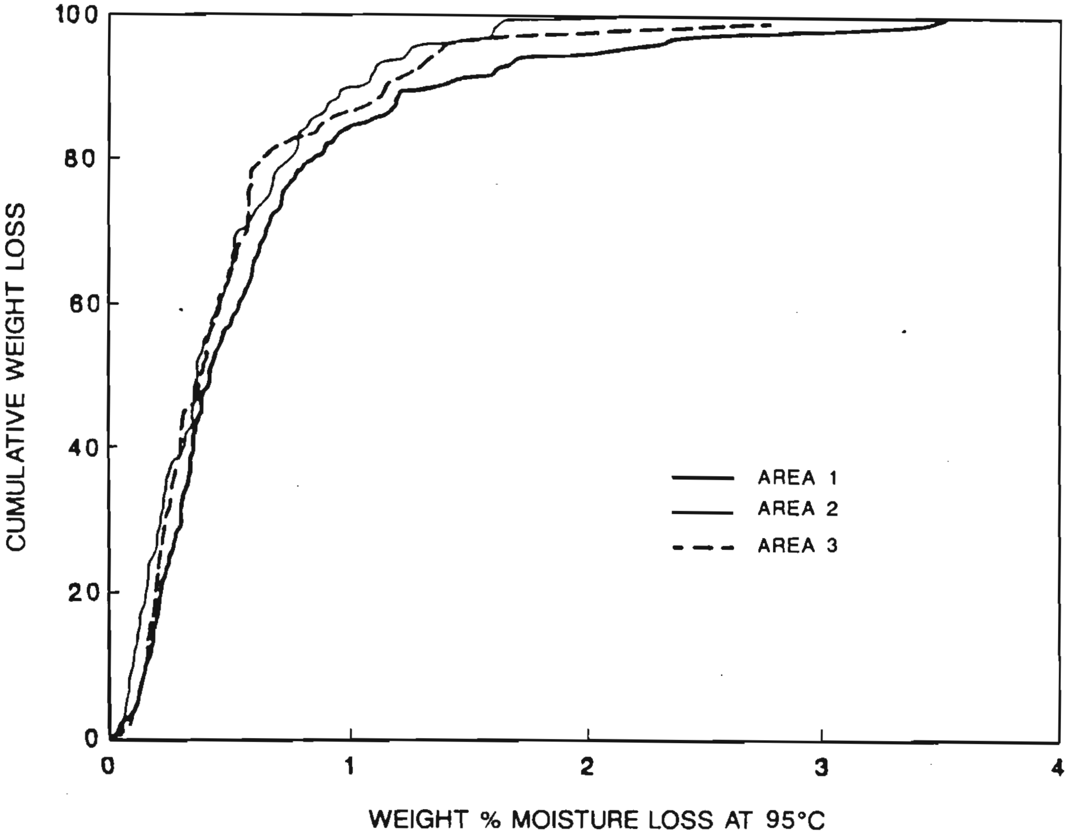

FIGURE 4-9 CUMULATIVE FREQUENCY PLOTS OF AREA 1, 2, AND 3 DATA

distributions for the areas were determined to come from the same population at the 95 percent confidence level. Although the groups are areally separated, no systematic statistical difference exists and the null hypothesis is satisfied.

The T-Test was also applied to the data to provide a further test of the degree of spatial variation in moisture contents. This test is an analytical approach used to test the null hypothesis (that two sample sets may be accepted as coming from the same population), much like the KS statistic. However, unlike the KS statistic, the T-Test assumes that the variables are normally and independently distributed. The T-Test was applied to the same sample set pairs as the KS statistic. The variables were assumed to be normally distributed as discussed in the following section (Section 4.1.5.3). The T-Test analysis was performed using a commercially available statistical software package for personal computers called SAS (SAS Institute, 1985).

The spatial difference comparisons for Area 1 versus Area 2 and Area 2 versus Area 3 were accepted as having come from the same population. Comparison of Area 1 to Area 3 resulted in rejection of the null hypothesis. This is based on a confidence interval of 90 percent, which is a reasonable assumption for the two T-Tests. The slight discrepancy between the T-Test and the KS statistic test results (where the T-Test rejected the Area 1 versus Area 3 comparison) may be explained by the fact that the Area 2 distribution is similar enough to the Area 1 and Area 3 distributions to be considered from the same population, but Area 1 and Area 3 are far enough to either extreme that they are not interpreted to be of the same population. Also, the graphic approach in the KS statistic may not provide the same resolution as a pure analytical technique (T-Test) and a greater error may be introduced in using the KS test. Regardless, results from either technique are close enough to conclude that no difference exists between areas with similarly sampled stratigraphy and that any spatial differences between areas are negligible.

4.1.5.3 Testing Distributional Assumptions

The W-Test and F-Test were used to evaluate the assumption of a normal or log-normal distribution. Normal distributions were assumed in applying the T-Test in the above evaluation. A SAS procedure using a method developed by Shapiro and Wilk for the W-Test was applied to the sample sets (SAS Institute, 1985). The F-Test compares a ratio of the two group's variances against tabulated values for acceptance or rejection of a hypothesis. The details of these approaches will not be discussed here.

The majority of tests rejected the populations as being normally distributed because of the limited data and low probability. Therefore, it was concluded that the distributions tested are not normal. However, the central-limit theorem states that, under general conditions, samples of random measurements drawn from a population tend to possess an approximately normal distribution in repeated sampling (Mendenhall, 1975). Further, earth processes will be normally distributed if large samples are included in the population sample set (Mendenhall, 1975). Therefore, the frequency distributions were treated as normal distributions and application of the T-Test was then considered appropriate. (If normality was not assumed, few, if any, other techniques would be suitable in this evaluation.)

4.1.5.4 Stratigraphic Comparison

The majority of sampling was conducted in Units 0 through 4 (Figure 2-2). A summary of the maximum and minimum moisture contents for the units sampled is provided in Table 4-1. Also included are the number of samples from each unit and the average moisture for the units. The averages for Units 0 through 4 range from 0.2 percent to 0.88 percent. The "solution pits" located in the repository horizon fell within the range defined by the averages of Units 1 through 4, but clay seam F and Unit 5 are greater than 1 percent outside that range. These three horizons have been sampled to a lesser extent (total of 15 specimens). The maximum and minimum values for repository-level sampling range from 6.67 percent (for one isolated clayey sample in Unit 0) to 0.01 percent (for a clear halite specimen in Unit 3).

The specimens collected from older drift excavation surfaces are generally represented by Units 6 through 14 (Figure 2-2). The moisture values for these units range from a maximum of 1.64 percent to a minimum of 0.02 percent with unit averages ranging between 0.58 percent to 0.08 percent. The average moisture content of the upper stratigraphic units is less than 0.5 weight percent.

Deal and others (1987) concluded that greater variability in the clay content in a unit resulted in greater variability in the moisture content. As the clay content increases, the moisture content also increases. Comparison of unit descriptions from Figure 2-2 and average moisture contents listed in Table 4-1 support this conclusion. These data show that units generally having argillaceous zones will tend to have higher average moisture contents and also will have greater deviations from the mean.

TABLE 4-1

SUMMARY OF UNIT MOISTURE CONTENT (WEIGHT PERCENT; SAMPLES HEATED TO 95°C)

UNIT	MAXIMUM	MINIMUM	N	MEAN	STANDARD DEVIATION
14	0.31	0.15	3	0.23	0.08
13	0.21	0.05	3	0.12	0.08
12	0.17	0.05	11	0.13	0.04
11 (Anhydrite "a")	0.98	0.16	6	0.58	0.36
9	0.11	0.05	28	0.08	0.02
8 (Anhydrite "b")	1.44	0.07	5	0.47	0.57
Clay G	2.44	1.34	9	1.75	0.34
7	1.64	0.13	20	0.42	0.34
6	0.59	0.02	22	0.16	0.14
5	2.76	0.86	2	1.81	1.34
Clay F	3.94	0.87	3	2.23	1.56
4	3.75	0.04	104	0.88	0.82
3	0.84	0.01	62	0.24	0.15
2	1.70	0.22	53	0.74	0.37
1	0.94	0.03	69	0.20	0.15
0	6.67	0.08	136	0.66	0.70
*Solution Pits	0.71	0.11	10	0.39	0.22
All Units	6.67	0.01	545	0.55	0.64

*Penecontemperaneous feature having distinct lithology characteristics.

This conclusion is geologically reasonable, as the clays in the Salado Formation are probably relatively uncompacted. They were included within the massive salt, which is relatively impermeable and plastic, and appear to have remained there, probably since Permian time. The clay, in the deforming environment of the disturbed rock zone, may actually be undergoing compaction and may finally be able to release what was originally connate water to the underground excavations. This was observed to occur, at least locally, in the days immediately following the excavation of Room H in February 1985, where clay and moisture were quickly squeezed out of the central pillar, as verified through field observations by Deal (1985). Additionally, clay is commonly extruded from vertical surfaces in the WIPP underground in areas where active weeps occur (Figures 4-10 and 4-11).

4.1.5.5 Age Comparison

The effects of excavation age on the moisture content of the host rock were evaluated by three methods: (1) using an area (Area 3) that was reexcavated four years after the initial excavation to evaluate old and new surfaces in the same location; (2) performing qualitative analyses on limited vertical borehole data; and (3) statistically analyzing data throughout the repository for time effects on moisture content. For samples where age of excavation might be significant, the results would be expected to show that the distributions came from different populations. In other words, the frequency distribution curves for the older excavation samples were similar to the general population and, therefore, suggest that the age of excavation is insignificant.

Samples from Area 3 were used to evaluate moisture content as a function of relative time since excavation. They were divided into those samples taken from the old excavation surface, a newly excavated surface, and a transitional area between the two. The KS statistic was applied to these three areas, as was done for the spatial comparison of Areas 1, 2, and 3, described above. The results indicated that no systematic statistical difference existed between the sample sets.

Although a qualitative inspection of the averages for all samples collected in Area 3 (Table 4-2) indicates that the newer surfaces have slightly higher moisture contents, averages for similar stratigraphic units (Units 1 and 3) are nearly the same. Based on this qualitative comparison of similar stratigraphic units, age of excavation does not appear to be significant.

FIGURE 4-10

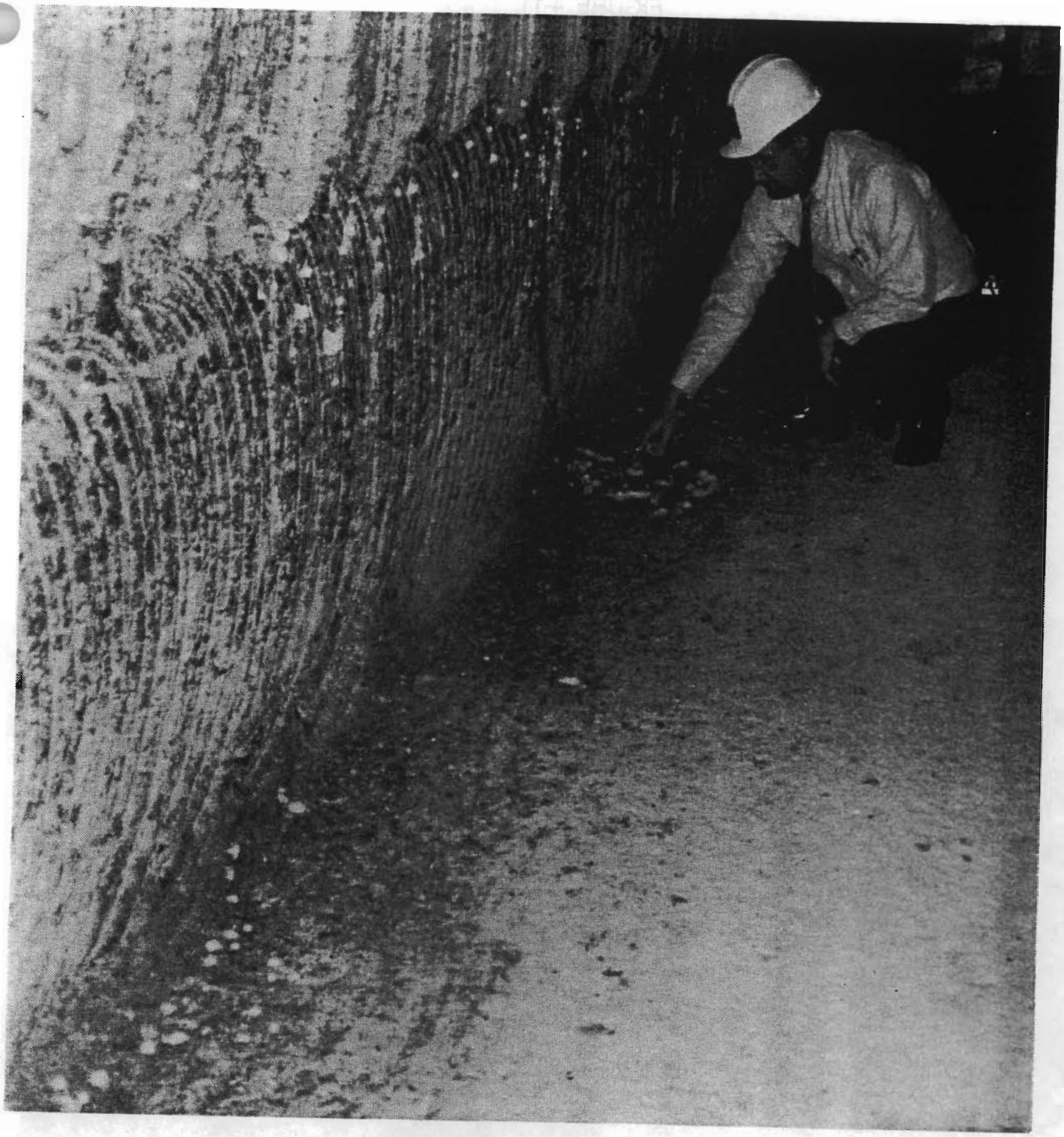

FIGURE 4–10 CLAY PELLETS IN EXCAVATION WALLS. HUNDREDS OF THOUSANDS OF SMALL CLAY PELLETS HAVE BEEN SQUEEZED OUT OF THE WALLS IN THE WIPP EXCAVATIONS. THE ACCUMULATION IS SEEN AS THE DARK BAND ABOUT ONE HALF METER WIDE ON THE FLOOR, AT THE BASE OF THE WALL. THIS EXAMPLE IS IN PANEL 1, ROOM 6.

FIGURE 4-11

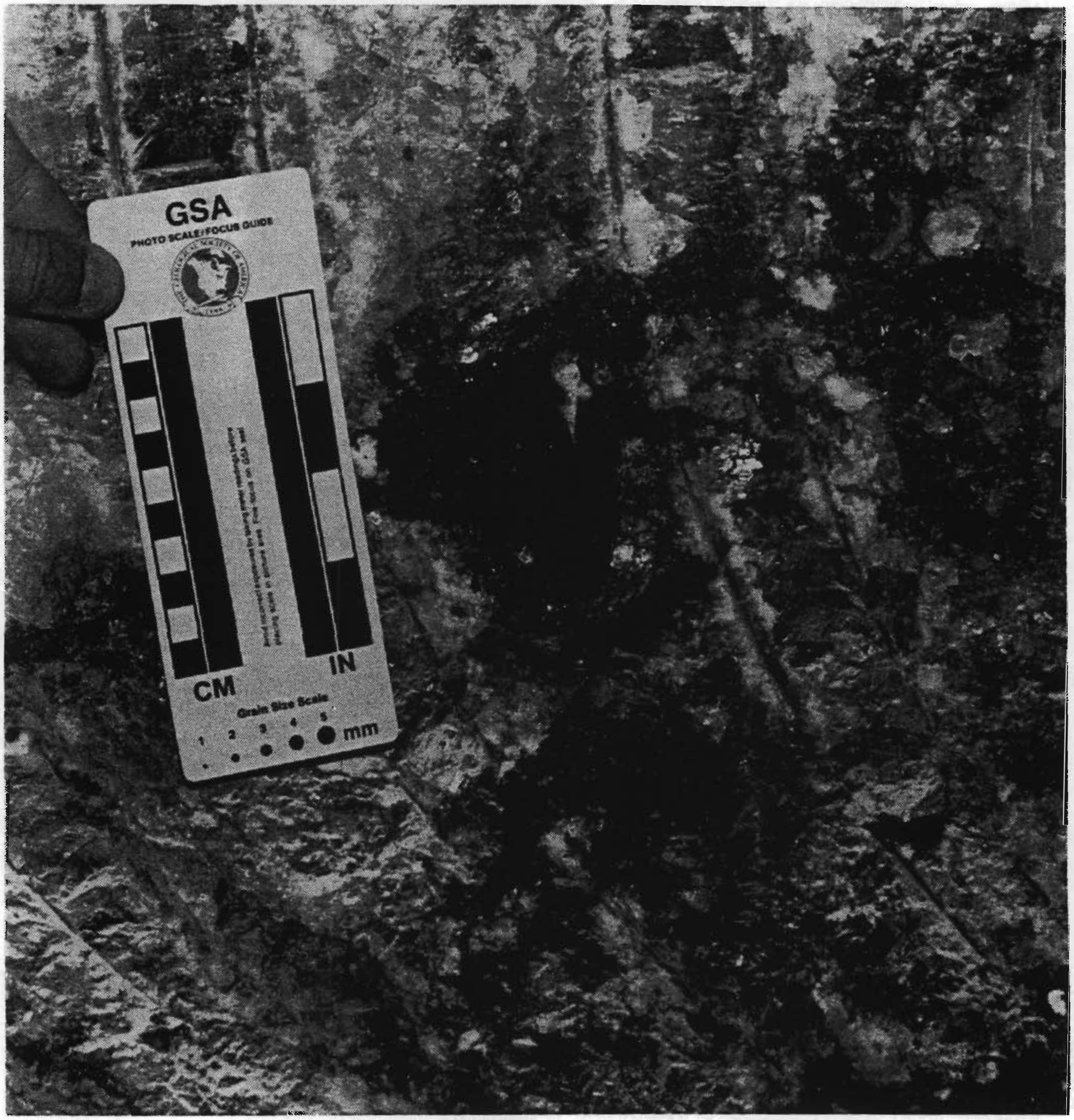

FIGURE 4-11 CLOSE-UP OF CLAY IN EXCAVATION WALL.
CLAY BLEB IN MAP UNIT 0, JUST BELOW THE
ORANGE MARKER BAND, PANEL 1, ROOM 6.

TABLE 4-2

SUMMARY OF AVERAGE UNIT MOISTURE CONTENT FOR AREA 3 SAMPLES

	MEANS		
	NEW	OLD	TRANSITION
All Samples	0.70	0.54	0.41
Select Units*	0.21	0.24	0.24

---

*NOTE: These samples represent Units 1 and 3.

Moisture content data collected in early sampling efforts from one corehole drilled vertically upward were presented in the BSEP Phase II report. Additional rib sampling of this upper sequence in Area 2 (Air Intake Shaft access drifts) and Area 4 (northern experimental area) has been accomplished and results of the analyses were compared to the vertical corehole data obtained earlier. Figure 4-12 presents the moisture content data summary for the corehole and rib excavation sampling. The correlation is very good, particularly considering that the sampling and time since excavation for the two sample sets differ by 18 months. The argillaceous halite unit at six feet of depth in the back appears to be the only unit to have experienced some drying between collection of the corehole and rib samples. The moisture contents for the remaining corresponding units in the corehole and ribs correlate very well. There does not appear to be any influence due to time of sampling.

The effects of age on sample moisture contents were also examined by arbitrarily grouping the data into sets representing six-month time periods between excavation and sampling. The data were combined; means, medians, and standard deviations were calculated and the averages plotted for the time groups. No discernible trends were recognized. Another qualitative exercise was performed by plotting the difference between the 95°C and 150°C moisture contents versus the time since excavation. This approach did not suggest a relationship between moisture content and time since excavation. Neither of these preliminary approaches was pursued further, nor have the results been presented in this report.

4.1.5.6 Other Studies

Several other studies evaluating the moisture content of the repository host rock were discussed previously. They were performed in the Site Validation Program, by Hohlfelder (1979), the U.S. Geological Survey (1974), and in early portions of the BSEP (Deal and Case, 1987; Deal and others, 1987). The results of these studies are summarized in Tables 4-3 through 4-6.

Figure 4-13 shows the cumulative frequency curves for the data presented in Appendix G and Tables 4-3 through 4-6. The figure is provided as a qualitative comparison. It should be recognized that the samples analyzed in these studies come from different zones (i.e., McNutt Potash Zone) and different stratigraphic sequences and were analyzed at different temperatures using different techniques. The variations in parameters between the studies do not allow them to be directly related to the current program. However, it is evident that the trends for the BSEP rib and corehole data are similar (Figure 4-12). The corehole data was derived from limited sampling of horizons above and below the actual repository level.

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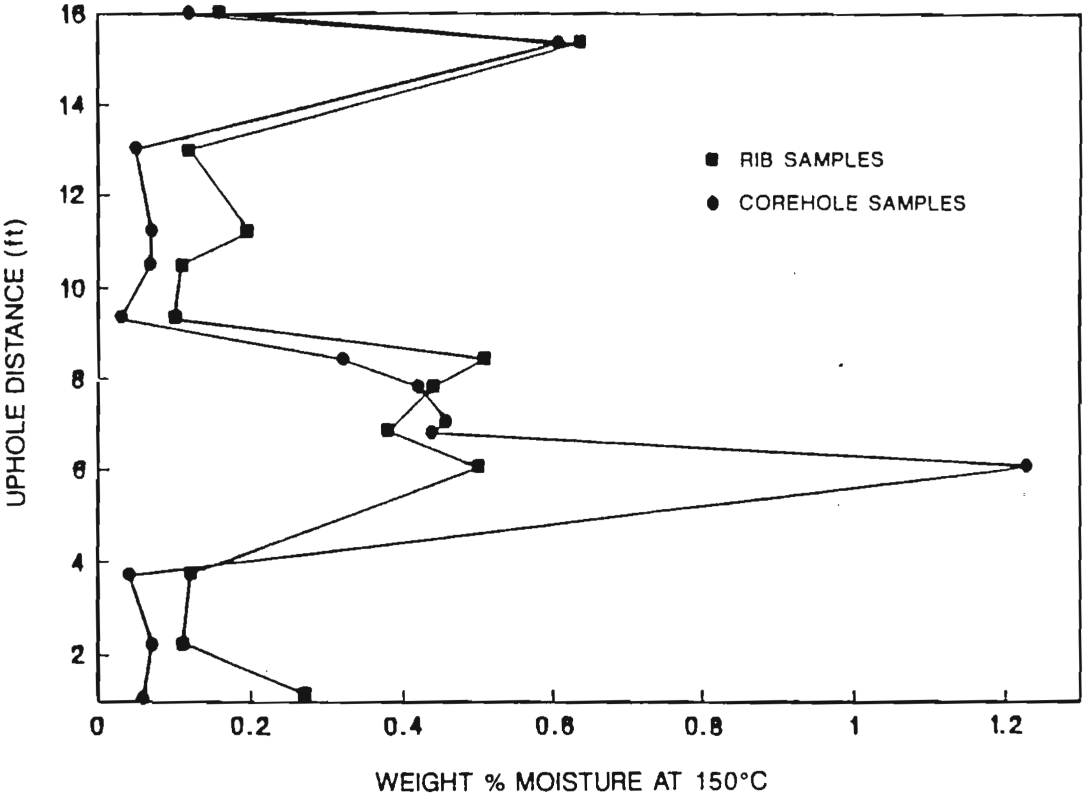

FIGURE 4-12 COREHOLE VERSUS RIB SURFACE DATA

TABLE 4-3

MOISTURE CONTENT DATA FROM BSEP VERTICAL COREHOLE SAMPLING

SAMPLE NUMBER	DATE SAMPLED	GEOLOGIC UNIT	SAMPLED (DAYS AFTER EXCAVATION)	CUMULATIVE PERCENT WEIGHT LOSS AT	
				95°C	150°C
BTP 01	06/30/86	UNIT 6	299	0.05	0.07
BTP 02	06/30/86	UNIT 6	299	0.05	0.07
BTP 03	06/30/86	UNIT 6	299	0.03	0.04
BTP 04	07/01/86	UNIT 7	300	1.14	1.23
BTP 05	07/01/86	UNIT 7	300	0.40	0.44
BTP 06	07/01/86	UNIT 7	300	0.38	0.42
BTP 07	07/01/86	ANHYD B	300	0.28	0.32
BTP 08	07/01/86	UNIT 9	300	0.03	0.03
BTP 09	07/01/86	UNIT 7	300	0.43	0.46
BTP 10	07/01/86	UNIT 9	300	0.06	0.07
BTP 11	07/01/86	UNIT 9	300	0.06	0.07
BTP 12	07/01/86	UNIT 9	300	0.00	0.00
BTP 13	07/01/86	UNIT 9	300	0.04	0.05
BTP 18	07/15/86		314	0.25	0.26
BTP 19	07/15/86		314	0.24	0.25
BTP 20	07/15/86		314	0.50	0.51
BTP 21	07/15/86		314	1.14	1.20
BTP 22	07/15/86		314	0.22	0.23
BTP 23	07/15/86		314	0.09	0.10
BTP 24	07/16/86		315	0.20	0.20
BTP 25	07/16/86		315	0.09	0.11
BTP 26	07/16/86		315	0.21	0.24
BTP 27	07/16/86		315	0.08	0.12
BTP 28	07/16/86		315	1.61	1.66
BTP 29	07/16/86		315	0.70	0.71
BTP 30	07/17/86		316	0.26	0.27
BTP 31	07/18/86		317	0.12	0.13
BTP 32	07/18/86		317	0.12	0.16
BTP 33	07/18/86		317	0.06	0.15

TABLE 4-3

MOISTURE CONTENT DATA FROM BSEP VERTICAL COREHOLE SAMPLING
(CONTINUED)

SAMPLE NUMBER	DATE SAMPLED	GEOLOGIC UNIT	SAMPLED (DAYS AFTER EXCAVATION)	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
BTP 34	07/18/86		317	0.12	0.19
BTP 35	07/18/86		317	0.14	0.16
BTP 36	07/18/86		317	0.18	0.18
BTP 37	07/18/86		317	0.32	0.34
BTP 38	07/18/86		317	1.54	0.57
BTP 39	07/30/86		329	0.24	0.27
BTP 40	07/30/86		329	0.13	0.13
BTP 41	07/30/86		329	0.10	0.11
BTP 42	07/30/86		329	0.10	0.10
BTP 43	07/30/86		329	0.62	0.62
BTP 44	07/30/86		329	0.13	0.13
BTP 45	08/05/86		335	0.00	0.61
BTP 46	08/05/86		335	0.00	0.12

TABLE 4-4

MOISTURE CONTENT DATA FROM THE SITE AND PRELIMINARY DESIGN VALIDATION PROGRAM

SAMPLE NUMBER	DATE SAMPLED	GEOLOGIC UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 250°C	400°C	400°C
WIPP-FH-01	11/04/82		5	0.00	0.17	0.28
WIPP-FH-04	11/08/82		24	0.02	0.20	0.28
WIPP-FH-06A	11/11/82	UNIT 3	0	0.04	0.37	0.45
WIPP-FH-06B	11/11/82	UNIT 0/3	0	0.19	0.19	1.16
WIPP-FH-06B2	11/11/82	UNIT 0/3	0	0.03	0.06	0.11
WIPP-FH-10	11/04/82		12	0.04	0.07	0.47
WIPP-FH-11	11/04/82		12	0.08	0.08	0.29
WIPP-FH-14	11/04/82		12	0.00	0.11	0.19
WIPP-FH-16	11/10/82		17	0.03	0.03	0.35
WIPP-FH-20	11/17/82		0	0.15	0.23	0.68
WIPP-FH-24	11/26/82		1	0.02	0.11	1.51
WIPP-FH-26	12/07/82		0	0.01	0.03	0.08
WIPP-FH-27	12/14/82		0	0.04	0.23	0.38
WIPP-FH-28	12/17/82		29	0.22	0.49	0.82
WIPP-FH-31	12/22/82		6	0.13	0.66	0.78
WIPP-FH-32	12/22/82		0	0.22	0.31	0.84
WIPP-FH-33	01/06/83		0	0.22	0.30	0.58
WIPP-FH-34	01/06/83		0	0.08	0.14	0.32
WIPP-FH-35	01/17/83		8	0.01	0.01	0.05
WIPP-FH-36	01/15/83		2	0.07	0.12	0.18
WIPP-FH-37	01/21/83		0	0.26	0.37	0.76
WIPP-FH-40	01/20/83		88	0.04	0.17	0.45
WIPP-FH-43	01/19/83		7	0.00	0.37	0.86
WIPP-FH-45	01/23/83		3	0.27	0.38	1.46
WIPP-FH-48	01/31/83		93	0.11	0.25	0.44
WIPP-FH-49	01/29/83		4	0.20	0.25	0.85

TABLE 4-5

MOISTURE CONTENT DATA FROM HOHLFELDER

SAMPLE NUMBER	DATE SAMPLED	GEOLOGIC UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 200°C	250°C	400°C
1	NA	POTASH ZONE	0	0.02	0.08	0.41
2	NA	POTASH ZONE	0	0.03	0.09	0.43
3	NA	POTASH ZONE	0	0.01	0.05	0.46
4	NA	POTASH ZONE	0	0.03	0.04	0.47
5	NA	POTASH ZONE	0	0.03	0.05	0.29
6	NA	POTASH ZONE	0	0.03	0.10	1.19
7	NA	POTASH ZONE	0	0.04	0.04	0.24
8	NA	POTASH ZONE	0	0.03	0.12	0.64
9	NA	POTASH ZONE	0	0.03	0.06	0.35

TABLE 4-6

MOISTURE CONTENT DATA FROM USGS-WELL NO. AEC-8 (McNUTT POTASH ZONE)

SAMPLE NUMBER	DATE SAMPLED	GEOLOGIC UNIT	SAMPLED DAYS AFTER EXCAVATION	PERCENT WEIGHT LOSS AT 60°C
8-01	05/30/74	ZONE #4	19	0.14
8-02	05/30/74	ZONE #4	19	0.13
8-03	05/30/74	ZONE #4	19	0.14
8-04	05/30/74	ZONE #4	19	0.17
8-05	05/30/74	ZONE #4	19	1.30
8-06	05/30/74	ZONE #4	19	1.24
8-07	05/30/74	ZONE #4	19	0.11
8-08	05/30/74	STRAY ZONE	19	0.32
8-09	05/30/74	STRAY ZONE	19	0.54
8-10	05/30/74	STRAY ZONE	20	0.25
8-11	05/30/74	ZONE #10	20	0.17
8-12	05/30/74	ZONE # 10	20	2.84
8-13	05/30/74	ZONE #10	20	3.29
8-14	05/30/74	ZONE #10	20	18.67
8-15	05/30/74	ZONE #10	20	1.61
8-16	05/30/74	ZONE #10	20	0.42
8-17	05/30/74	ZONE #9	20	6.24
8-18	05/30/74	ZONE #9	20	14.49
8-19	05/30/74	ZONE #9	20	4.62
8-20	05/30/74	ZONE #9	20	1.15
8-21	05/30/74	ZONE #9	20	0.85
8-22	05/30/74	ZONE #8	20	0.15
8-23	05/30/74	ZONE #8	20	2.80
8-24	05/30/74	ZONE #8	20	0.10
8-25	05/30/74	ZONE #8	20	0.13
8-26	05/30/74	ZONE #8	20	0.07
8-27	05/30/74	ZONE #8	20	0.08
8-28	05/30/74	ZONE #8	20	0.15
8-29	05/30/74	ZONE #8	20	2.79
8-30	05/30/74	ZONE #8	20	0.85

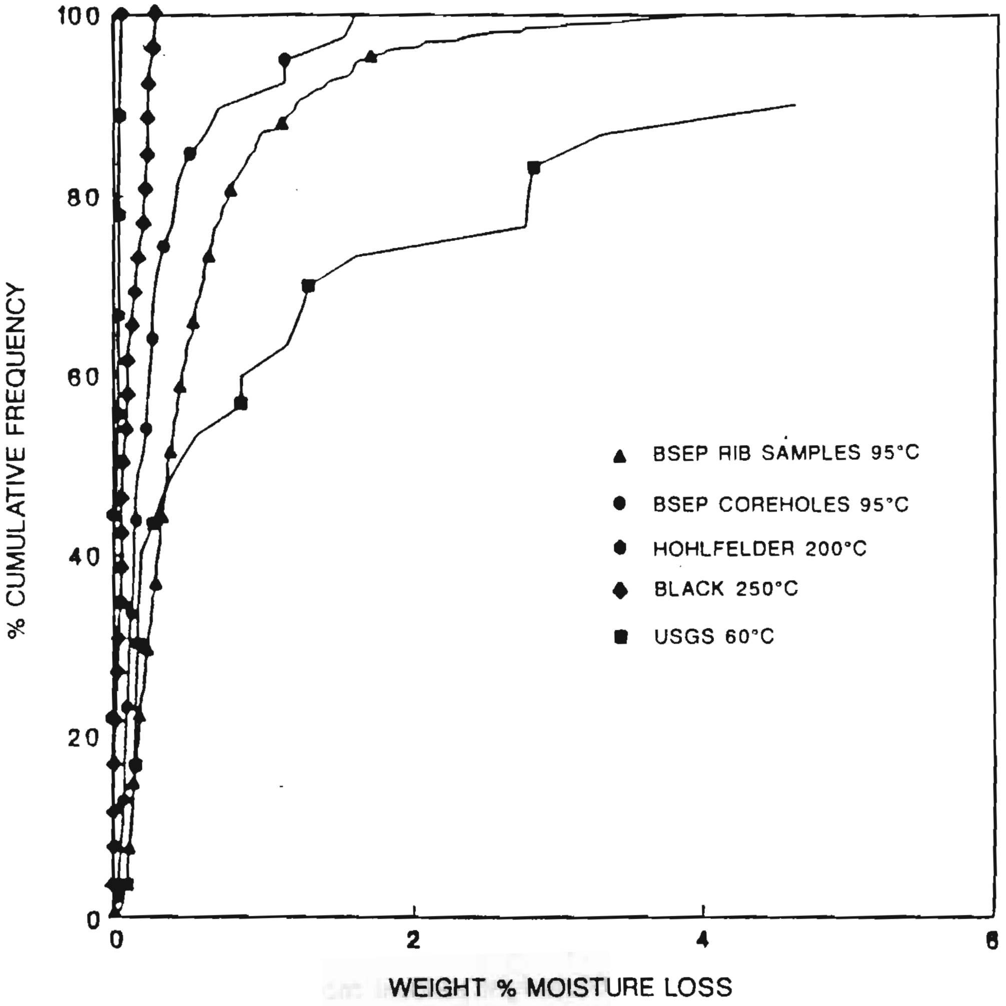

FIGURE 4-13 CUMULATIVE FREQUENCY PLOTS FOR PREVIOUS AND CURRENT MOISTURE CONTENT STUDIES

The rib sampling emphasized the repository horizon, but also included the upper stratigraphy. The frequency curves for the two groups suggest that moisture distributions are similar on the average when enough samples are collected, although this observation is based upon limited samples from boreholes.

4.1.6 Summary and Conclusions

This task was initiated to determine whether areal or stratigraphic variations exist within the Salado Formation. The analyses show that moisture content in samples from different underground locations, but from the same stratigraphic intervals, can be considered to have come from the same population. No areal differences were recognized in the sample sets and the three areas that were extensively sampled at the repository level appear to be from the same population. Stratigraphic variations in moisture content were shown by Deal and others (1987) and, in this report, to be related to the clay content of the units. In general, the units having higher percentages of clay content are those which have higher average moisture contents and which also have a greater range of maximum and minimum moisture content. Table 4-1 is a summary of moisture values for the units sampled. Units 0, 2, and 4 are considered most variable at the repository level. The basic statistics for Units 0 through 4 at the repository level, Units 5 through 14, and the entire sample set are given in Table 4-7.

Based upon the thicknesses of the stratigraphic units, a weighted average was calculated for Units 0 through 4, which are typically exposed in the underground excavation. The weighted average is approximately 0.60 weight percent moisture content. It appears from the data collected to date that an average near-field moisture content of 0.5 to 0.75 percent by weight is a reasonable representative moisture for the repository host rock. This range is also reasonable for the overlying strata given the results from limited vertical sampling of vertical boreholes and its relation to the rib sample results.

In addition, to further confirm the values reported here, it may be suitable to continue analyzing samples obtained at depth from the excavation surface. As probe holes or vertical instrumentation boreholes are drilled, samples collected for moisture content determinations may further improve the data base. Special procedures may be applied to preserve the in situ moisture of the cores during sampling. These samples could then be used to indicate the suitability of applying the near-surface rib sample results to a volume of rock at a given depth from the excavation and to determine at what point that relation may break down. Consideration should be given to collecting additional, deeper samples when construction activities are conducive to such a procedure.

TABLE 4-7

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES (WEIGHT PERCENT)

	N	MAX	MIN	MEAN	STANDARD DEVIATION	VARIANCE
Units 0 thru 4 (Areas 1, 2, & 3)	424	6.67	0.01	0.59	0.64	0.41
Units 5 thru 14 (Area 4)	95	2.76	0.02	0.25	0.36	0.13
All Samples	545	6.67	0.01	0.55	0.64	0.41

NOTE: Samples heated to 95°C.

4.2 MOISTURE CONTENT DETERMINATION USING BOREHOLE INDUCTION LOGGING

4.2.1 Introduction

Electromagnetic (EM) induction logging of 28 boreholes was performed at the WIPP facility from May 24 through June 2, 1988. Fifteen boreholes were selectively modeled to determine the conductivities for individual beds within the boreholes. The logging was performed to:

- Determine the material conductivity,
- Further delineate the geological stratigraphy throughout the repository, and
- Use that material conductivity by applying Archie's Law (Archie, 1942) to determine a gross material moisture content.

Table 4-8 lists the logged and modeled boreholes and their locations within the WIPP facility. A Geonics EM-39 Borehole Induction Logger (EM-39) with an intercoil spacing of 50 cm was utilized in the exercise.

4.2.2 General Theory

Conductivity is a measure of the ease with which electric current can flow through a material. Conductivity is the inverse of resistivity, as shown by the formula (Gieck, 1986):

$$C = \frac{1}{R} \tag{4.2}$$

where

C = conductivity in mhos (siemens) and
R = resistivity in ohms.

EM induction logging of ground conductivity has been widely used in ground water exploration and ground water contaminant plume mapping. The surface geophysical method has recently been used to develop a borehole conductivity measuring probe (Snelgrove and McNeill, 1985).

The EM method of measuring conductivity by induction uses a probe containing a transmitting coil and a receiving coil. The coils are located at either end of the borehole probe, which thereby defines the intercoil spacing (50 cm in the instrument used). The transmitting coil generates an electromagnetic field due to an alternating current passing through the coil. This magnetic field induces an electric (eddy) current in conductive media

TABLE 4-8
LOGGED AND MODELED BOREHOLES

BOREHOLE	LOCATION	DIRECTION	COLLAR* ELEVATION	LENGTH OF HOLE	DATE DRILLED	DATE OF GEOLOGIC LOG	DATE OF INDUCTION LOG
A1X01	Room A-1 South End	Vertical, Down	400.4 m, 1313.0 ft	15.2 m, 49.75 ft	2/26/85	2/26/85	5/26/88
A1X02	Room A-1 South End	Vertical, Up	405.8 m, 1331.5 ft	18.0 m, 59.0 ft	3/7/85	3/7/85	6/1/88
A2X01	Room A-2 North End	Vertical, Down	399.9 m, 1312.0 ft	15.3 m, 50.15 ft	2/9/85	2/9/85	5/26/88
A2X02	Room A-2 North End	Vertical, Up	405.5 m, 1330.5 ft	16.1 m, 52.75 ft	2/20/85	2/20/85	6/1/88
A3X01	Room A-3 South End	Vertical, Down	399.1 m, 1309.5 ft	15.4 m, 50.5 ft	1/14/85	1/14/85	5/26/88
A3X02	Room A-3 South End	Vertical, Up	404.8 m, 1328.0 ft	15.5 m, 50.75 ft	1/22/85	1/22/85	6/1/88
BX01	Room B, North End	Vertical, Down	401.7 m, 1318.0 ft	15.3 m, 50.15 ft	1/27/85	1/27/85	5/26/88
BX02	Room B, North End	Vertical, Up	407.2 m, 1336.0 ft	15.0 m, 49.25 ft	2/1/85	2/1/85	6/2/88
DH-35	Room G, N1102, W1882	Vertical, Up	394.5 m, 1294.4 ft	15.8 m, 52.0 ft	1/27/85	2/13/85	5/31/88
DH-36	Room G, N1102, W1882	Vertical, Down	391.5 m, 1284.6 ft	15.7 m, 51.5 ft	1/26/86	1/27/85	5/24/88

TABLE 4-8
LOGGED AND MODELED BOREHOLES
(CONTINUED)

BOREHOLE	LOCATION	DIRECTION	COLLAR* ELEVATION	LENGTH OF HOLE	DATE DRILLED	DATE OF GEOLOGIC LOG	DATE OF INDUCTION LOG
DH-37	Room G, N1101, W2182	Vertical, Up	395.4 M, 1297.4 ft	15.7 m, 51.5 ft	1/26/85	1/26/85	5/31/88
DH-38	Room G, N1101, W2182	Vertical, Down	392.3 m, 1287.0 ft	14.5 m, 47.5 ft	1/26/85	1/26/85	5/24/88
DH-41	Room G, N1101, W2782	Vertical, Up	395.0 m, 1295.8 ft	15.2 m, 49.9 ft	1/24/85	1/24/85	5/31/88
DH-42	Room G, N1101, W2782	Vertical, Down	391.9 m, 1285.9 ft	15.6 m, 51.2 ft	1/23/85	1/14/85	5/24/88
DH-42A	Room G, N1101, W2789	Vertical, Down	391.9 m, 1285.7 ft	12.3 m, 40.5 ft	1/25/85	1/24/85	5/24/88

---

*Collar elevations of boreholes located in rooms A-1, A-2, A-3, and B were estimated from known elevations in the area and room geometry.

in the subsurface and the resulting magnetic field is measured by the receiving coil. Figure 4-14 shows this relation in a vertical borehole. Tx and Rx represent the transmitting and receiving coils, respectively.

Physical contact with the borehole surface by the probe is not necessary and the coils are configured to be reasonably insensitive to any borehole fluid. These characteristics are achieved by selecting the proper intercoil spacing during construction of the probe. Large spacings minimize nearby borehole effects, including the borehole fluid, and achieve a large lateral range of exploration away from the borehole, whereas smaller spacings allow high resolution of thin layers (McNeill, 1986). A compromise spacing will optimize the two. Additional coils can be used to focus the probe, further reducing its sensitivity to the borehole fluid and improving vertical resolution.

As discussed above, the intercoil spacing of the transmitter and receiver determines the depth of optimum response in the probe. This optimum response is approximately half the spacing. Figure 4-15 shows the relative response of the EM-39 used in this exercise as a function of distance from the borehole axis. Maximum response is achieved at approximately 25 cm from the borehole axis, with a relatively small fraction of the response coming from within the borehole itself.

The induction log curves were modeled using the DAT39Q "Forward Layer Model" software provided by Geonics with the EM-39 (McNeill, 1986). The objective of the modeling was to calculate successive approximations so that the modeled layering produced the same conductivity response as the actual measured data. Input to the model consisted of up to 20 units, for which thickness and conductivity were specified, although some of the boreholes were modeled in two parts because greater than 20 units were required for accurate modeling. A first approximation for stratigraphic thickness and unit conductivity in the model was based on details provided in the geologic log for a particular borehole. The modeled curve was then plotted over the actual induction log data curve and compared.

The preliminary modeling was based on depth-stratigraphic unit relationships of the cores obtained from the boreholes. In some cases the induction log data curve was shifted in relation to the modeled log to adjust for cable slippage during measurement or inaccuracies associated with the relation between the probe and the borehole collar. Clay seams and anhydrite near clay seams were used to position the peaks of the induction log and determine the amount of shift necessary when this adjustment was required.

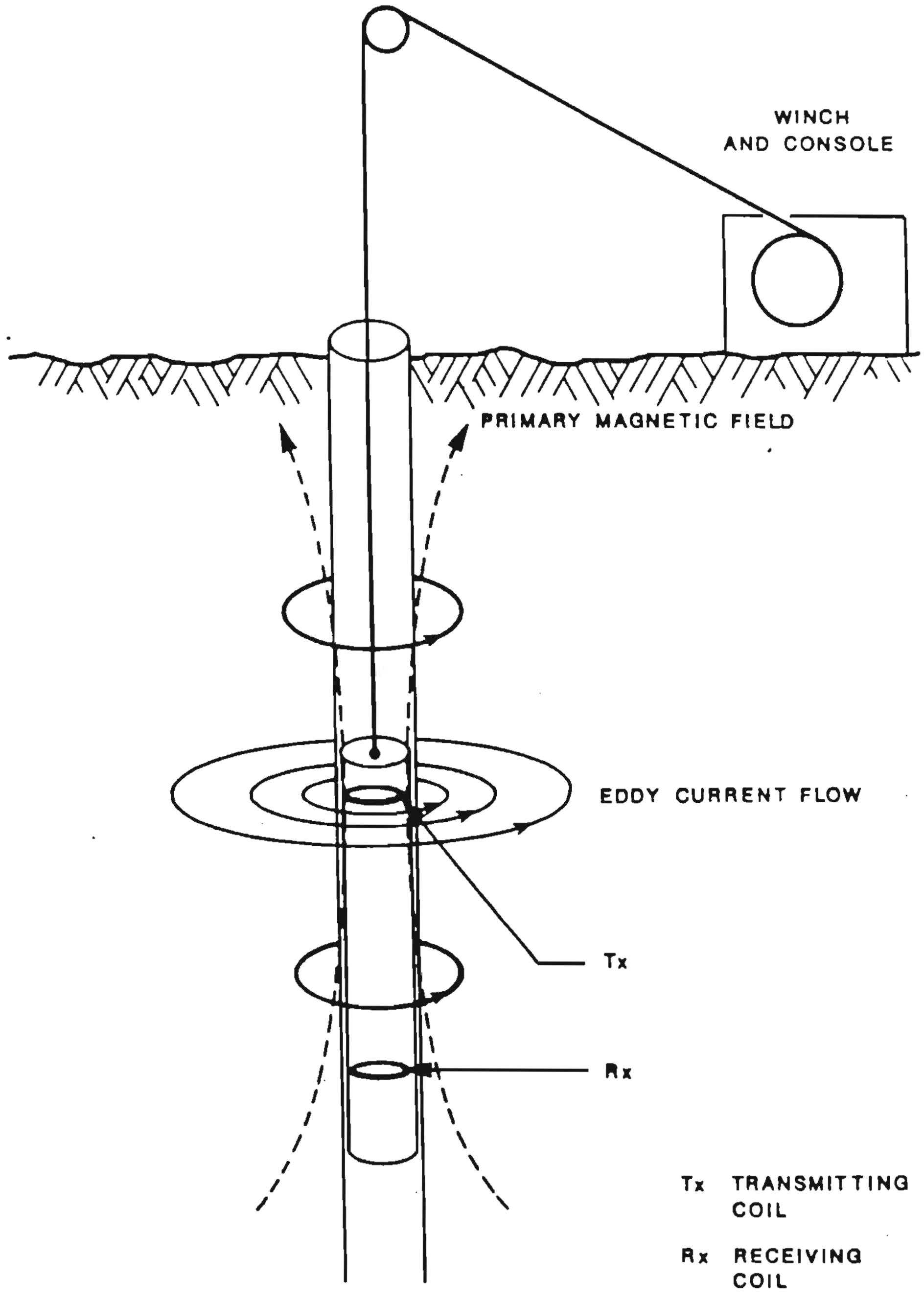

FIGURE 4-14 RELATION OF MAGNETIC FIELD AND INDUCED ELECTRIC EDDY CURRENTS IN VERTICAL BOREHOLE *(AFTER McNEILL, 1986)*

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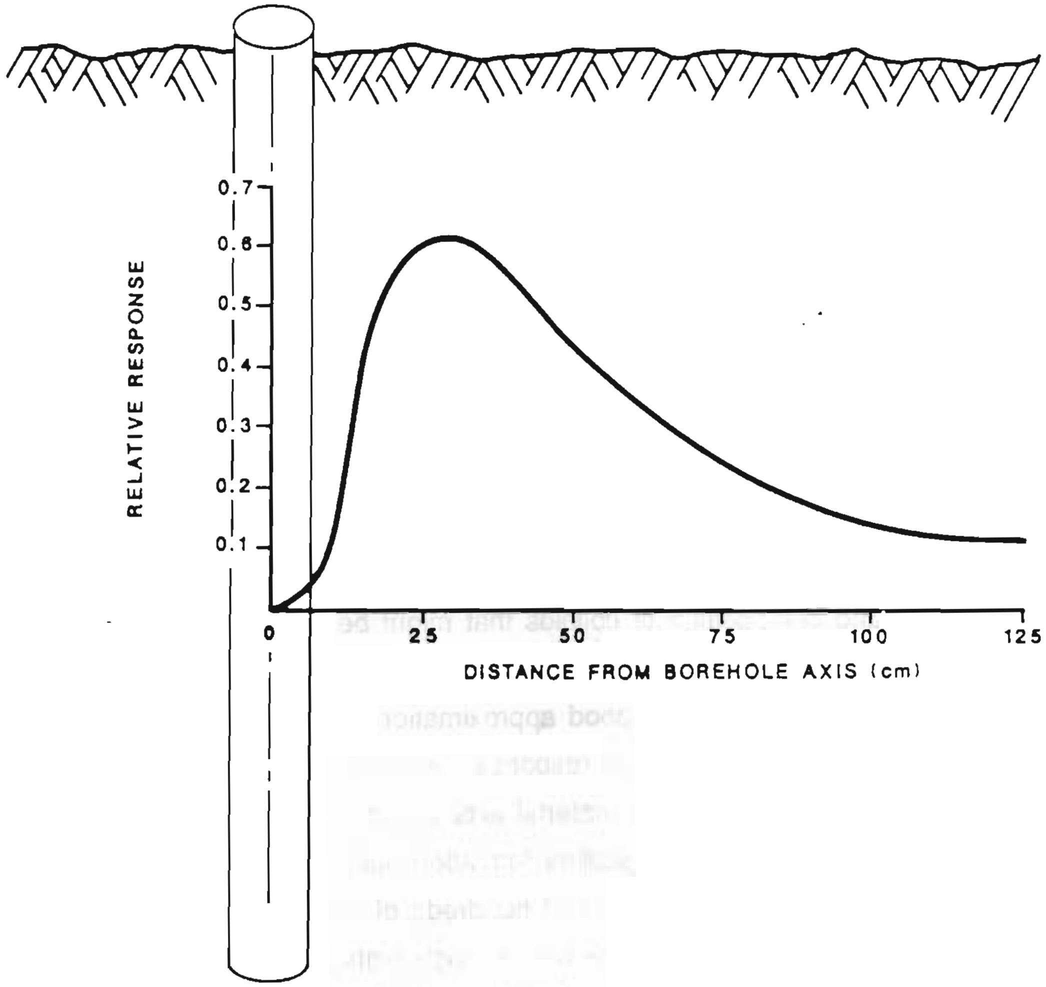

FIGURE 4-15 DISTANCE FROM BOREHOLE VERSUS RELATIVE RESPONSE–GEONICS EM–39 BOREHOLE INDUCTION LOGGER *(AFTER SNELGROVE AND McNEILL, 1985)*

Subsequent model runs were performed by modifying unit conductivities and/or thicknesses until the modeled curve adequately matched the induction log data curve by visual inspection. The final modeled curves, the corresponding stratigraphic unit thicknesses and conductivities, and the geologic core logs are provided in Appendix H, along with the measured induction log data curves for each borehole modeled.

Conduction generally takes place through the electrolyte (brine) contained within the moisture-filled pores of the matrix of interest (Dobrin, 1976). Because the resistivity of individual salt crystals is extremely high, they do not contribute appreciably to the conductivity of the salt rock. Conductivity in the rock mass is considered to be controlled by (McNeill, 1980):

- Effective porosity and the size, number, and shape of these interconnected passages,
- Moisture content,
- Concentration of the electrolyte,
- Temperature and phase of the fluid, and
- Amount and composition of colloids that might be present in the fluids.

Archie's Law (Archie, 1942) provides a good approximation of the moisture content of the material based on the measured electrical response. Archie's Law, an empirical relationship, assumes that the formation material acts as an insulator and that the conductivity is due solely to the intercrystalline formation fluid. Crystalline halite has a low conductivity (or high resistivity, on the order of hundreds of thousands of ohm-meters [ohm-m]), whereas salt saturated with brine has a much higher conductivity, on the order of 1 mho/m or 1 ohm-m (Matula, 1981). The formation salt acts as an insulator and the conductivity is controlled by the brine fluid contained in the interconnected formation pore spaces. It is also assumed that, like crystalline halite, dry polyhalite, anhydrite, and clay have a very low conductivity relative to the formation fluid and, therefore, Archie's Law can be applied equally well to stratigraphic units consisting of these materials. Archie's Law is expressed as:

$$\frac{P_o}{P_w} = n^m \tag{4.3}$$

where

P_w = conductivity of brine solution (assumed constant = 2.17 mho/m [Kessels and others, 1985]),
P_o = measured conductivity of the medium (from modeled values),
m = cementation factor (assumed 1.8), and
n = formation porosity.

The cementation factor of 1.8 was assumed to closely represent the average conditions in the WIPP stratigraphy after comparison (similar to Kessels and others, 1985) with moisture contents determined by physical sample analyses of several stratigraphic map units (Figure 4-16).

4.2.3 Methodology

The EM-39 hardware consists of transmitter and receiver coils contained within a borehole probe 4.2 cm in diameter and 133 cm in length. The probe is electrically connected to a data acquisition unit that maintains a digital record of the material conductivities which are later downloaded to a microcomputer. Prior to the logging of each borehole, the tool is calibrated by moving the probe to a reasonable distance from any metal in the workings and adjusting it to zero conductivity for air.

During operation, the probe was lowered or raised to the back of the borehole, depending upon whether downholes or upholes were being logged. It was then slowly returned to the borehole collar, recording formation response. The instrument cable connecting the probe to the instrument recorder was run over a counter wheel and meterage was automatically recorded. Data points were taken every 10 cm as measured by the counter wheel with a logging speed of approximately 0.1 meter/second. Normally, at least two runs in each hole were made to ensure repeatability. At this rate, a 50-foot borehole can be logged, on average, in approximately one hour or less, including setup and transportation time.

4.2.4 Borehole Locations

A total of 28 boreholes were logged. Only boreholes in the northern repository area were logged because of the availability of open vertical holes. Additionally, the boreholes in the northern repository area penetrated the stratigraphic sequence of interest (Units 0 through 4). In Appendix H, Figure H-1 shows the stratigraphy in the area of the WIPP horizon and the position of test room and waste room horizons to the stratigraphy and Table H-1 contains descriptions of the stratigraphic units and the approximate distance of

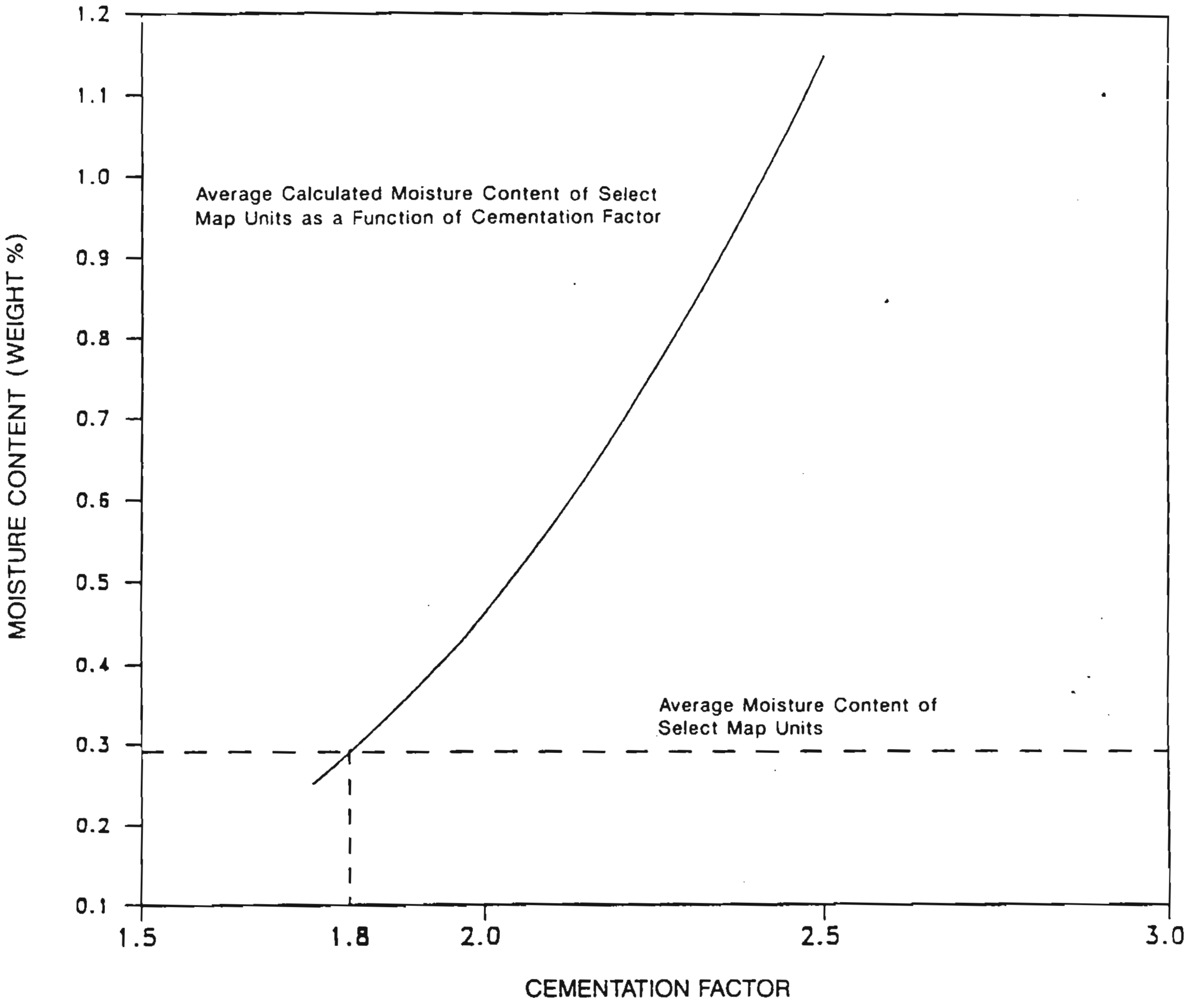

FIGURE 4-16 ESTIMATION OF CEMENTATION FACTOR

each from the reference seam clay G. Eight of the logged and modeled boreholes were oriented vertically downward into the floor of the excavation, and seven of the logged and modeled holes were oriented vertically upward into the roof. Six additional horizontal boreholes were logged, but not modeled. These horizontal holes did not penetrate more than a single stratigraphic unit and consequently were not included in this report.

4.2.5 Induction Log Data

The conductive response of several of the boreholes logged and modeled is presented in Appendix H. The response is a function of both the conductivity and thickness of the unit represented. Sharp peak responses typically represent thinner, more highly conductive units; lower, rounded peaks typically represent thicker, slightly conductive units. The actual conductivity of each stratigraphic unit is a function of both the magnitude and shape of the measured response, although in general, the higher the measured peak response, the higher the conductivity of that unit. The height of the response is roughly equal to the conductivity of the unit times its thickness, e.g., a unit with a conductivity of 0.075 mho/m and a 0.5-meter thickness would have a measured response of 0.0375 mho/m, as would a unit with a conductivity of 0.150 mho/m and a 0.25-meter thickness.

Because the coils are asymmetrical in the instrument probe, the response for a highly conductive, narrow seam shows a shoulder or shadow on the far side of the peak (toward the back of the hole). This is evident in a number of the logs presented in Appendix H, due to the existence of thin, moist clay seams in the stratigraphic sequence.

4.2.6 Moisture Content by Applying Archie's Law

The modeled induction log response was used to determine the resistivity of the stratigraphic intervals in the underground boreholes. The modeled conductivities shown in Appendix H were used as input to Archie's Law to determine the moisture content values of the stratigraphic intervals (Archie, 1942).

At partially saturated conditions, the conductivities were decreased due to the insulating effects of the gas or air particles in impeding the current flow. However, Archie's Law was still applied by assuming a cementation factor of approximately 2 for this condition (McNeill, 1980). The cementation factor of 1.8 appeared to represent the average conditions in the WIPP stratigraphy after comparison (similar to Kessels and others, 1985) with moisture contents determined by physical sample analyses of several stratigraphic map units (Figure 4-16).

Archie's Law was applied in this analysis, assuming saturated conditions within the measured medium, as was assumed by other investigators (Kessels and others, 1985). Porosities for the various stratigraphic units were calculated from Equation (4.3) above. Knowing the formation porosity and assuming a specific gravity for the solid particles in the various materials being considered, a percent moisture by weight was then determined. These calculated moisture contents and the formation conductivities are shown in Appendix H.

4.2.7 Qualitative Comparison with Physical Samples

The estimated moisture contents developed using Archie's Law may be compared to previous physical sample analyses performed and summarized in Section 4.1. This previous work focused on the repository horizon stratigraphy, as do the surveys presented here. Comparisons of the two approaches are made where data for similar horizons are available. Tables 4-9 and 4-10 present the calculated moisture content for each stratigraphic unit by borehole and the average moisture content for each unit. The average moisture contents from the previous work (Section 4.1) are also reported in Tables 4-9 and 4-10 for comparison.

The correlation between the two sources is variable, depending upon the stratigraphic unit. Figure 4-17 presents the relative correlation for each map unit. Some of the scatter in this figure may be explained by differences in materials type and/or degree and location of physical sampling. Map Units 0, 2, and 4 contain argillaceous zones and Map Units 8 and 11 represent anhydrites "b" and "a", respectively. The cementation factor selected was based on clean halite beds and then applied to other material types. The cementation factor for these other materials may need to be refined with the aid of additional data. The anhydrite layers are usually associated with clay seams, and it is difficult to distinguish the clay seams in the induction log modeling. Therefore, calculated moisture contents for the anhydrite layers may have been influenced by higher moisture contents of the clay seams. Map Units 5 and 14 are layers that had limited physical moisture sampling performed (two and three samples, respectively). These two units are also adjacent to clay seams, which may have influenced both the calculated moisture content and the physical sampling.

The absolute difference between the calculated moisture contents (from Archie's Law) and the physical sample analyses ranges from 0.02 percent for Map Unit 3 to 1.55 percent for Map Unit 5. The absolute difference for Units 0 through 4 (units with the highest number of physically tested specimens) is less than 0.57 percent or better. This is considered to

TABLE 4-9

MOISTURE CONTENTS (WEIGHT PERCENT) UP BOREHOLES

STRATIGRAPHIC UNIT	A1X02	A2X02	A3X03	BX02	DH-35	DH-37	DH-41	AVERAGE(1) (%)	STANDARD DEVIATION	MEAN(2) LABORATORY MOISTURE CONTENT	ABSOLUTE(3) DIFFERENCE (%)
PH-6	0.269		0.217	0.217				0.234	0.030	----	----
AH-4	0.431	0.219	0.219	0.301				0.292	0.100	----	----
H-8	0.343	0.408	0.386	0.324				0.365	0.038	----	----
PH-5	0.217	0.217	0.147	0.217				0.200	0.035	----	----
AH-3	0.844	0.813	1.089	1.406				1.038	0.274	----	----
H-7	0.342	0.321	0.407	0.423	0.219	0.219		0.322	0.088	----	----
H-6	0.345	0.322	0.813	0.327	0.149	0.149	0.219	0.332	0.228	----	----
MB-138	4.397	1.964	2.772	2.806	3.189	2.744	2.047	2.846	0.812	----	----
AH-2	0.500	0.387	0.339	0.858	0.260	0.250	0.267	0.409	0.217	----	----
H-5	0.404	0.322	0.259	0.322	0.165	0.165	0.112	0.250	0.106	----	----
AH-1	0.404	0.322	0.259	0.592	0.165	0.089	0.112	0.278	0.179	----	----
Map Unit 15	0.404	1.983	0.274	0.596	0.330	0.270	0.193	0.579	0.633	----	----
Map Unit 14	0.404				0.219	0.538	3.098	1.065	1.362	0.230	0.835
Map Unit 13					0.149	0.122	0.179	0.150	0.029	0.120	0.030
Map Unit 12					0.075	0.274	0.261	0.203	0.111	0.130	0.073
Map Unit 11 (Anhydrite "a")					1.204	1.394	1.185	1.261	0.116	0.580	0.681

TABLE 4-9

MOISTURE CONTENTS (WEIGHT PERCENT) UP BOREHOLES (CONTINUED)

STRATIGRAPHIC UNIT	A1X02	A2X02	A3X03	BX02	DH-35	DH-37	DH-41	AVERAGE[1] (%)	STANDARD DEVIATION	MEAN[2] LABORATORY MOISTURE CONTENT	ABSOLUTE[3] DIFFERENCE (%)
Map Unit 10					0.344	0.149	0.219	0.237	0.099	----	----
Map Unit 9					0.307	0.212	0.247	0.255	0.048	0.080	0.175
Map Unit 8 (Anhydrite "b")					1.780	2.175	1.825	1.927	0.216	1.110*	0.817
Map Unit 7					0.365	0.322	0.322	0.336	0.025	0.420	0.084
Map Unit 6					0.284	0.475	0.373	0.377	0.096	0.160	0.217
Map Unit 5							0.475	0.475	----	1.810	1.335

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* This unit was divided into two sub units for the laboratory moisture content measurement. The reported value here is the average of 0.47% for Map Unit 8 (anhydrite "b") and 1.75% for clay G.

(1)Average moisture content calculated from induction log data.

(2)Average moisture content reported from laboratory testing of soil samples (Section 4.1).

(3)Absolute difference between the calculated moisture content and the laboratory data in Section 4.1.

TABLE 4-10

MOISTURE CONTENTS (WEIGHT PERCENT) DOWN BOREHOLES

STRATIGRAPHIC UNIT	A1X01	A2X01	A3X01	BX01	DH-36	DH-38	DH-42	DH-42A	AVERAGE[1] (%)	STANDARD DEVIATION	MEAN[2] LABORATORY MOISTURE CONTENT	ABSOLUTE[3] DIFFERENCE (%)
Map Unit 7	0.219	0.665	0.715						0.533	0.273	0.42	0.11
Map Unit 6	0.406	0.219	0.726	0.219					0.392	0.239	0.16	0.23
Map Unit 5	0.219	0.219	0.219	0.399					0.264	0.090	1.81	1.55
Map Unit 4	0.489	0.309	0.219	0.219					0.309	0.127	0.88	0.57
Map Unit 3	0.219	0.149	0.468	0.217					0.263	0.140	0.24	0.02
Map Unit 2	0.219	0.149	0.468	0.217					0.263	0.140	0.74	0.48
Map Unit 1	0.219	0.279	0.219	0.760					0.369	0.262	0.20	0.17
Map Unit 0	0.219	0.165	0.219	0.200	0.219	0.297	0.252	0.257	0.228	0.040	0.66	0.43
PH-4	0.389	0.165	0.381	0.200	0.272	0.301	0.130	0.251	0.261	0.095	-----	-----
MB-139	1.025	0.900	1.067	0.989	1.027	1.180	0.873	0.956	1.002	0.098	-----	-----
H-4	0.219	0.219	0.219	0.200	0.340	0.219	0.205	0.225	0.231	0.045	-----	-----
PH-3	0.309	0.268	0.271	0.217	0.315	0.293	0.130	0.204	0.251	0.063	-----	-----
H-3	0.219	0.219	0.219	0.289	0.219	0.219	0.955	1.404	0.468	0.456	-----	-----
PH-2	0.344	0.294	0.217	0.211	0.217	0.191	0.163	0.191	0.228	0.060	-----	-----
H-2	0.219	0.368	0.288	0.441	0.310	0.289	0.311	0.404	0.329	0.071	-----	-----

TABLE 4-10

MOISTURE CONTENTS (WEIGHT PERCENT) DOWN BOREHOLES (CONTINUED)

STRATIGRAPHIC UNIT	A1X01	A2X01	A3X01	BX01	DH-36	DH-38	DH-42	DH-42A	AVERAGE[1] (%)	STANDARD DEVIATION	MEAN[2] LABORATORY MOISTURE CONTENT	ABSOLUTE[3] DIFFERENCE (%)
PH-1		0.415	0.217		0.218	0.217	0.218	0.161	0.241	0.088	------	------
Anhydrite "c"					0.819	1.154	0.722	0.827	0.881	0.188	------	------
H-1					0.219	0.219	0.219	0.224	0.220	0.003	------	------
All Units									0.504	0.523	0.55	0.05

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[1] Average moisture content calculated from induction log data.

[2] Average moisture content reported from laboratory testing of soil samples (Section 4.1).

[3] Absolute difference between the calculated moisture content and the laboratory data in Section 4.1.

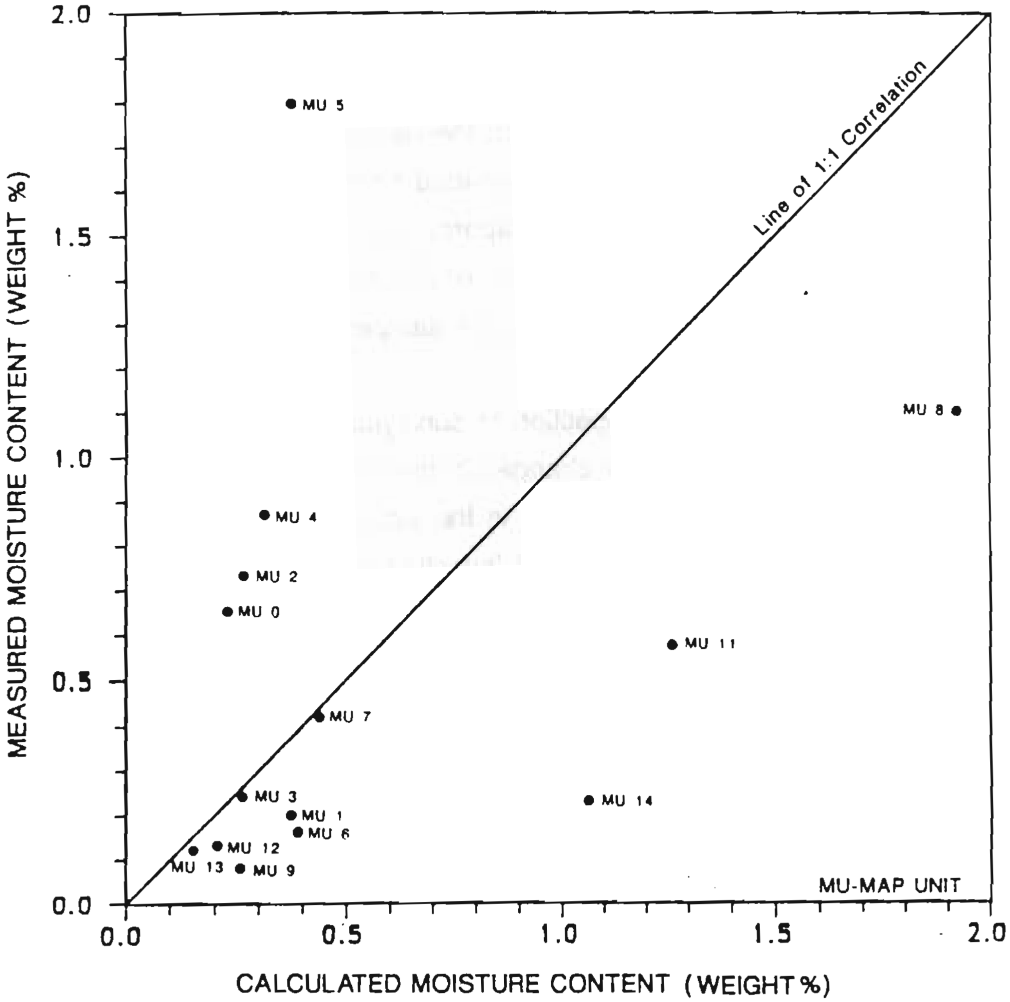

FIGURE 4-17 CORRELATION OF CALCULATED MOISTURE CONTENT TO MEASURED MOISTURE CONTENT

be a fairly good relationship, given the coarseness of the induction log survey. The average calculated moisture content for all the units is 0.50 percent, only 0.05 percent difference from the average moisture content (0.55 percent) for all units reported in Section 4.1.

4.2.8 Conclusions

Borehole induction logging performed in this exercise has proven to be a reasonably efficient and accurate method for measuring material conductivity and, thereby, its moisture content. The moisture contents determined from the geophysical logging compare reasonably well with the moisture contents determined from the laboratory analyses. The previous discussions have shown that the two approaches exhibit an absolute difference in moisture content of 0.05 percent if the averages for all units are considered, which is a good correlation given the spatial differences in the sampling sets.

The geophysical approach allows the repetition of surveying the same borehole intervals (i.e., the same rock volumes) to monitor changes in the material response over time. Drying or, possibly, wetting fronts that develop in the vicinity of the excavated borehole are expected to be readily observed in subsequent induction log surveys. Further investigation into the relation of moisture content to excavation depth may also be evaluated with induction logging by observing overall moisture trends from borehole surface to some depth. Unlike physical samples, which are difficult to obtain undisturbed at depth (i.e., representative of in-situ moisture) the induction logging approach allows in situ measurement.

Future recommended activities include:

- Performing additional select borehole surveys to evaluate the time effects of moisture variation (especially on boreholes in areas of new excavation),
- Performing induction log surveys in conjunction with laboratory and field analyses of physical samples from fresh boreholes to further correlate moisture content measurements obtained from physical sampling with those obtained from conductivity logging,
- Performing additional borehole logging where deep open boreholes become available (particularly in the area of declined boreholes drilled in the first panel area for brine inflow monitoring), and
- Performing additional laboratory analyses of the WIPP geologic materials to define resistivity, specific gravity, and average effective porosity to be used in calculating moisture contents from the unit conductivity and Archie's Law.

4.3 RESULTS OF THE DRILLHOLE VIDEO-CAMERA SURVEY

One of the questions raised during Phase I of the BSEP concerned the exact stratigraphic source of the brine inflows into the WIPP underground drillholes. A drillhole video-camera survey was undertaken in an attempt to help answer that question. The primary objective was to determine if it was possible to observe the location of wet areas or salt encrustation on the walls of drillholes that might indicate points of brine inflow. A secondary objective was to determine the usefulness of the existing drillhole camera in discerning lithologic and structural features.

Twenty-one drillholes were selected for observation from those used in the BSEP - Appendix B (Deal and Case, 1987). Eleven of these were downholes and ten were upholes. Six of these drillholes were logged between February 12, 1987 and April 28, 1987 (Table 4-11), at which time the drillhole camera malfunctioned. The results from that survey are reported in the BSEP Phase II report (Deal and others, 1987). After repair of the camera, the remaining 15 holes were logged between June 7, 1988 and September 1, 1988 (Table 4-12). The results of the completed survey are presented in Appendix I and discussed below.

4.3.1 Equipment

This survey was conducted using the same camera that was used in the first part of the video survey, a Circon color drillhole camera fitted with a wide-angle lens placed at right angles to the axis of the drillhole. Snap-together aluminum rods 1.8 meters long were attached to the back of the camera and were used to manipulate the camera in the drillholes. The camera was connected to a Circon color video control unit by a cable 15.2 meters long. The camera cable could not be lengthened without redesigning the circuitry. This camera's limited usefulness with this configuration only allowed it to be inserted a maximum of 13.40 meters into the downholes and 14.63 meters into the upholes. As a result, the end part of most of the holes could not be observed with this equipment. The control unit was connected to a video recorder and TV monitor (Figure 4-18). Video tapes produced during the examinations are kept on file in the Geotechnical Engineering Section at WIPP. The unit is powered by 120V AC current or a 12V DC battery pack. The battery pack was used during this survey.

4.3.2 Method

Both upholes and downholes were examined in the survey. The downholes were sounded with the Solinst tape to determine the brine level prior to inserting the camera so that the

TABLE 4-11

DRILLHOLES INVESTIGATED WITH THE VIDEO CAMERA DURING THE FIRST SURVEY

HOLE	ROOM	LOCATION (MINE COORDINATES)	DIRECTION	DATE DRILLED	DATE INVESTIGATED	DEPTH (METERS)
Experimental Rooms						
A2X01	A2	N1393.7 E1338.9	Down	02/09/85	04/28/87	15.4
Facility Horizon						
L1X00	L1	N1538.5 W225.0	Down	05/13/84	02/12/87	3.8
DH-38	G	N1101.0 W2182.0	Down	01/26/85	02/12/87	14.5
DH-40	G	N1101.0 W2482.0	Down	01/25/85	02/12/87	15.5
DH-42	G	N1101.0 W2782.0	Down	01/23/85	02/12/87	15.6
DH-42A	G	N1101.0 W2789.0	Down	01/23/85	02/12/87	12.3

TABLE 4-12

DRILLHOLES INVESTIGATED WITH THE VIDEO CAMERA DURING THE SECOND SURVEY

HOLE	ROOM	LOCATION (MINE COORDINATES)	DIRECTION	DATE DRILLED	DATE INVESTIGATED	DEPTH (METERS)
Experimental Rooms						
BX01	B	N1394.6 E982.3	Down	01/27/85	06/09/88	15.3
BX02	B	N1384.4 E982.9	Up	02/01/85	08/29/88	15.0
A1X01	A1	N1147.0 E1254.4	Down	02/26/85	06/09/88	15.1
A1X02	A1	N1146.9 E1254.2	Up	03/07/85	09/01/88	17.0
A2X02	A2	N1393.6 E1338.9	Up	02/20/85	09/01/88	16.1
A3X01	A3	N1125.0 E1408.0	Down	01/14/85	09/01/88	15.4
A3X02	A3	N1104.0 E1408.0	Up	01/22/85	09/01/88	15.5
DH-15	D	N1104.0 E1688.5	Up	03/09/84	06/09/88	15.5
Facility Horizon						
DH-35	G	N1102.0 W1882.0	Up	01/27/85	06/08/88	15.8
DH-36	G	N1102.0 W1882.0	Down	01/26/85	06/08/88	15.7
DH-37	G	N1101.O W2182.0	Up	01/26/85	06/07/88	15.7
DH-39	G	N1101.0 W2482.0	Up	01/24/85	06/07/88	15.5
DH-41	G	N1101.0 W2782.0	Up	01/24/85	06/07/88	15.2
DHP-401	Panel 1	S1950.0 E1320.0*	Up	12/08/86	08/29/88	15.0
DHP-402A	Panel 1	S1950.0 E1320.0*	Down	12/04/86	08/29/88	15.2

*Locations only approximate.

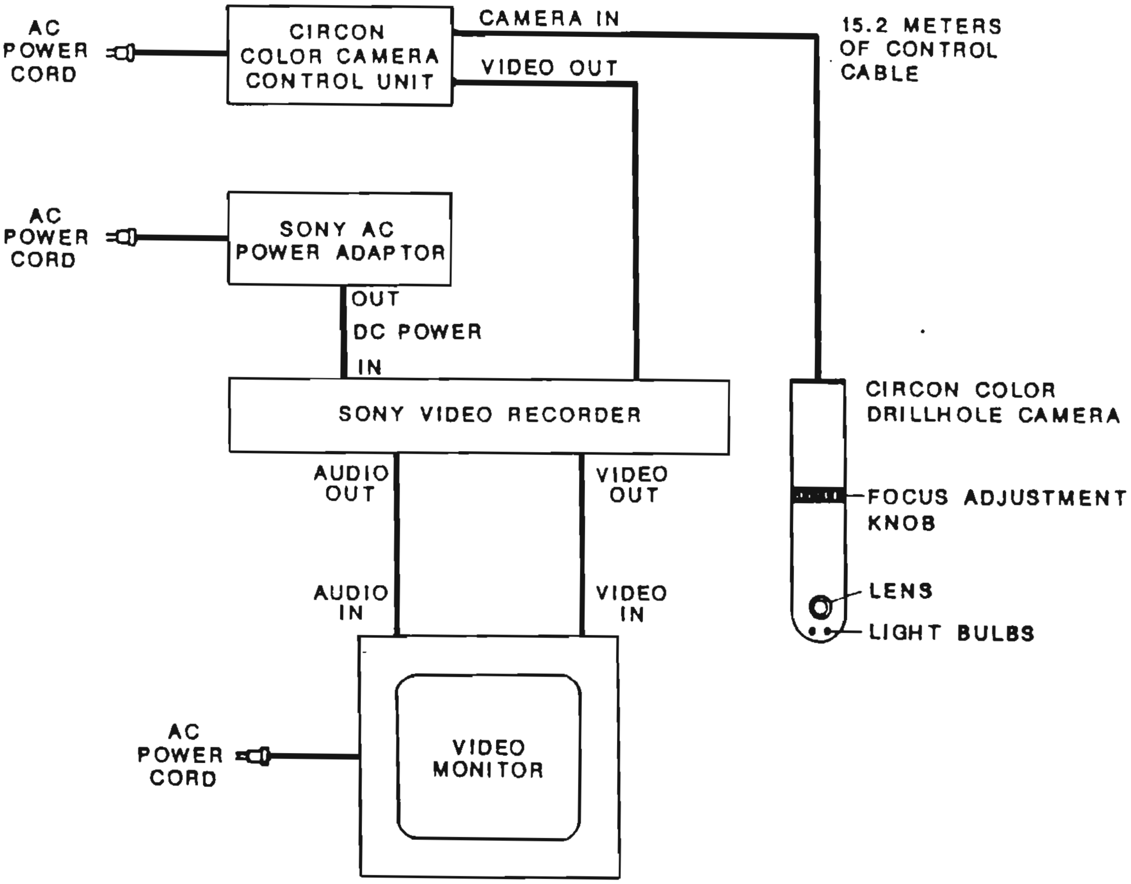

FIGURE 4-18 COMPONENTS AND ARRANGEMENT OF THE DRILLHOLE VIDEO-CAMERA SYSTEM

camera would not be immersed in brine. Once the level of the brine was determined (for downholes) the camera was slowly inserted into the hole by a technician using the aluminum rods while the other member of the team watched the TV monitor, measured how far the camera had been inserted in the hole, and recorded any features noted on the TV monitor. The depth of the camera was determined by adding the length of the camera and the length of the aluminum rods attached to it. If an exact depth was needed to record a particular feature, the distance from the end of the rod protruding from the hole to the collar of the hole was measured and that distance was subtracted from the total length of the rods and the camera. Interesting zones noted on the monitor were examined on all sides of the hole by rotating the camera a full 360 degrees. For downholes, the camera was lowered to within 15 cm of the brine level or to the end of the cable, whichever was shorter. For upholes, the camera was inserted to the end of the cable. The camera was then retrieved from the hole. All observations and camera depths were recorded on drillhole video survey log sheets.

During the survey, 21 drillholes were examined in Rooms A1, A2, A3, B, D, G, and L1 and Panel 1 (Figure 2-1). Four of the drillholes examined in Room G and one in Room L1 were examined on February 12, 1987, as a trial run to test the camera's effectiveness for determining locations of brine inflow. Following this trial run, the data was analyzed and a second trial run was conducted on April 28, 1987, on a drillhole with known wet and dry areas to see if a difference could be observed between a wet drillhole wall and one that was reflecting the camera light from dry crystal faces. After looking at a drillhole where the wet and dry areas were known, drillhole A2X01 was examined. From these examinations, it was determined that the difference between wet areas and areas where dry halite was reflecting the camera light was neither easily discernible using the drillhole video camera nor defined sufficiently to be used in logging wet areas in the drillholes. However, salt encrustations and some lithologic units were discernible; thus, the decision was made to continue the survey once the drillhole camera was repaired. Nine holes (four downholes and five upholes) were examined on June 7, 8, and 9, 1988, and six more (five upholes and one downhole) were observed between August 29 and September 1, 1988. This last effort completed the survey.

4.3.3 Results

Even though wet and dry areas could not be defined using the drillhole video camera, salt encrustations, contacts between anhydrite and salt, clay and anhydrite stringers, fractures, and offsets in the drillholes were identifiable (Appendix I). Salt crusts and knobs were observed in eight of the upholes and eight of the downholes. Anhydrite beds and seams were seen in all of the upholes and nine of the downholes. Four of the drillholes, three downholes and an uphole also had identifiable fractures. In five of the downholes which had a salt buildup, the buildup started either at the top of or within the polyhalitic anhydrite of Marker Bed 139 and ended near the bottom of the unit. Even in Hole A2X01, where the top of Marker Bed 139 is 6.9 meters below the collar of the hole, there was a salt buildup at the top of the unit. In two of the holes that had salt crusts not associated with Marker Bed 139, the crust was associated with a fracture that had been identified in the core. In all eight of the upholes, salt buildups occurred within two meters of the collar of the hole. There were a few buildups deeper inside one of the holes, but there was no identifiable correlation between the buildups and observed features in either the drillhole or the lithologic drillhole log.

In the downholes, Marker Bed 139 was identified in five of the holes and anhydrite "c" was identified in four of the holes. However, six of the holes were not deep enough to reach anhydrite "c".

In the upholes, Marker Bed 138 was identified in all of the drillholes and anhydrites "a" and "b" were seen in five of the holes. The other five holes, those in the experimental area, were collared above those units.

4.3.4 Conclusions

The buildup of salt crust around Marker Bed 139 (drillholes L1X00, DH40, and DH42A) indicates that it is a source for some of the brines in the drillholes. Anhydrite "c", located approximately 10.6 meters below Marker Bed 139, is another possible source for brine, as evidenced by the wet appearance of the unit (drillholes DH38 and DH42) and the buildup of salt crust around it (drillhole DH40). Another source of brine may be fractures, as evidenced by the salt buildups between 2.0 and 2.2 meters in drillhole A2X01 and at 2.6 meters in hole BX01, both of which occur just below fractures identified in the core when the drillholes were logged (Gallerani, 1985).

The drillhole camera is not useful for locating wet areas in the salt sections because it is extremely difficult to differentiate wet areas from areas where the light from the camera is reflected by the salt. In anhydrite and clay sections, it is easier to distinguish wet areas because these section do not reflect light from the dry surfaces. Although it is difficult to distinguish between clay and anhydrite in the smaller seams, the larger ones greater than 2.5 cm are relatively easy to distinguish. The camera is most useful for identifying changes in lithology, fractures, salt encrustations, and offsets in the drillholes.

5.0 MODELING EXERCISES TO DETERMINE THE EFFECTS OF ROCK DEFORMATION ON BRINE INFLOW

5.1. INTRODUCTION

Although the excavations in bedded salt at the WIPP are for all practical purposes dry, small amounts of brine have been observed to weep from exposed surfaces in the repository horizon and seep into drillholes in the underground excavations. As part of the BSEP at the WIPP, a modeling study has been undertaken to formulate and analyze the complex problem of brine and nitrogen flow through deforming salt. The modeled relations involve rock mechanics and fluid flow phenomena, and have been coupled, where appropriate, in order to closely describe the natural phenomena. The main objectives of this section and Appendix J are to (1) present the comprehensive formulation of rock deformation and brine flow and suggest methods by which the formulation might be solved in order to estimate the brine inflow rate into the excavated rooms at the WIPP repository level, (2) implement a preliminary solution by utilizing modifications to two existing codes (modeling rock mechanics and fluid flow) to obtain an initial estimate of the effects of salt deformation on the flow of brine to a 1.8-meter-radius shaft at a depth of 655 meters, and (3) provide modeling support for interpreting the brine inflow measurements for identification of both sources of brine and flow mechanisms.

Excavations at the WIPP create openings at atmospheric pressure, and the resulting pressure gradients induce fluids (contained in the salt) to flow toward the excavated rooms. In rock salt that cannot sustain deviatoric stress over long periods of time, the brine pressure is approximately equal to the lithostatic state of stress (~ 15 MPa). Excavation creates a stress differential between atmospheric pressure and the virgin rock stress in the intact salt. This stress differential causes salt to creep into the excavated rooms and shafts. Gases (mostly nitrogen) dissolved in the brine also exsolve and move toward the excavation, moving through both the salt and the brine. The result is that excavation-induced flow of three phases (represented by salt, brine, and nitrogen) occurs simultaneously.

The relevant factors and mechanisms involved in brine inflow are as follows (Deal and Case, 1987): (1) the nonuniform distribution of brine; (2) the surrounding salt is continuously deforming resulting in local changes in permeability; (3) a coupling of salt deformation and the flow of brine; (4) the presence of unsaturated flow conditions, especially in the proximity of the excavation; (5) the development of fractures around excavations; (6) the exsolution of nitrogen from brine; and (7) the stratigraphic variations within the salt sequence.

The processes of salt creep and fluid flow are coupled in a complex manner. As brine flows into the rooms of the WIPP repository, the rock salt around these rooms is also creeping into the excavation. The creep of intact salt will modify the permeability and porosity of the salt itself, which in turn results in changes in the fluid pressure. Fluid pressure in rock pores may then affect stresses in the rock and, consequently, the salt creep rate. Because detailed experimental data on these coupling effects are not available at the present time, the relative importance of each mechanism is unknown.

The comprehensive formulation of brine inflow is presented in this section and Appendix J. The equations describing brine flow through deformable porous media are derived and expanded for the potential two-phase flow conditions. Consideration is given to the existence of material properties and modeling assumptions. A simplified mathematical model is developed and used to perform a preliminary numerical analysis. The results are evaluated relative to the modeling assumptions to provide guidance for future work.

5.2 OCCURRENCE OF BRINE AND NITROGEN IN BEDDED SALT AT THE WIPP

The brine occurrences and flow mechanisms have been discussed elsewhere (Deal and Case, 1987). This section presents a brief discussion of the important modeling assumptions made in performing the analysis. The complex evaporite sequence exposed in and near the WIPP excavations was initially deposited in the Permian sea, where normal marine waters were concentrated by evaporation. Rainfall, muddy runoff from nearby land, and influxes of normal marine water caused the salinity of the water to fluctuate, so that periods of precipitation of halite alternated with periods of dissolution. Although the Salado Formation is composed predominantly of halite, the resultant rock contains some clay and other evaporite minerals such as polyhalite, anhydrite, and various potash minerals (Holt and Powers, in preparation). Some residual sea water containing gases dissolved from the Permian atmosphere was trapped in the precipitating evaporites.

After burial beneath the sea floor, a chemically and physically complex set of diagenetic processes acted on the deposits, causing extensive recrystallization to occur (Holt and

Powers, in preparation). The composition of the residual brine and gases in the salt was also changed during diagenesis and it is likely that whatever residual oxygen was present combined with other elements at that time. The WIPP brines are notable for the fact that they contain essentially no dissolved oxygen or carbon dioxide and that the gas exsolving from the brine is mostly nitrogen with traces of methane. The nitrogen today may either exist within the rock matrix as free gas or be dissolved in the brine. The amount of nitrogen dissolved in the brine depends upon the pressure and temperature of the undisturbed salt.

Observations in the WIPP excavations indicate that delicate features formed during deposition and diagenesis are very well preserved and that the bedding is nearly horizontal and appears to be essentially undisturbed since Permian time. Only burial, uplift, and gentle warping has occurred. There is evidence that local pressure gradients in the salt near the WIPP repository were probably insignificant and that little or no flow of salt or brine occurred for a long time prior to excavation.

Prior to excavation, fluid pressure in the pore spaces prevents additional plastic closure of those pore spaces. Since salt is a plastic material and creeps under deviatoric stress, it is likely that brine pressure is near lithostatic and the salt exhibits low permeability. After excavation, the salt creeps into the opening and the porosity and permeability of the adjacent salt near that excavation increases.[1] If the salt has any effective permeability, it is likely that the brine and gas will move through openings in the salt under a high pressure gradient more rapidly than the salt can deform. It is therefore possible that at some distance from the excavation, in the far field (but not so far that undisturbed conditions persist) where a small pressure gradient toward the excavation exists, brine and gas flow through the pore spaces reducing the pressure within them, allowing salt-creep closure and consolidation of clays within the pillars due to loading with a reduction of the size of the intercrystalline pore space (microfractures, intergranular spaces, pores, or the apertures that connect them). This process might continue until the open pathways become so small that surface-tension forces dominate, Darcy's Law no longer applies and, for all practical purposes, the fluids become immobile and effective permeability is reduced to zero. Brine seepage phenomena may be

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[1] The salt dilates in response to a decreased confining stress, resulting in an increase in both intracrystalline and intercrystalline porosity.

self-limiting and, at least in a horizontal direction away from the excavations, a "barrier" zone of reduced or negligible permeability might naturally develop.

5.3 FLUID FLOW THROUGH DEFORMABLE ROCKS

The hydraulic regime around the excavations at the WIPP is more complex than that encountered in most common geohydrologic settings, in which it is reasonable to assume that the rock properties of porosity and permeability remain constant and that the rock matrix is an elastic solid. Further, salt deformation causes changes in fluid pressure which influence flow (a consolidation problem). At the WIPP the rock matrix is an elastoviscoplastic material and, once excavations at atmospheric pressure are created, the porosity and permeability of the rock matrix close to the excavations change dramatically with time as the salt creep occurs. Additionally, the atmospheric pressure in the excavated rooms acts like a pressure sink for fluids and gases stored in the salt. As brine and nitrogen flow toward the pressure sinks (rooms), the steepness of the pressure gradient decreases and the zone of pressure relief propagates outward with time. Distribution of pore pressures may eventually reach steady state after some time.

A two-step approach has been taken to understanding this flow regime. This formulation assumes:

- Rocks can be modeled as continuous and porous flow media,
- Permeability and porosity of rock salt are affected by salt creep and brine flow,
- Darcy's Law applies,
- Linear relationships are applied wherever possible, and
- Compressibility of brine is consistent over the applicable range of pressure.

The set of derived equations (Appendix J, Sections J.1-J.6) describe, in general, the flow of brine through creeping salt under the influence of stress and temperature change. The equations include:

- Mass conservation equations for two-phase flow of fluids through a porous media,

- Stress equilibrium and displacement compatibility equations,

- Stress-strain constitutive relations.

Derivations are carried out based upon:

- Darcy's Law and a piece-wise application of linear relationships between pressure gradient and fluid flow rate,
- The concept of mass and energy balance, and
- A proposed constitutive model for salt deformation.

These equations provide a theoretical basis for understanding the relationships between parameters in multiphase coupled flow. The constitutive relations proposed in Appendix J can be applied to conditions at the WIPP only after there is better information on the specific properties of the Salado Formation near the facility horizon.

In order to define the properties necessary to perform the analyses using the proposed relationships, it may be necessary to consider the following variabilities near the WIPP excavations:

- The Salado Formation is a complex, bedded stratigraphic unit with considerable vertical variation and numerous horizontal discontinuities,
- Brine is not uniformly distributed within the Salado Formation,
- Unsaturated flow conditions are known to exist, at least locally, in close proximity to the excavations, and
- Fracturing is part of the salt deformation process close to the excavations.

The fracturing is associated with several near-field deformation mechanisms. These include (Holt and Powers, in preparation):

- Vertical surficial spalling in pillars,
- Low-angled (relative to horizontal) fracturing that develops from the rib/roof and rib/floor lines,
- Subhorizontal fractures that develop within the first 18 inches of the roof,
- Bed separation that develops at the Anhydrite B interface in the roof,

- Vertical surficial spalling in the roof that probably develops as a result of restraint by remedial bolting, and
- Low-angled shear fractures that daylight across the roof.

While the aperture, length, width, and orientation of individual fractures may be characterized, the hydraulic properties of the fractured zone are currently unknown.

We did not attempt to develop a totally new modeling code based on the global derivation (such as Niou and Deal, 1989; and Appendix J, Sections J.1-J.6). Our approach used simplifying assumptions and coupled two existing codes to obtain a preliminary evaluation of the effects of deformation on fluid flow to the WIPP excavations. We then applied the coupled code to a test case.

5.4 MODELING ASSUMPTIONS

The technical approach adopted in performing the analysis is to model both salt deformation and fluid flow simultaneously, subject to the following major assumptions:

- The Salado formation, although known to contain horizontal stratigraphic discontinuities, is modeled here as a continuous media.
- The salt is modeled as an elastoviscoplastic material exhibiting time-dependent deformation.
- Effective stress equals total stress in the rock. The porosity is so small (.001) (Peterson and others, 1985) in the deforming salt that the change in pore pressure is assumed not to affect total stress. Therefore, the presence of brine does not affect the creep rate or the elastic deformation of the rock. This allows simplification of the coupling of the modeling codes.
- The permeability and porosity of the rock are affected by salt creep in that stresses are redistributed around the opening.
- The brine is uniformly distributed through the salt and flows under Darcy's Law under saturated conditions as fluid pressure is reduced at the opening due to development of brine inflow.
- The nitrogen exsolves rapidly following excavation. The precise gas content is unknown, though estimates based on the solubility of nitrogen in sea water yield volumetric changes of 20 percent for a saturated brine that is depressurized (Roggenthen, 1988).

The fundamental assumption is that porosity and permeability are affected by the response of the salt to excavation (Borns and Stormont, 1988; Case and Kelsall, 1987). For infinitesimal strains which relate to porosity

$$\Delta V \doteq V_o \, \varepsilon_{ii} \tag{5.1}$$

where

ε_{ii} = first strain invariant,
V_o = initial volume, and
ΔV = change in volume.

Note that the repeated index i indicates summation from 1 to 3. The porosity is given by

$$\theta = \frac{V_v}{V} = \frac{V_0 \, \theta_0 + \Delta V}{V_0 + \Delta V} \tag{5.2}$$

where

θ_o = initial porosity,
V = volume of a rock element,
V_v = volume of pores in the same rock element when strains are very small, and
V_0 = initial volume.

For infinitesimal strains

$$\theta \doteq \frac{\theta_0 + \varepsilon_{ii}}{1 + \varepsilon_{ii}} \tag{5.3}$$

To relate porosity with permeability for rock salts, the following equation was obtained through laboratory tests (Lai, 1971)

$$\frac{\theta^3}{(1 - \theta)^2} = \frac{k^a}{b} \tag{5.4}$$

where

k = intrinsic permeability,
a = constant, and
b = constant.

Lai's experimental tests were conducted in a high-pressure, triaxial cell with external hydrostatic stress and pore pressure held constant. Salt samples were prepared in the laboratory and were free of joints and fractures. Because of the experimental set up, his results have the following shortcomings:

- The tests were conducted on a short-term basis as opposed to a long-term basis.
- The pore pressure was independent of rock stress.
- The migrating fluid used by Lai was kerosene, which is nonreactive to the salt. In the current study, the migrating fluid is brine that, if unsaturated, may react with the salt and affect permeability.
- The induced fracture system and stratigraphic variations in the vicinity of the WIPP excavations cannot be modeled in small rock samples.

While equation (5.4) does not completely describe the relationship between porosity and permeability found in the vicinity of the repository excavation, this equation is suggested for the time being until such time that better relationships between rock deformation and permeability become available.

5.5 EQUATIONS FOR FLUID FLOW

The general fluid-flow equations were developed from the continuity equations and then expanded based on several proposed constitutive relationships. To describe the flow system for a deforming media, the following relationship is used (Huyakorn and Pinder, 1983 - Equation [6.2.1.22]):

$$\frac{\partial}{\partial x_i}\left[\frac{k}{\mu}\left(\frac{\partial P}{\partial x_i}+\rho g_i\right)\right] = \theta\beta\frac{\partial P}{\partial t} + \frac{\partial}{\partial t}\left(\frac{\partial u_i}{\partial x_i}\right) \qquad (5.5)$$

where

u_i = displacement,
k = intrinsic permeability,
ρ = fluid density,
θ = porosity,
β = fluid compressiblity,
P = fluid pressure,
t = time,
x_i = i^{th} coordinate axes,
g_i = i^{th} component of gravitational acceleration, and
μ = absolute viscosity.

Assuming that the pressure potential is large relative to the elevation potential at the repository horizon, one can neglect the ρg_i term. Then, given constant density and viscosity for a two-dimensional analysis (x, y plane), Equation (5.5) simplifies to

$$\frac{1}{\mu}\left[\frac{\partial}{\partial x}\left(\frac{k}{}\frac{\partial P}{\partial x}\right) + \frac{\partial}{\partial y}\left(\frac{k}{}\frac{\partial P}{\partial y}\right)\right] = \theta\beta\frac{\partial P}{\partial t} + \frac{\partial}{\partial t}\left(\frac{\partial u_x}{\partial x} + \frac{\partial u_y}{\partial y}\right) \tag{5.6}$$

The second term (Q_d) on the right-hand side of the equation is defined as

$$Q_d = \frac{\partial}{\partial t}\left(\frac{\partial u_x}{\partial x} + \frac{\partial u_y}{\partial y}\right)$$

It is assumed that this term represents the time rate of change of elastic strain and represents the compression or expansion of the void space due to changes in stress in the salt as determined from the elastoplastic stress analysis.

5.6 EQUATIONS FOR STRESS ANALYSIS

In the absence of external forces, the change in the stress tensor over space is equal to the body forces distributed over the volume. The general static equilibrium is given by

$$\sigma_{ij,j} + F_j = 0 \tag{5.7}$$

or

$$\dot{\sigma}_{ij,j} = 0 \qquad (5.8)$$

where

σ_{ij} = the stress tensor, and
F_j = the body forces.

Note that the comma indicates partial differentiation on the σ_{ij} term.

The equilibrium relations are solved in conjunction with the constitutive relationships for rock salt and strain compatibility relationships. These relations were selected for performing the analysis discussed below. The relations assume:

- Elastic deformation occurs under hydrostatic compression,
- Viscoelastic deformation is neglected,
- Thermal elastic deformation is neglected because temperatures at the repository horizon are constant,
- The yield stress for viscoplastic deformation is equal to zero, and
- The influence of moisture and pore pressure on salt creep is neglected.

The analysis uses the elastic-secondary-creep constitutive relations of Krieg (1982) used in performing the WIPP benchmark problem (Morgan and others, 1981) under isothermal conditions.

5.7 COMPUTER CODE DESCRIPTIONS AND VERIFICATIONS

To implement the model, a coupled finite-element analysis was performed using two modified computer codes. These include the VISCOT code (Intera, 1983) for modeling rock mechanics and the SUTRA code (Voss, 1984) for saturated fluid flow. The resulting computer code is written in modular form such that if further refinements become necessary, they can be easily accommodated. A more complete description of solution algorithms is presented in Appendix J, Section J.7.

In implementing the computer code, a number of verification calculations against closed form solutions were performed. These include:

- Elastic Kirsch solution under external hydrostatic loading,
- Elastic Kirsch solution under external hydrostatic loading with stress relief at the circular boundary,
- A cylindrical laboratory specimen of salt with viscoplastic constitutive relations (Sandia Creep Law) subject to triaxial compression, and
- The Theis solution for drawdown versus radius versus time.

The details of these verification problems are presented in Appendix J, which shows comparisons between closed form and numerical solutions.

5.8 ANALYSIS OF A CIRCULAR OPENING IN HOMOGENEOUS SALT

In performing the pilot analysis described in this report, several key issues are addressed to provide guidance in future modeling efforts. These issues include the development of the disturbed rock zone (DRZ) around the excavation, the relationship of rock strain to changes in porosity and permeability, and the nature of flow into the excavation cavity as described below.

In order to demonstrate the current computer code capabilities and to perform a sensitivity study, an analysis of a circular opening in homogeneous salt was performed. The results of the analysis can be compared against closed form solutions for elastoviscoplastic deformation. The results provide an indication of phenomenological behavior of the disturbed zone and its modification in space and time. The number of degrees of freedom is also comparable to solving a large-scale problem with the computer code.

5.8.1 Problem Description

The following discussion presents the excavation geometry and boundary conditions in Section 5.8.1.1, the salt brine constitutive properties in Section 5.8.1.2, and other modeling parameters in Section 5.8.1.3.

5.8.1.1 Geometry and Boundary Conditions of Opening

The circular excavation has a radius of 1.8 meters, which corresponds approximately with the radius of the construction and salt handling shaft (C and SH shaft) at the WIPP. The VISCOT code reasonably models the observed closure rates in that shaft (U.S. Department of Energy, 1989b - Section 5.4.4). The analysis ignores the effects of surrounding excavations. The finite element model, which is composed of 400 elements as illustrated in Figure 5-1, models one quadrant surrounding the excavation. The boundary conditions for the salt-creep analysis are shown in Figure 5-2. The model utilizes an initial lithostatic stress field corresponding to a depth of 670m. The stresses on the inner boundary were set to zero for the simulation.
For the fluid-flow analysis, the far-field and inner boundaries were fixed pressure boundaries. An initial hydrostatic pressure equal to a lithostatic pressure of 15 MPa was assumed. The inner boundary was fixed at atmospheric pressure.

5.8.1.2 Model Input Properties

The material properties for performing the coupled analysis include the elastic and secondary creep properties of the salt, the compressibility of the brine, and the best estimate for permeability of the undisturbed rock salt. Wherever possible, reference properties for the WIPP repository as summarized in Table 5-1 were used in the analysis.

The permeability of the intact, undisturbed salt was taken as 10^{-6} millidarcy (md) (Peterson and others, 1985). Brine in salt may flow through either the intercrystalline or intracrystalline structure of salt. Owing to the relatively low permeability of individual salt crystals, fluid inclusions within individual crystals may move very slowly, whereas fluid movement occurs more rapidly in the intercrystalline structure of the salt. Case and Kelsall (1987) compiled data on salt permeability from laboratory and field studies; they found that laboratory measurements and field measurements show the permeability of salt ranges from 1 md to 10^{-6} md, while the measurement of a single salt crystal was 10^{-9} md.

Theoretical studies (Kelsall and others, 1982; Case and Kelsall, 1987) as well as field measurements (Peterson and others, 1985; Borns and Stormont, 1988) support the existence of a zone of increased permeability. This physically disturbed zone in the rock occurs in the immediate vicinity of the excavations, following excavation of a new opening and continues

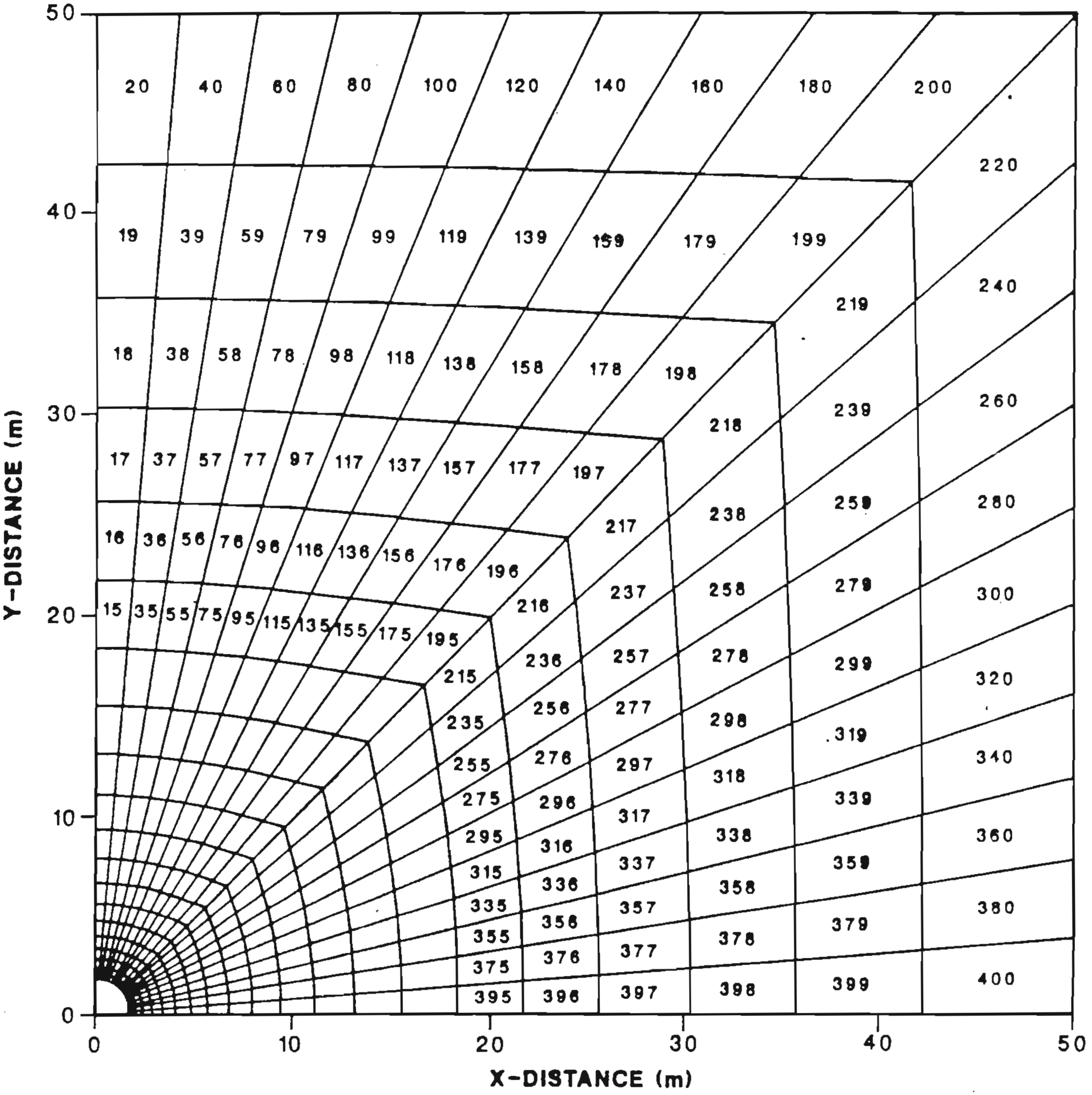

FIGURE 5-1 FINITE ELEMENT MESH

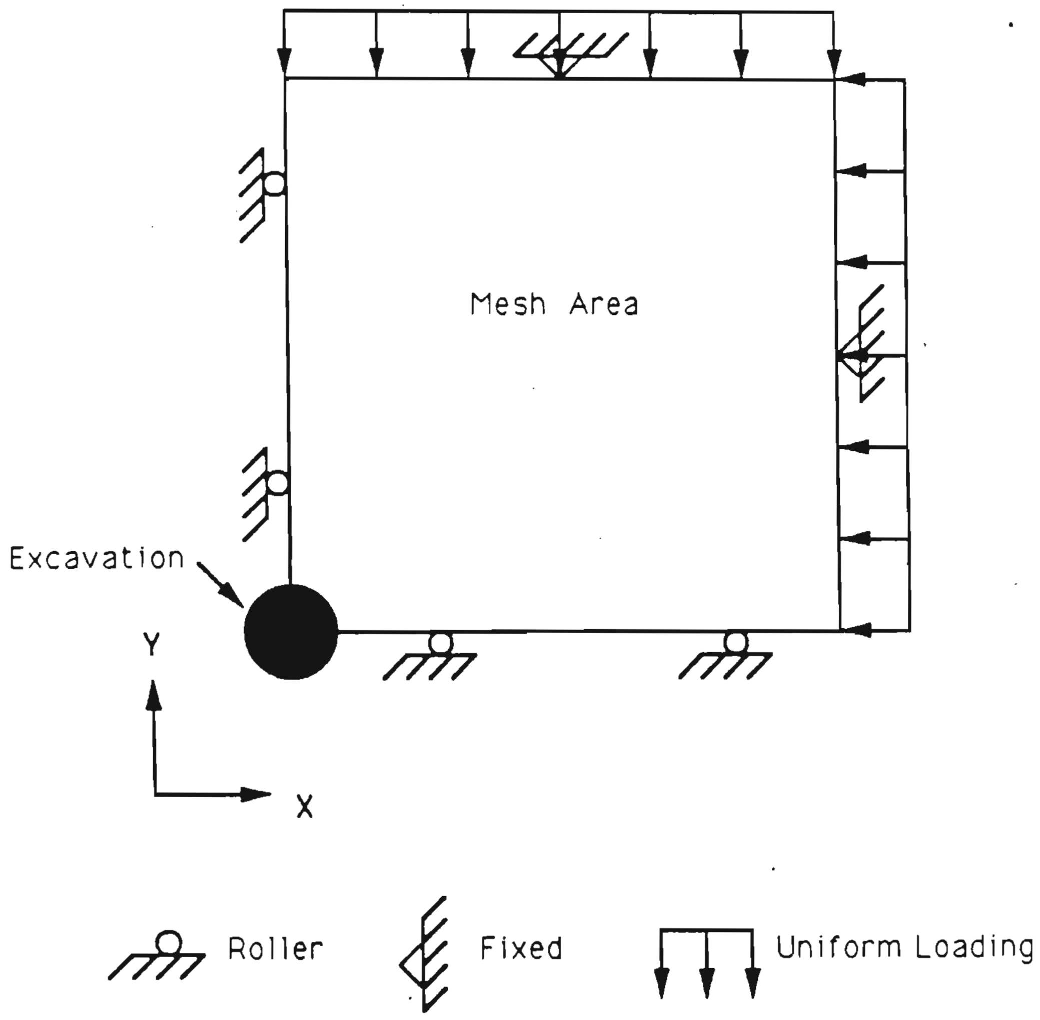

FIGURE 5-2 THE MODEL BOUNDARY AND LOADING CONDITIONS FOR THE SALT CREEP ANALYSIS

TABLE 5-1
SALT/BRINE MATERIAL CONSTITUTIVE PROPERTIES

PARAMETER	BASE CASE VALUE	UNITS
Salt		
Activation Energy, Q	12,000	Calories/mole
Stress Exponent, n	4.9	
Empirical Constant, A	0.126	$MPa^{-4.9}$/day
Universal Gas Constant, R	1.987	calories/(mole °K)
Salt Temperature	300°K	°K
Young's Modulus	31,000	MPa
Poisson's Ratio	0.25	
Salt Far Field Stress, P_o	15	MPa
Brine Compressibility	5×10^{-10}	1/Pa
Salt Porosity	.001	
Brine Viscosity	1.6×10^{-3}	Pa - S
Intact Salt Permeability	1.0	Nanodarcy

until repressurization after closure. In a practical sense, this zone extends approximately a few tens of meters away from the excavation.

Evidence regarding this change in permeability around an entry has been obtained using a guarded, straddle-packer system. The tests were performed to determine the permeability of salt, its variation with distance from the mined surface, and the influence of interspersed anhydrite and clay seams. The combined permeability measurements indicate that there is a relationship of permeability with test interval depth. The data indicate that permeability in salt is reduced by two orders of magnitude (10^{-4} to 10^{-6} md) over depths of 1 to 14 meters. This trend is similar to that predicted by Kelsall and others (1982). Because measurements are made for flow parallel to the drift surface and normal to the direction of stress relief, the results were expected.

Predictions of the zone of increased permeability at the WIPP have been made using the porosity-permeability relations developed by Lai (1971). In order to make predictions of the development of a modified permeability zone, the porosity-permeability relationship of Equation (5.4) was written in logarithmic form and modified (Figure 5-3) as:

$$\log\left[\frac{\theta^3}{(1-\theta)^2}\right] = a \log k - \log b \qquad (5.9)$$

If it is assumed that the empirical constant, a, the constant related to the relative changes in permeability with porosity, which represents the slope in the above relation, is the same as in Lai's experimental work, then the linear relationship presented above may, with the measured properties, be used for undisturbed salt. Intrinsic permeability is 10^{-6} millidarcies at a porosity of 0.1 percent (Peterson and others, 1985).

In the evaluations of brine flow rates, two alternate hypotheses have been presented for brine flow to the underground repository. In the first hypothesis, the ultimate source of the brine is from the far field, in which flow occurs at very slow rates. In the second hypothesis, the far-field permeability is too low to permit significant flow through salt and, therefore, flow to the repository is a consequence of desaturation or the enhanced permeability of the DRZ around the excavation.

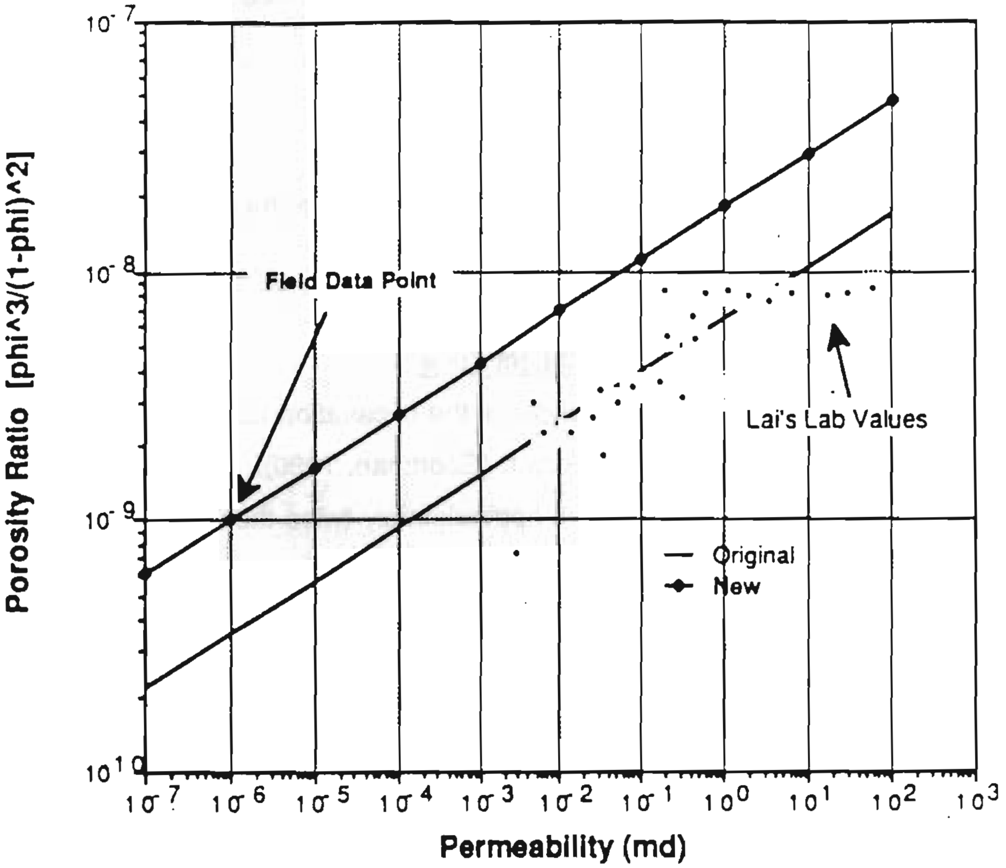

FIGURE 5-3 MODIFICATION OF LAI'S ORIGINAL RELATIONSHIP

By constructing models of each, these hypotheses were investigated for effects on brine flux at the repository. The model of the first hypothesis incorporated a far-field permeability of 1 nanodarcy. The far-field permeability for the model of the second hypothesis was set to much lower than 1 nanodarcy, so that the far field was essentially impermeable. The near-field permeability for both models was taken from the stress analysis; the permeability distribution used was similar to the trend of measured permeabilities with distance reported by Peterson and others (1985).

5.8.2 Deformational Response of the Salt

The following sections describe stress relaxation in an abutment zone and the development of a zone of enhanced permeability.

5.8.2.1 Stress Relaxation in the Abutment Zone

It was anticipated that the stress analysis of the excavation for the circular opening should initially follow the elastic solution of Kirsch (Goodman, 1980). At the excavation, the boundary or tangential stress should increase to approximately twice the value of the initial stress, while the radial stress is zero. In the absence of creep, this stress state would be maintained throughout time. However, in response to the high deviatoric stress, the salt will creep inward and the radial and tangential stresses (Figures 5-4 and 5-5) will relax with time. The tangential stress will form a stress abutment zone in the salt. The stress abutment zone will propagate radially outward with time and this process is essentially complete after approximately 1,000 days. Because stresses are also changing with time, elastic strains are changing in response to these changing stresses.

An alternative view of the stress development at the excavation surface is shown in Figure 5-6, where the radial stress adjacent to the excavation is reduced slightly over time. The radial stresses 20 meters from the excavation do not change appreciably from the initial stress state as might be expected.

Because the elastic strains which affect porosity and permeability are a direct consequence of the state of stress, it can be seen from the preceding discussion that the initial response to excavation produces a large change in tangential stress, as predicted by the Kirsch solution.

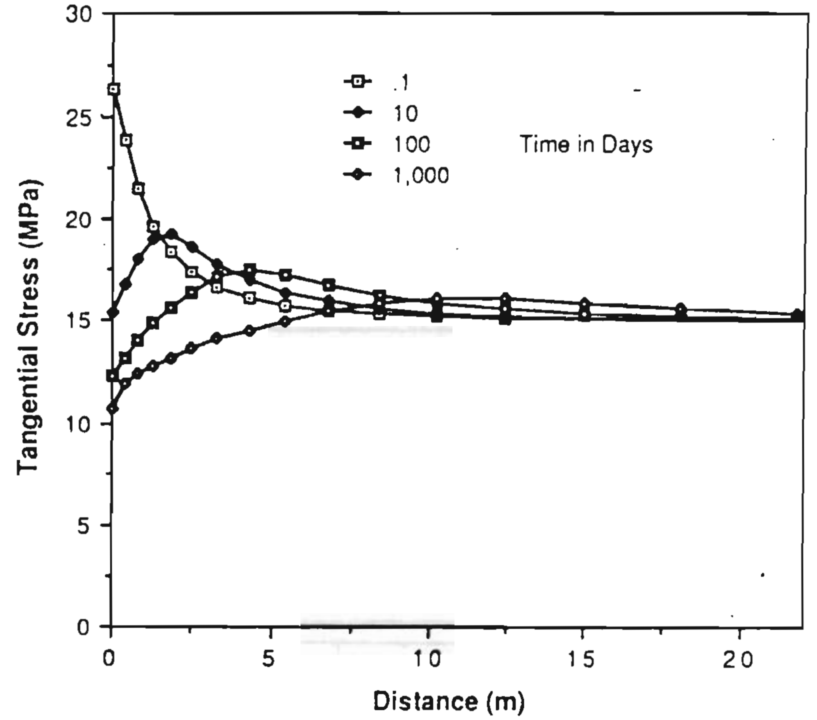

FIGURE 5-4 TANGENTIAL STRESS DEVELOPMENT

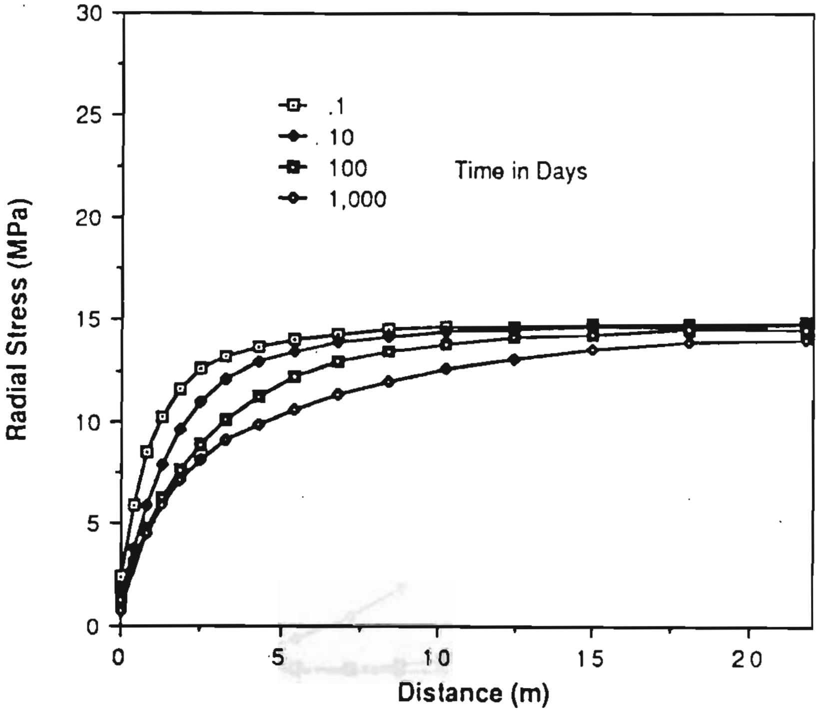

FIGURE 5-5 RADIAL STRESS DEVELOPMENT

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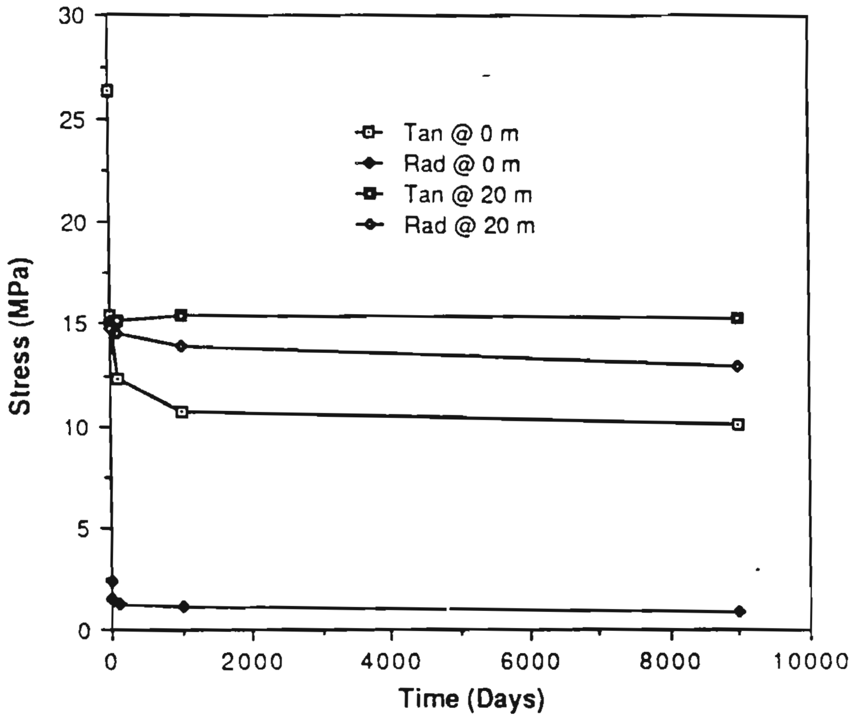

FIGURE 5-6 STRESS VERSUS TIME FOR VARIOUS POINTS

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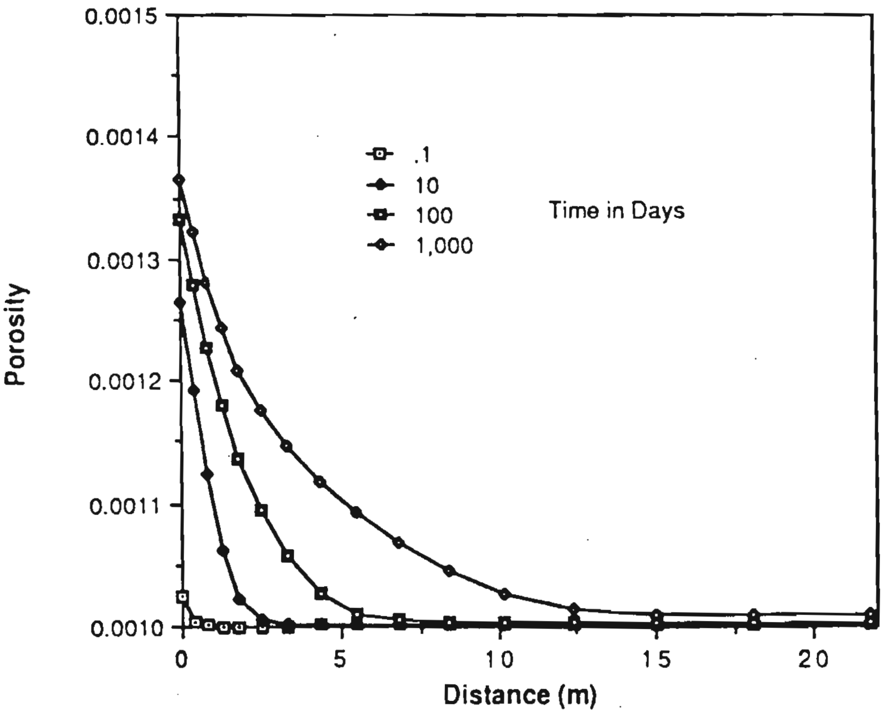

FIGURE 5-7 DEVELOPMENT OF POROSITY WITH TIME

Tangential stress thereafter relaxes, because of salt creep, and the elastic response to this changing stress produces changes in porosity and, in turn, changes in permeability.

5.8.2.2 Development of the Disturbed Rock Zone

Initially, a small increase in porosity occurs near the excavation (Figure 5-7). As boundary stresses relax and the stress abutment zone moves outward into the salt, a distinct zone of enhanced porosity develops. The maximum increase in porosity is approximately 40 percent over the undisturbed porosity of .001.

The development of permeability with time is illustrated in Figure 5-8. The far-field permeability is approximately 1.0 nanodarcy ($10^{-21}m^2$). At the earliest time shown, there is very little permeability enhancement. This result also follows from the Kirsch solution in that the sum of the normal strains (the first strain invariant is dependent on the first stress invariant), which enter into the porosity calculation described previously, should be equal to zero initially. As salt creep relaxes the built-up stresses, the sum of the strains is no longer constant, and porosity and permeability increase with time. Because only the tangential stresses relax significantly over time (compare tangential and radial stress relaxation in Figures 5-4 and 5-5), the changes in permeability in the model may be chiefly attributed to changes in tangential stress.

Following 1,000 days, at a distance of 12 meters from the excavation, the model predicts insignificant increases in porosity and permeability. Figure 5-9 shows the predicted permeability distribution versus radius at 1,000 days after excavation. This figure also shows the data from Peterson and others (1985). The trend of the predicted permeabilities appears to agree reasonably well with in situ measurements. The good agreement between predicted and measured results presented here suggests that the elastic response of the rock due to excavation, coupled with the modeled salt creep phenomena, may be responsible for the trend of reduced permeabilities with depth observed in situ.

The model predicts a radius for the DRZ of approximately 12 meters for a circular excavation of radius 1.8 meters. Peterson and others (1985) suggest a radius for the DRZ of approximately ten meters for a comparable size excavation, while Borns and Stormont (1988)

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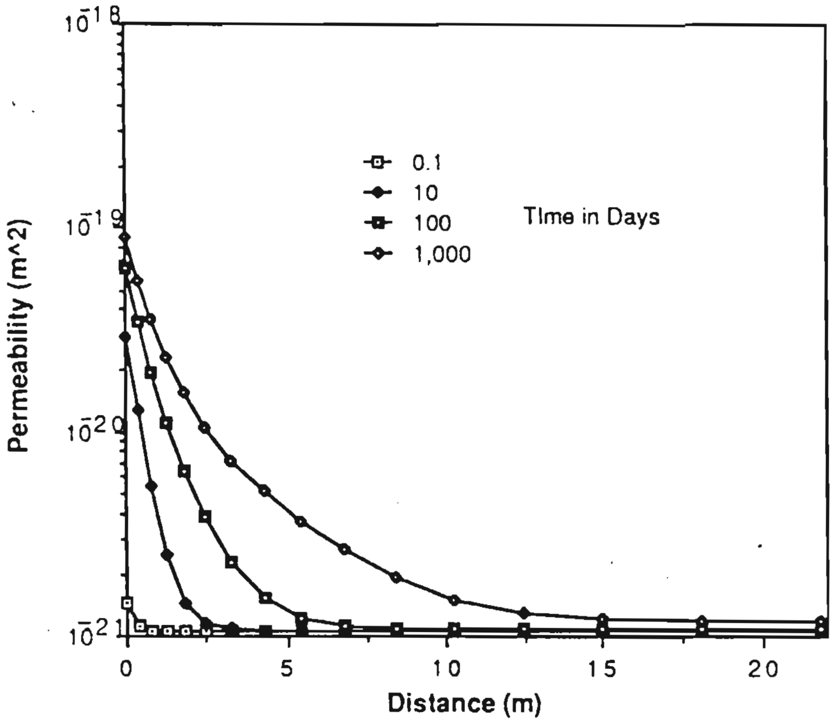

FIGURE 5-8 DEVELOPMENT OF PERMEABILITY WITH TIME

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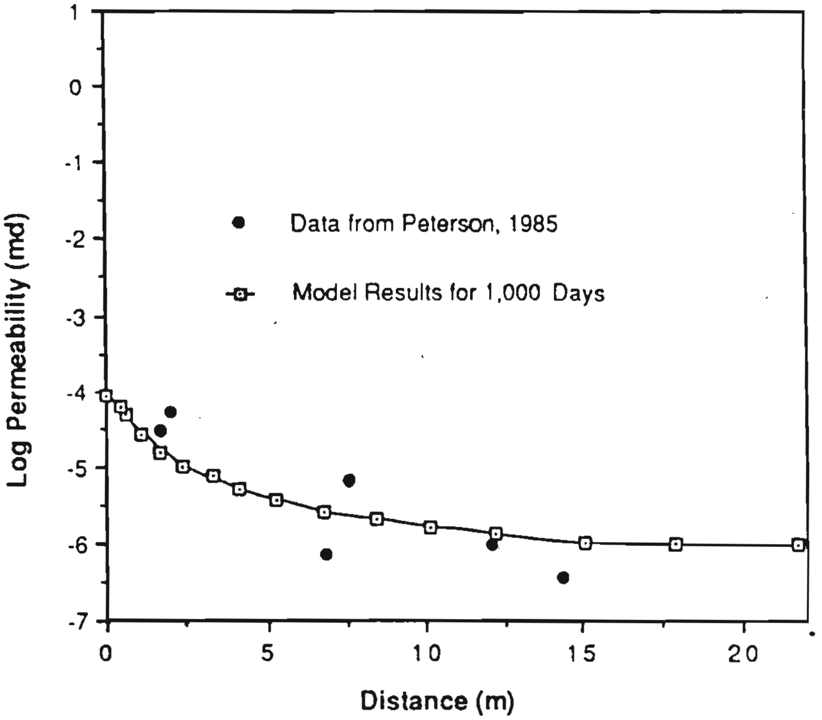

FIGURE 5-9 COMPARISON OF PREDICTED AND FIELD PERMEABILITIES

describe the DRZ radius as approximately 1 to 5 meters. It is noted that a larger excavation would produce a larger disturbed rock zone.

5.8.3 Brine Flow Response in Salt

The following sections describe the pressure and fluid flow response in the DRZ.

5.8.3.1 Fluid Pressure Response in Salt

Shortly after the simulation began, the predicted pressures near the excavation opening dropped to near atmospheric. These results indicate the potential development of an unsaturated zone near the excavation. The unsaturated zone is a consequence of both the increases in porosity due to stress relaxation and the relative impermeability of the salt. Fluid flow from the surrounding salt is not sufficient to keep the expanding void spaces saturated.

This conclusion was borne out in subsequent parametric analyses. Each of these analyses involved the modification of only one parameter from the base case. When permeabilities were raised by three orders of magnitude (all other things being equal) the analysis did not predict a zone of desaturation. When the fluid compressibility term was raised by several orders of magnitude, the analysis again did not predict a zone of desaturation.

However, all values for each of these parameters required to prevent desaturation were unrealistic and confidence exists in the order of magnitude for the assigned values. Furthermore, observations of moisture content suggest that unsaturated conditions do exist within at least the first 5 meters of the salt (Borns and Stormont, 1988).

The extent of propagation of this unsaturated zone is not possible to predict with the current model, because it was not designed to simulate variably saturated (or multiphase) flow. However, the parametric analyses have shown that when strain rates are several orders of magnitude lower than the maximum predicted rates, the analysis did not predict a zone of desaturation. The maximum strain rates occur at early times in the immediate vicinity of the opening. After 10 days, the strain rates dampen out dramatically and the above conditions are nearly satisfied throughout the flow regime. At this time, the stress abutment zone itself has migrated out approximately 2 meters into the salt.

Strain rates which are a function of Young's Modulus, are the only parameters in the analyses which vary significantly with time or distance. Therefore, their distribution in time and space are likely to play a significant role in determining the ultimate extent of the unsaturated zone.

One could conclude that the unsaturated zone would extend no farther than the boundary of significant strain rates. That boundary is coincident with the boundary of the DRZ which, as implied in Figure 5-4, extends approximately 12 meters into the host rock. Beyond that radius, the rock may remain saturated with brine.

5.8.3.2 Brine Flow Response Under Near-Field and Far-Field Boundary Conditions

A subsequent analysis utilized the unmodified SUTRA code to determine whether flow measurements can distinguish, in an ideal case, between near-field and far-field boundary conditions operating in the salt. The assumptions are that the physical properties of the salt remain constant, that the pore spaces remain saturated, and that the opening is a 1.8-meter-radius shaft at a depth of 655 meters. In the near-field model, the permeability for radial distances greater than 12 meters was set to zero. In the far-field model, the permeability was set to 1.0 nanodarcy ($10^{-21}m^2$). A constant porosity of .001 was also used for these simulations. For both cases, the permeability distribution within the DRZ (0 to 12 meters) was identical. (The permeability distribution shown in Figure 5-9 for approximately 1,000 days was used.) Furthermore, this permeability distribution did not vary with time.

Figure 5-10 illustrates the dimensionless flux with time for both models. The flux has been normalized to focus attention on the trends with time rather than actual quantities of brine moving across the surface of the shaft. The dimensionless flux rate appears indistinguishable for approximately the first 30 years. The flux for the near-field case decreases below the level for the far-field case later in time, as the brine available within the DRZ diminishes. Over the time frame of the simulations, both of these results are consistent with classical analytical solutions; the far-field model is similar to flow in a semi-infinite media and the near-field model is similar to the solution obtained for flow from a finite region (0 to 12 meters) with a no-flow condition on the outer boundary.

These results suggest that short-term measurements of brine inflow across the surface of the shaft cannot distinguish between the near-field and far-field models for the ideal case of

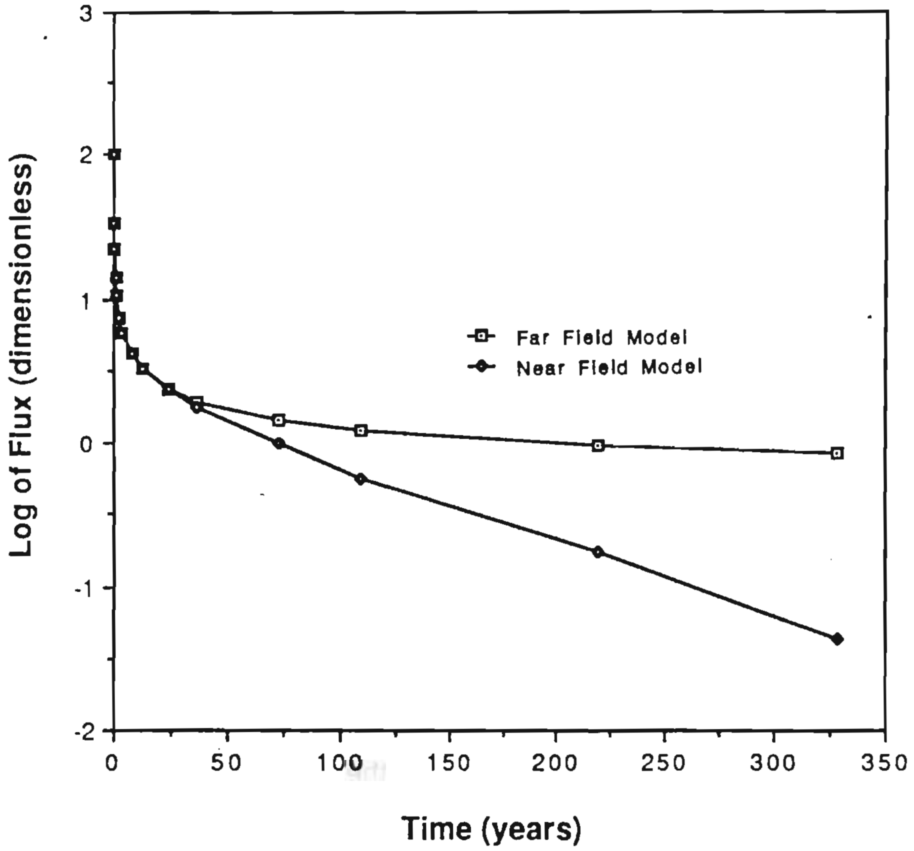

FIGURE 5-10 DIMENSIONLESS FLUX FOR NEAR-FIELD AND FAR-FIELD CASES, SIMULATIONS GENERATED BY SUTRA ONLY

homogeneous salt possessing the assumed properties. For the actual repository, the presence of fractures may decrease the time necessary for such a distinction if the presence of fractures substantially increases the average permeability.

5.8.4 Potential for Hydrofracturing in the Disturbed Zone

Hydrofracturing within the zone of modified rock stresses will occur if the fluid pressure exceeds the confining stress. If this occurs, then fracturing will occur in a direction perpendicular to the minimum confining stress. In Figures 5-4 and 5-5, the tangential stress and radial stress development is shown versus time. Given the initial fluid pressures and these stress distributions, hydrofracturing appears at least qualitatively possible. The zone of potential for hydrofracturing roughly corresponds to the measurements that suggest a DRZ of 5 to 10 meters.

5.9 DISCUSSION

The following discussion provides a framework for evaluating the flow of brine to the excavation.

5.9.1 Development of the DRZ

Excavation induces stress concentrations near the opening in accordance with classical solutions for a circular geometry. With time, salt creep serves to reduce this stress concentration for an excavation in salt. In the modeling results presented here, the elastic strains induced by a circular excavation in the tangential and radial directions were assumed to offset each other, and no porosity increase due to the excavation-induced strains initially occurred. For the circular excavation, the compression in the tangential direction and the dilation in the radial direction were equal and opposite, producing no net change in porosity. However, as salt creep relaxed the excavation-induced stress build-up, the sum of the principal elastic strains became nonzero and porosity increases occurred (Figure 5-7).

The model for the development of the DRZ is preliminary and may be refined through subsequent office, laboratory, and field studies. In their discussion of DRZ formation, Borns and Stormont (1988) have alluded to a rate-of-strain failure criteria for salt. This concept may have potential for describing the initial excavation-induced response of the salt, which in the current model is assumed to yield no initial porosity increase.

Creep strains do not directly enter into the porosity calculation in this model. Creep-induced fracturing and fracture propagation is a geometric effect and was beyond the scope of the current model.

5.9.2 Development of Brine Flow

The simulation results for the salt-creep analysis have indicated the presence of a stress-abutment zone and a corresponding zone of enhanced porosity around the excavation. It is useful to construct the possible sequence of events which affect brine flow along with a discussion of the possible models for boundary conditions within the salt which affect flow, such as the permeability or impermeability of the far field.

The excavation, as demonstrated in the model results, induces a response in the salt that increases the porosity and permeability within the DRZ. The presence of dissolved gas, mostly nitrogen, within the brine may then exsolve from the brine and result in a relatively rapid, transient increase in brine flow from the excavation walls, which is consistent with the observation of brine efflorescence.

The model results indicate, depending on the compressibility of the brine, the strain-rate distribution with time and space, and the initial permeability distribution that an unsaturated zone can form near the excavation. This zone may extend as far into the host rock as the DRZ.

The modeling and analyses presented above have focused on the enhanced porosity resulting from the excavation response, assuming a porous media. Creep fracturing near the surface of the excavation and underground mine ventilation may also cause the formation of an unsaturated zone.

According to the model results, stress relaxation due to the excavation is essentially complete within approximately 3 years. Salt-creep-induced fracturing near the excavation surface will enhance the effective permeability of the salt. The maximum distance for this effect, given the geometry of repository rooms, appears to be related to the stress build-up caused by salt creep. Because of geometric effects, the depth of fractures caused by creep may be significant. The variation of mechanical properties for features such as anhydrite marker beds may affect not only the creep fracture response, but also the original excavation-induced response modeled in this report. Within the framework of the model developed in this work, heterogeneities and their effect on the excavation-induced response may be easily incorporated into the model.

5.10 SUMMARY OF MAJOR LIMITATIONS AND ASSUMPTIONS

The modeling and analysis of the development of a DRZ and brine inflow rates was not directed at the development of a totally new code based on a global derivation (such as that of Niou and Deal, 1989), but rather was an attempt to couple two existing codes to obtain a preliminary evaluation of the effects of deformation of initially very impermeable salt on the flow of brine to a 1.8-meter-radius shaft at a depth of 655 meters. Limitations exist in both codes and in the assumptions necessary to couple them. The following limitations and assumptions apply:

- Deformations do not significantly affect model geometry. Both models (VISCOT and SUTRA) are based upon small-strain theory.
- The governing equation for fluid flow is taken from the soil consolidation equation of Huyakorn and Pinder (1983), in which changes in local strain affect fluid pressure.
- Effective stress equals total stress in the rock. The porosity is so small in the deforming salt that the change in pore pressure is assumed not to affect total stress. This allows unidirectional coupling from VISCOT to SUTRA, eliminating the need to input the change in pore pressure from SUTRA into each iteration run of VISCOT.
- Only elastic strain (no plastic strain) is considered in the calculation of changes in porosity.
- Elastic strain of the salt is entirely converted to change in porosity.
- The rock is assumed to be saturated with fluid.
- Permeability is calculated from a relationship derived from the empirical relationship found by Lai (1971), that was modified to more closely simulate the salt at the WIPP.
- Neither microfracture nor macrofracture porosity were considered.

5.11 CONCLUSIONS AND RECOMMENDATIONS

This work has described a coupled model for the simulation of salt-creep and fluid-flow characteristics for the near term. The coupling between salt creep and the fluid flow was unidirectional in that the effective stress acting to deform the porosity was taken to be the total stress. The pore pressure was thus assumed not to affect the deformation of the rock. A second critical assumption states that the development of elastic strains is equivalent to changes in porosity.

After excavation of the circular opening, the tangential stress predicted by the model is equal to the stress given by the elastic Kirsch solution. Salt creep serves to relax this stress build-up, and the relaxation of this stress build-up causes the propagation of a stress abutment zone into the salt. This stress abutment zone, in turn, causes elastic deformation of the salt, which increases porosity and permeability.

For the base case simulation using reference properties, including the measured brine compressibility, the model results show the development of an unsaturated zone near the excavation. This unsaturated zone results from an increase in void volume and the inability of the fluid to flow and expand into the new void volume within the time frame of the simulation. For compressibilities two orders of magnitude higher, the brine expanded into the enhanced porosity and the development of the unsaturated zone was not observed. For permeabilities three orders of magnitude higher, the rock remained saturated. Finally, the rock remained saturated if strain rates were several orders of magnitude lower. The values of any of these parameters required to maintain saturation are not considered realistic.

Because strain rates are the only parameters of the three discussed that change significantly with time and distance, they are believed to play a singular role in determining the extent of the unsaturated zone. Beyond the DRZ, the strain rates are significantly lower than the highest predicted rates throughout the simulation. Therefore, it is possible that the unsaturated zone does not extend substantially beyond the DRZ.

Use of the DRZ permeability distribution for the near field, and either 1.0 nanodarcy ($10^{-21}m^2$) or approximately zero permeability for the far field gave two cases representing the far-field flow and near-field boundary conditions, respectively. Dimensionless flux for these two cases showed that they are indistinguishable for early times (over a period of 30 years).

Depending on the value of the initial fluid pressure, hydrofracturing appears possible because of the decay of the excavation-induced stresses by salt creep. The stresses within approximately 7 meters of the excavation may decrease significantly enough for fluid pressures to exceed the level of confining stress and thus produce hydrofracturing.

The model results appear to concur with measured results in two important areas. First, a radius of 10 to 12 meters for the DRZ appears roughly to correspond to the radius indicated by permeability measurements conducted by Peterson and others (1985) and DRZ measurements conducted by Borns and Stormont (1988). Secondly, the use of Lai's relationship appeared to accurately predict the trend of the permeabilities as measured by Peterson and others (1985).

From this standpoint, the assumed relationship between elastic strain and porosity, in which all of the elastic strain is converted into porosity, appears to yield at least a qualitative fit to the observed permeabilities and radius for the DRZ. Future work may involve the refinement of the relationship between elastic strain and porosity. One approach may be an examination of the threshold stress at which crystal boundaries in salt elucidate.

The coupled model can be used to model more realistic geometries. Future work may involve the construction of a grid that includes heterogeneities of the salt, as well as more realistic room geometries. Because of the assumption of insignificant volumetric deformations, the model may not be used to show the long-term behavior of the salt. To model the long-term behavior, a large strain theory may be required.

Anticipated flow measurements from long horizontal boreholes into intact salt may provide information for the determination of the effective boundary conditions within the salt. The nature of these boundary conditions obviously affects the long-term performance of the repository; if these boundary conditions are near field, the amount of brine may be limited by the volume of brine within the DRZ, which in the actual repository, must be extended to include the excavation-induced disturbances in heterogeneities and marker beds.

Finally, the presence of heterogeneities within the salt may mask any attempt to generalize results from modeling unless these heterogeneities are incorporated into a model. Heterogeneities within the salt may cloud the distinction between near- and far-field effects. Where permeabilities are relatively low in the far field, the near-field disturbed zone may dominate. Where permeabilities of the intact salt are higher, such as in marker beds, the far field may dominate.

Recommendations for additional work are listed below:

- Investigation of failure criteria for intact salt to refine the relationship between salt strain and porosity,
- Construction of a more realistic model geometry that incorporates features such as marker beds,
- Assessment of gas exsolution driving forces using a multiphase numerical model,
- Investigation of the gas content of the brine, and
- Investigation of flow rate data from long horizontal boreholes to determine a better estimate of the far-field salt permeability.

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APPENDIX A

BRINE ACCUMULATION

PART I - LIST OF UNDERGROUND LOCATIONS WHERE BRINE OCCURRENCES WERE OBSERVED AND MONITORED

PART II - BRINE ACCUMULATION DATA TABLES

APPENDIX A

BRINE ACCUMULATION

PART I - LIST OF UNDERGROUND LOCATIONS WHERE BRINE OCCURRENCES WERE OBSERVED AND MONITORED

TABLE A-1

LIST OF UNDERGROUND LOCATIONS WHERE BRINE OCCURRENCES WERE OBSERVED AND MONITORED THROUGH DECEMBER, 1988 AS PART OF THE BRINE SAMPLING AND EVALUATION PROGRAM AT WIPP

Hole Number	Room or Location	Survey Accuracy S=Surveyed A=Approximate	North-South Coordinates	East-West Coordinates	Elevation	Dia. (in)	Depth (ft)	Direction U=Up D=Down H=Horizontal	Angle	References	Remarks
A1X01	A1	S	N1147.02	E1254.40	1313.26	4	49.75	D	90	B, D, E	Monitored as part of the BSEP since it was drilled in 3/85.
A1X02	A1	S	N1146.88	E1254.24	1331.29	4	59.0	U	90	B, D, E	Monitored as part of the BSEP since it was drilled in 3/85
A2X01	A2	S	N1393.72	E1338.88	1311.20	4	50.15	D	90	B, D, E	Monitored as part of the BSEP since it was drilled in 2/85.
A2X02	A2	S	N1393.65	E1338.89	1328.86	4	52.75	U	90	B, D, E	Monitored as part of the BSEP since it was drilled in 2/85. At the present, no brine is collected because of insufficient inflow.
A3X01	A3	S	N1137.94	E1406.84	1309.78	4	50.5	D	90	B, D, E	Monitored as part of the BSEP since it was drilled in 1/85. Drillers did not report any moisture while drilling. Hole started producing brine a few weeks later.
A3X02	A3	S	N1138.00	E1406.89	1327.93	4	50.75	U	90	B, D, E	Monitored as part of the BSEP since it was drilled 1/85. Drillers did not encounter moisture while drilling. Hole started producing brine a few weeks later. At the present, no brine is collected because of insufficient inflow.
BTPA1	S1620/W170	A	S1638	W162	1258	3	5.1	D	90	B	Open from 0 to 5.1 ft. Drilled for BSEP study 7/86 and monitored until 12/02/88.
BTPA2	S1620/W170	A	S1638	W166	1258	3	9.1	D	90	B	Cased from 0 to 5.4 ft. Open from 5.4 to 9.1 ft. Drilled for BSEP study 7/86 and monitored until 12/02/88.
BTPA3	S1620/W170	A	S1638	W170	1258	3	14.0	D	90	B	Cased from 0 to 10.3 ft. Open from 10.3 to 14.0 ft. Drilled for BSEP study 7/86 and monitored until 12/02/88.
BTPA4	S1620/W170	A	S1638	W166	1271	3	4.6	U	90	B	Open from 0 to 4.6 ft. Drilled for BSEP study 7/86 and monitored until 9/27/88. Dry.
BTPA5	S1620/W170	A	S1638	W170	1271	3	5.3	U	90	B	Open from 0 to 5.3 ft. Drilled for BSEP study 7/86 and monitored until 9/27/88. Dry.
BTPB1	S1620/W170	A	S1636	W162	1258	3	5.1	D	90	B	Open from 0 to 5.1 ft. Drilled for BSEP study 7/86 and monitored until 9/27/88.
BTPB2	S1620/W170	A	S1636	W166	1258	3	9.6	D	90	B	Cased 0 to 5.9 ft. Open from 5.9 to 9.6 ft. Drilled for BSEP study 7/86 and monitored until 9/27/88.
BTPB3	S1620/W170	A	S1636	W170	1258	3	13.3	D	90	B	Cased 0 to 10.0 ft. Open from 10.0 to 13.3 ft. Drilled for BSEP study 7/86 and monitored until 9/27/88.
BTPB4	S1620/W170	A	S1636	W166	1271	3	9.75	U	90	B	Cased 0 to 6.8 ft. Open from 6.8 to 9.75 ft. Drilled for BSEP study 7/86 and monitored until 9/27/88.
BTPB5	S1620/W170	A	S1636	W170	1271	3	10.3	U	90	B	Cased 0 to 6.3 ft. Open from 6.3 to 10.3 ft. Drilled for BSEP study 7/86 and monitored until 9/27/88.
BTPC1	S1620/W170	A	S1634	W162	1258	3	5.0	D	90	B	Open from 0 to 5.0 ft. Drilled for BSEP study 7/86 and monitored until 9/27/88.
BTPC2	S1620/W170	A	S1634	W166	1258	3	9.8	D	90	B	Cased from 0 to 5.5 ft. Open from 5.9 to 9.8 ft. Drilled for BSEP study 8/86 and monitored until 9/27/88.

LIST OF UNDERGROUND LOCATIONS WHERE BRINE OCCURRENCES WERE OBSERVED AND MONITORED THROUGH DECEMBER, 1988 AS PART OF THE BRINE SAMPLING AND EVALUATION PROGRAM AT WIPP (CONTINUED)

Hole Number	Room or Location	Survey Accuracy S=Surveyed A=Approximate	North-South Coordinates	East-West Coordinates	Elevation	Dia. (in)	Depth (ft)	Direction U=Up D=Down H=Horizontal	Angle	References	Remarks
BTPC3	S1620/W170	A	S1634	W170	1258	3	14.4	D	90	B	Cased from 0 to 10.0 ft. Open from 10.0 to 14.4 ft. Drilled for BSEP study 8/86 and monitored until 9/27/88.
BTPC4	S1620/W170	A	S1634	W166	1271	3	17.6	U	90	B	Cased from 0 to 13.9 ft. Open from 13.9 to 17.6 ft. Drilled for BSEP study 7/86 and monitored 9/27/88.
BTPC5	S1620/W170	A	S1634	W170	1271	3	18.2	U	90	B	Cased from 0 to 14.0 ft. Open from 14.0 to 18.2 ft. Drilled for BSEP study 7/86 and monitored until 9/27/88. Dry.
BTR1	S1950/E100	A	S1942	E98	1269.5	3.25	1.0	H	5	B	Hole slightly declined below horizontal. Collar above upper clay seam, about 1 ft. below back. Drilled 6/86 and monitored until 9/27/88. Dry.
BTR2	S1950/E100	A	S1942	E100	1269.5	3.25	3.2	H	5	B	Hole slightly declined below horizontal. Collar above upper clay seam, about 1 ft. below back. Drilled 6/86 and monitored until 12/02/88.
BTR3	S1950/E100	A	S1942	E101	1269.5	3.25	3.3	H	5	B	Hole slightly declined below horizontal. Collar above upper clay seam, about 1 ft. below back. Drilled 6/86 and monitored until 12/02/88.
BTR4	S1950/E100	A	S1942	E98	1267.5	3.25	0.95	H	5	B	Hole slightly declined below horizontal. Collar in halite about 3.5 ft. below back. Drilled 6/86 and monitored until 12/02/88.
BTR5	S1950/E100	A	S1942	E100	1267.5	3.25	3.0	H	5	B	Hole slightly declined below horizontal. Collar in halite about 3.5 ft. below back. Drilled 6/86 and monitored until 12/02/88.
BTR6	S1950/E100	A	S1942	E101	1267.5	3.25	3.0	H	5	B	Hole slightly declined below horizontal. Collar in halite about 3.5 ft. below back. Drilled 6/86 and monitored until 12/02/88.
BTR7	S1950/E100	A	S1942	E98	1264.7	3.25	1.1	H	5	B	Hole slightly declined below horizontal. Collar just above orange band. Drilled 6/86 and monitored until 12/02/88. Dry.
BTR8	S1950/E100	A	S1942	E100	1264.7	3.25	3.1	H	5	B	Hole slightly declined below horizontal. Collar just above orange band. Drilled 6/86 and monitored until 12/02/88.
BTR9	S1950/E100	A	S1942	E101	1264.7	3.25	3.1	H	5	B	Hole slightly declined below horizontal. Collar just above orange band. Drilled 6/86 and monitored until 12/02/88.
BTR10	S1950/E100	A	S1942	E98	1262.2	3.25	1.2	H	5	B	Hole slightly declined below horizontal. Collar about 2.5 ft. above floor. Drilled 6/86 and monitored until 12/02/88. Dry.
BTR11	S1950/E100	A	S1942	E100	1262.2	3.25	3.05	H	5	B	Hole slightly declined below horizontal. Collar about 2.5 ft. above floor. Drilled 6/86 and monitored until 12/02/88.
BTR12	S1950/E100	A	S1942	E101	1262.2	3.25	3.05	H	5	B	Hole slightly declined below horizontal. Collar about 2.5 ft. above floor. Drilled 6/86 and monitored until 12/02/88.

TABLE A-1

LIST OF UNDERGROUND LOCATIONS WHERE BRINE OCCURRENCES WERE OBSERVED AND MONITORED THROUGH DECEMBER, 1988 AS PART OF THE BRINE SAMPLING AND EVALUATION PROGRAM AT WIPP (CONTINUED)

Hole Number	Room or Location	Survey Accuracy S=Surveyed A=Approximate	North-South Coordinates	East-West Coordinates	Elevation	Dia. (in)	Depth (ft)	Direction U=Up D=Down H=Horizontal	Angle	References	Remarks
BX01	B	S	N1384.68	E0982.33	1317.44	4	50.15	D	90	B, E	Monitored as part of the BSEP since it was drilled in 1/85. Core moist from 10.6 to 11.1 meters in coarsely crystalline clear halite. MB139 at 7.1 to 7.9 meters.
BX02	B	S	N1384.44	E0982.87	1335.47	4	49.25	U	90	B, E	Monitored as part of the BSEP since it was drilled in 1/85. At the present no brine is collected because of insufficient inflow.
DH15	N1140/E1689	A	N1104	E1688.5	1319.9	3	51	U	90	B	Moisture noticed at collar in 4/86. Collecting device installed 5/86 and monitored as part of the BSEP since then.
DH35	G	A	N1102	W1882	1294.4	3.5	52.0	U	90	A3, B	Monitored as part of BSEP since 2/85. At present no brine is collected because of insufficient inflow.
DH36	G	A	N1102	W1882	1284.6	3.5	51.5	D	90	A3, B	Monitored as part of BSEP since 1/85.
DH37	G	S	N1101	W2182	1297.4	3.5	51.5	U	90	A3, B	Monitored as part of BSEP since 1/85. At the present no brine is collected because of insufficient inflow.
DH38	G	S	N1101	W2182	1287.0	3.5	47.5	D	90	A3, B	Monitored as part of BSEP since 1/85.
DH39	G	S	N1101	W2482	1296.0	3.5	50.7	U	90	A3, B	Monitored as part of BTP since 2/85. At the present no brine is collected because of insufficient inflow.
DH40	G	S	N1101	W2482	1286.1	3.5	51.0	D	90	A3, B	Monitored as part of BSEP since 1/85.
DH41	G	S	N1101	W2782	1295.8	3.5	49.9	U	90	A3, B	Monitored as part of BSEP since 2/85. At the present no brine is collected because of insufficient inflow.
DH42	G	S	N1101	W2782	1285.9	3.5	51.2	D	90	A3, B	Monitored as part of the BSEP since 2/85.
DH42A	G	S	N1101	W2789	1285.7	3.5	40.5	D	90	A3, B	Monitored as part of the BSEP since 2/85.
DH215	S1960/E153	S	S1960	E0153	1272.0	3	52.0	U	90	A1, B	Gas releases had been observed in this hole. Monitored as part of the BSEP since 1/85.
DH216	S1960/E153	S	S1960	E0153	1262.6	3	54.2	D	90	A1, B	Gas releases had been observed in this hole. Monitored as part of the BSEP from 1/85 to 6/85 when collar was destroyed and hole plugged by mining.
DH317	S1600/W33	S	S1600	W0030	1271.3	3	50.1	U	90	A2, B	Stalactite growth monitored as part of the BSEP from 5/85 to 2/86.
DH317A	S1600/W30	S	S1600	W0028	1271.2	3	5.0	U	90	A2, B	Stalactite growth monitored as part of BSEP from 5/85 to 2/86.
DH317B	S1600/W30	S	S1597	W0027	1271.2	3.5	51.0	U	90	A2, B	Gas pocket at 45.91. Brine seeped from hole after drill rods were broken at end of run at depth of 16.3 ft. Probable source was anhydrite "a". Stalactite growth monitored as part of BSEP from 5/85 to 2/86.
DHP401	S1950/E1330	A	S1950	E1330	1268.0	4	49.5	U	90	B	Drilled 1/87, observed as part of BSEP since 3/87.
DHP402A	S1950/E1330	A	S1950	E1330	1255.8	4	49.8	D	90	B	Drilled 12/86, observed as part of BSEP since 12/86. Hole offset at 45 ft. There may be a rock bolt or piece of steel in hole.
EES12B		A	N1430	E0140		1.87	9.8	D	90	K	Drilled 6/86 as part of the Excavation Effects Study. Observed as part of BSEP from date of drilling until 12/86. Rapid brine and gas inflow through open fractures.

LIST OF UNDERGROUND LOCATIONS WHERE BRINE OCCURRENCES WERE OBSERVED AND MONITORED THROUGH DECEMBER, 1988 AS PART OF THE BRINE SAMPLING AND EVALUATION PROGRAM AT WIPP (CONTINUED)

Hole Number	Room or Location	Survey Accuracy S=Surveyed A=Approximate	North-South Coordinates	East-West Coordinates	Elevation	Dia. (in)	Depth (ft)	Direction U=Up D=Down H=Horizontal	Angle	References	Remarks
EES21B		A	S0700	E0066		1.87	9.1	D	90	K	Drilled 7/86 as part of the Excavation Effects Study. Observed as part of the BSEP since drilling until 12/86. Rapid brine and gas inflow through fractures.
G Seep	G	A	N1095	W1837	1284					B	Damp area on the floor of Room G, near south rib, approximately 45 ft. east of DH35. Seep noticed 8/85. Damp area larger in 11/85. Monitored as part of BSEP since 11/85. 16-inch diameter collecting sump drilled 9/87.
IG201	2	S	N1275.54	W0379.51	1294.97	2.875	53.83	D	90	A3, B, H, J	Monitored as part of BSEP from 11/84 to 9/87 when shear closure pinched hole shut so that sampler would not go to bottom.
IG202	1	S	N1264.79	W0246.11	1296.49	2.875	48.16	D	90	A3, B, H, J	Monitored as part of BSEP from 11/84 to 7/87 when shear closure pinched hole shut so that sampler would not go to bottom. Last BSEP brine data collected in 3/87.
JV8	J	S	N1067	W0374	1290	36	8.1	D	90	D, F, G	Drilled 8/08/85, drillers reported water at 7 ft. 10 inches.
JV9	J	S	N1067	W0378	1290.4	36	8.1	D	90	D, G	Brine in bottom of pilot hole on 8/20/85.
L1S25	L1	A	N1524	W0218	1312	4	11.90	D	90	B, H	Monitored as part of BSEP since 8/85.
L1S26	L1	A	N1524	W0220	1312	4	11.72	D	90	B, H	Monitored as part of BSEP since 8/85.
L1S27	L1	A	N1524	W0222	1312	4	11.93	D	90	B, H	Monitored as part of BSEP since 8/85.
L1S29	L1	A	N1524	W0226	1312	4	12.03	D	90	B, H	Monitored as part of BSEP since 8/85.
L1S30	L1	A	N1524	W0228	1312	4	12.18	D	90	B, H	Monitored as part of BSEP since 8/85.
L1S32	L1	A	N1524	W0237	1312	4	11.95	D	90	B, H	Monitored as part of BSEP since 8/85.
L1S33	L1	A	N1524	W0239	1312	4	11.98	D	90	B, H	Monitored as part of BSEP since 8/85.
L1S36	L1	A	N1524	W0245	1312	4	12.22	D	90	B, H	Monitored as part of BSEP since 8/85.
L1X00	L1	A	N1538.5	W0225	1312	4	12.45	D	90	B, H	Drillers reported "found water in hole at 10 ft., 5/13/84", monitored as part of the BSEP since 10/84.
L2C03	L2	A	N1510	W0365	1312	16	12	D	90	B, H	Drilled 4/85 overcoring and destroying L2C25. Brine and gas enters hole quickly through open fractures. Monitored intermittently as part of BSEP from 12/85 through 12/86.
L2C25	L1	A	N1510	W0365	1312	5	11.36	D	90	B, H	L2C25 is a 5-inch overcore of a previously grouted SNL test hole. The overcore was drilled 3/85 and air and brine was blown through fractures into hole L2C29, 4 ft. to the north. In 4/85, a 16-inch overcore was made destroying this hole. The larger hole is designed L2C03.
MIIT2	J	S	N1088.03	W0377.02	1290.81	3.25	2.9	D	90	B, D, G	Brine since drilled, monitored from 10/26/85 to 4/23/85.
MIIT4	J	S	N1086.05	W0377.13	1290.82	3.25	3.275	D	90	B, D, G	Brine since drilled, monitored from 10/26/84 through 4/23/85.
MIIT6	J	S	N1084.16	W0377.15	1290.55	3.25	3.125	D	90	B, D, G	Brine since drilled, monitored from 10/26/84 through 4/23/85.
MIIT8	J	S	N1082.08	W0377.24	1290.48	3.25	3.05	D	90	B, D, G	Brine since drilled, monitored from 10/26/84 to 4/23/85.

TABLE A-1

LIST OF UNDERGROUND LOCATIONS WHERE BRINE OCCURRENCES WERE OBSERVED AND MONITORED THROUGH DECEMBER, 1988 AS PART OF THE BRINE SAMPLING AND EVALUATION PROGRAM AT WIPP (CONTINUED)

Hole Number	Room or Location	Survey Accuracy S=Surveyed A=Approximate	North-South Coordinates	East-West Coordinates	Elevation	Dia. (in)	Depth (ft)	Direction U=Up D=Down H=Horizontal	Angle	References	Remarks
MIIT10	J	S	N1079.98	W0377.23	1290.38	3.25	3.075	D	90	B, D, G	Brine since drilled, monitored from 10/26/84 through 4/23/85.
MIIT12	J	S	N1078.11	W0377.21	1290.20	3.25	3.05	D	90	B, D, G	Brine since drilled, monitored from 10/26/84 through 4/23/85.
MIIT14	J	S	N1076.18	W0377.30	1289.85	3	3.05	D	90	B, D, G	Brine since drilled, monitored from 10/26/84 through 4/23/85.
MIIT16	J	S	N1074.17	W0377.18	1289.2	3	2.975	D	90	B, D, G	Brine since drilled, monitored from 10/26/84 through 4/23/85.
MIIT17	J	S	N1072.03	W0379.10	1290.31	3	3.250	D	90	B, D, G	Brine since drilled, monitored from 10/26/84 through 4/23/85. Sandia filled hole with Brine A 4/30/85 and plugged with rubber cork.
MIIT18	J	S	N1071.91	W0377.18	1290.25	3	3.925	D	90	B, D, G	Brine since drilled, monitored from 10/26/84 through 4/23/85. Sandia experiment filled hole with Brine A 4/20/85 and plugged hole with rubber cork.
MIIT20	J	S	N1069.84	W0377.22	1290.34	3	5.975	D	90	B, D, G	Brine noted 10/26/84, monitored from 10/26/84 through 4/23/85.
MIIT22	J	S	N1067.93	W0377.23	1290.44	3	5.825	D	90	B, D, G	Brine noted 10/26/84, monitored from 10/26/84 through 4/23/85.
MIIT24	J	S	N1065.79	W0377.21	1290.74	3	5.975	D	90	B, D, G	Brine noted 10/26/84, monitored 10/26/84 through 4/23/85, Sandia experiment added Brine A to hole 4/30/85 and plugged with rubber cork.
MIITP	J	A	N1067	W0378	1290.8	1.5	8.8	D	90	B, F	Brine since drilled, pilot hole for 36-inch diameter hole that was never completed. Monitored from 4/02/85 through 4/23/85.
NG252	2	S	N1275.86	W0381.05	1294.89	1.5	7.54	D	90	A3, B, H, J	Monitored as part of the BSEP since 11/84. This hole continues to produce gas, first time noticed before 10/84.
PR2	S1600/E140	A	S1600	E0140	1271.2	2	20	U	90	B, C	Stalactite growth monitored as part of the BSEP from 5/85 to 2/86.
PR3	S1282/E140	A	S2182	E0140	1263	2	20	U	90	B, C	Stalactite growth monitored as part of the BSEP from 5/85 to 2/86.
PR4	S2748/E140	A	S2748	E0140	1250	2	20	U	90	B, C	Stalactite growth monitored as part of the BSEP from 5/85 to 2/86.
WWC1	N1420/RoomC1	A				36	16	SOUTH	0	B	Large horizontal hole on south rib of N1420 drift, across from Room C1. Photographically monitored for salt buildup.

References:

A1	TSC-D'Appolonia. 1983 (WIPP-DOE-163)
A2	Bechtel National, 1984 (WIPP-DOE-202)
A3	Bechtel National, 1985 (WIPP-DOE-213)
B	Brine Sampling and Evaluation Program File
C	Records of Special Drill Holes, 9/12/83: BSEP Files
D	As-Built Survey Calculation Sheets: BSEP Files
E	Field Notes, J. Gallerani, Bechtel National: BSEP Files
F	Field Notes, D. Deal, International Technology Corp.: BSEP Files
G	Room J Brine Survey: BSEP Files
H	Room L1 and L2 Field Notes: BSEP Files
J	Geotechnical Instrumentation List, 11/02/83: BSEP files
K	Excavation Effects Drilling Program, Data Transmittal 8/12/86: Excavation Effects Files: WIPP Geotechnical Engineering Files

APPENDIX A

BRINE ACCUMULATION

PART II - BRINE ACCUMULATION DATA TABLES

This appendix contains copies of the brine accumulation data collected by the WIPP Brine Sampling and Evaluation Program through December 31, 1988. The brine measurements were made in accordance with WIPP Procedure WP07-410. Sampling methodology, data handling, and calculations have been discussed by Deal and Case (1987), and reference is made to that document for a thorough discussion of the data.

WIPP BRINE SAMPLING AND EVALUATION PROGRAM
Appendix A for the 1988 BSEP Report
Data through December 31, 1988

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
A1X01	10/10/84	00:00	NA	0.000	0.000	0.00	0.000	Room A1 completed.
A1X01	02/26/85	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 2/21/85 to 2/26/85.
A1X01	03/12/85	12:20	00.08	70.514	1.000	0.08	0.000	First time collected.
A1X01	03/20/85	13:30	00.38	78.562	8.048	0.46	0.047	Brine plus some muck.
A1X01	03/26/85	11:25	00.23	84.476	5.914	0.69	0.039	Muck in hole, valved leaked, some brine drained back down hole.
A1X01	04/02/85	12:15	00.39	91.510	7.034	1.08	0.055	
A1X01	04/10/85	12:20	00.33	99.514	8.004	1.41	0.041	
A1X01	04/17/85	11:30	00.28	106.479	6.965	1.69	0.040	
A1X01	04/23/85	10:50	00.23	112.451	5.972	1.92	0.039	
A1X01	04/30/85	13:26	00.26	119.560	7.109	2.18	0.037	
A1X01	05/07/85	09:10	00.25	126.382	6.822	2.43	0.037	
A1X01	05/14/85	10:06	00.24	133.421	7.039	2.67	0.034	
A1X01	05/21/85	11:40	00.26	140.486	7.065	2.93	0.037	
A1X01	05/29/85	10:00	00.27	148.417	7.931	3.20	0.034	
A1X01	06/04/85	10:20	00.20	154.431	6.014	3.40	0.033	
A1X01	06/11/85	09:40	00.23	161.403	6.972	3.63	0.033	
A1X01	06/18/85	09:34	00.23	168.399	6.996	3.86	0.033	
A1X01	06/25/85	09:40	00.22	175.403	7.004	4.08	0.031	
A1X01	07/02/85	11:00	00.23	182.458	7.055	4.31	0.033	
A1X01	07/09/85	10:00	00.23	189.417	6.959	4.54	0.033	
A1X01	07/16/85	10:55	00.23	196.455	7.038	4.77	0.033	
A1X01	07/24/85	10:00	00.25	204.417	7.962	5.02	0.031	
A1X01	07/30/85	09:32	00.19	210.397	5.980	5.21	0.032	
A1X01	08/06/85	09:37	00.21	217.401	7.004	5.42	0.030	
A1X01	08/14/85	09:48	00.23	225.408	8.007	5.65	0.029	
A1X01	08/20/85	10:18	00.19	231.429	6.021	5.84	0.032	
A1X01	08/28/85	09:13	00.23	239.384	7.955	6.07	0.029	
A1X01	09/04/85	09:46	00.19	246.407	7.023	6.26	0.027	
A1X01	09/10/85	09:30	00.18	252.396	5.989	6.44	0.030	
A1X01	09/17/85	09:10	00.19	259.382	6.986	6.63	0.027	
A1X01	09/24/85	09:11	00.21	266.383	7.001	6.84	0.030	
A1X01	10/01/85	09:23	00.21	273.391	7.008	7.05	0.030	
A1X01	10/08/85	12:24	00.20	280.517	7.126	7.25	0.028	Room A1 heaters turned on 10/02/85.
A1X01	10/15/85	09:43	00.19	287.405	6.888	7.44	0.028	
A1X01	10/23/85	09:55	00.20	295.413	8.008	7.64	0.025	
A1X01	10/29/85	11:05	00.17	301.462	6.049	7.81	0.028	
A1X01	11/05/85	08:50	00.19	308.368	6.906	8.00	0.028	
A1X01	11/13/85	09:15	00.22	316.385	8.017	8.22	0.027	
A1X01	11/21/85	10:40	00.21	324.444	8.059	8.43	0.026	
A1X01	11/26/85	10:10	00.14	329.424	4.980	8.57	0.028	
A1X01	12/04/85	14:13	00.20	337.592	8.168	8.77	0.024	
A1X01	12/10/85	10:40	00.15	343.444	5.852	8.92	0.026	
A1X01	12/17/85	13:59	00.19	350.583	7.139	9.11	0.027	
A1X01	01/03/86	09:40	00.41	367.403	16.820	9.52	0.024	
A1X01	01/08/86	10:20	00.09	372.431	5.028	9.61	0.018	
A1X01	01/16/86	09:50	00.25	380.410	7.979	9.86	0.031	
A1X01	01/23/86	10:10	00.18	387.424	7.014	10.04	0.026	
A1X01	01/31/86	11:05	00.21	395.462	8.038	10.25	0.026	
A1X01	02/12/86	10:10	00.30	407.424	11.962	10.55	0.025	
A1X01	02/19/86	10:55	00.18	414.455	7.031	10.73	0.026	
A1X01	02/28/86	14:05	00.23	423.587	9.132	10.96	0.025	
A1X01	03/06/86	10:00	00.15	429.417	5.830	11.11	0.026	
A1X01	03/13/86	09:30	00.18	436.396	6.979	11.29	0.026	
A1X01	03/26/86	09:20	00.33	449.389	12.993	11.62	0.025	
A1X01	04/02/86	09:00	00.18	456.375	6.986	11.80	0.026	
A1X01	04/08/86	09:09	00.15	462.381	6.006	11.95	0.025	
A1X01	04/16/86	11:30	00.20	470.479	8.098	12.15	0.025	
A1X01	04/24/86	09:35	00.20	478.399	7.920	12.35	0.025	
A1X01	04/30/86	10:13	00.15	484.426	6.027	12.50	0.025	
A1X01	05/06/86	09:40	00.12	490.403	5.977	12.62	0.020	
A1X01	05/13/86	09:25	00.19	497.392	6.989	12.81	0.027	
A1X01	05/20/86	10:16	00.18	504.428	7.036	12.99	0.026	
A1X01	05/27/86	15:05	00.18	511.628	7.200	13.17	0.025	
A1X01	06/03/86	09:28	00.17	518.394	6.766	13.34	0.025	
A1X01	06/10/86	10:50	00.15	525.451	7.057	13.49	0.021	
A1X01	06/17/86	09:59	00.19	532.416	6.965	13.68	0.027	
A1X01	06/24/86	10:10	00.18	539.424	7.008	13.86	0.026	
A1X01	07/01/86	12:46	00.19	546.532	7.108	14.05	0.027	
A1X01	07/08/86	10:05	00.16	553.420	6.888	14.21	0.023	
A1X01	07/16/86	09:57	00.20	561.415	7.995	14.41	0.025	
A1X01	07/22/86	09:26	00.16	567.393	5.978	14.57	0.027	

A1X01	07/29/86	10:05	00.17	574.420	7.027	14.74	0.024	
A1X01	08/05/86	10:21	00.19	581.431	7.011	14.93	0.027	
A1X01	08/12/86	09:58	00.18	588.415	6.984	15.11	0.026	
A1X01	08/19/86	10:40	00.18	595.444	7.029	15.29	0.026	
A1X01	08/26/86	10:07	00.18	602.422	6.978	15.47	0.026	
A1X01	09/04/86	10:02	00.20	611.418	8.996	15.67	0.022	
A1X01	09/09/86	10:30	00.15	616.438	5.020	15.82	0.030	
A1X01	09/16/86	09:36	00.18	623.400	6.962	16.00	0.026	
A1X01	09/23/86	09:41	00.18	630.403	7.003	16.18	0.026	
A1X01	10/01/86	11:40	00.19	638.486	8.083	16.37	0.024	
A1X01	10/08/86	10:34	00.17	645.440	6.954	16.54	0.024	
A1X01	10/14/86	10:57	00.15	651.456	6.016	16.69	0.025	
A1X01	11/05/86	10:30	0.55	673.438	21.982	17.24	0.025	
A1X01	11/20/86	11:45	00.38	688.490	15.052	17.62	0.025	
A1X01	12/31/86	12:05	00.96	729.503	41.013	18.58	0.023	
A1X01	02/03/87	12:15	00.80	763.510	34.007	19.38	0.024	
A1X01	03/06/87	11:55	0.79	794.497	30.987	20.17	0.025	
A1X01	03/30/87	11:58	0.59	818.499	24.002	20.76	0.025	
A1X01	05/07/87	10:50	0.98	856.451	37.952	21.74	0.026	
A1X01	06/17/87	11:40	1.04	897.486	41.035	22.78	0.025	
A1X01	07/28/87	11:45	1.17	938.490	41.004	23.95	0.029	
A1X01	09/01/87	11:55	0.79	973.497	35.007	24.74	0.023	Hose came loose and some brine may have drained back down hole. Trace of diesel/oil in brine.
A1X01	10/20/87	11:08	1.39	1022.46	48.963	26.13	0.028	
A1X01	11/19/87	10:30	0.77	1052.44	29.980	26.90	0.026	
A1X01	01/04/88	11:10	1.20	1098.47	46.030	28.10	0.026	
A1X01	02/08/88	13:25	0.68	1133.56	35.090	28.78	0.019	Lost some brine back down into hole.
A1X01	03/30/88	12:10	2.25	1184.51	50.950	31.03	0.044	Volume high due to lack of complete evacuation on 2/08/88.
A1X01	05/12/88	10:10	1.09	1227.42	42.910	32.12	0.025	
A1X01	07/12/88	09:30	1.56	1288.40	60.980	33.68	0.026	
A1X01	09/27/88	08:25	1.82	1365.35	76.950	35.50	0.024	
A1X01	12/13/88	09:30	2.35	1442.40	77.050	37.85	0.030	

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
A1X02	10/10/84	00:00	NA	0.000	0.000	0.00	0.000	Room A1 completed.
A1X02	03/07/85	09:30	NA	65.396	1.000	0.00	0.000	Uphole drilled 2/27/85 to 3/07/85. Hit brine at 12 ft. on 2/27/85.
A1X02	03/12/85	12:00	NA	70.500	6.104	0.00	0.000	Trace brine, deepened hole to clay seam. Moisture on back 1 ft radius.
A1X02	03/20/85	13:00	NA	78.542	14.146	0.00	0.000	Trace brine, drip missing funnel.
A1X02	03/26/85	11:25	NA	84.476	20.080	0.00	0.000	Repositioned funnel, collected one cup of salt crystals with trace of brine.
A1X02	04/02/85	12:15	00.21	91.510	27.114	0.21	0.008	Some drips missing funnel.
A1X02	04/10/85	12:20	00.22	99.514	8.004	0.43	0.027	Collecting container had leak.
A1X02	04/17/85	11:30	00.12	106.479	6.965	0.55	0.017	Some drips missing funnel.
A1X02	04/23/85	10:50	00.12	112.451	5.972	0.67	0.020	Some drips missing funnel.
A1X02	04/30/85	13:16	00.12	119.553	7.102	0.79	0.017	Some drips missing funnel.
A1X02	05/07/85	09:05	00.16	126.378	6.825	0.95	0.023	
A1X02	05/14/85	10:04	00.19	133.419	7.041	1.14	0.027	
A1X02	05/21/85	11:35	00.13	140.483	7.064	1.27	0.018	Some drips missing funnel.
A1X02	05/29/85	10:00	00.21	148.417	7.934	1.48	0.026	
A1X02	06/04/85	10:25	00.17	154.434	6.017	1.65	0.028	
A1X02	06/11/85	09:40	00.05	161.403	6.969	1.70	0.007	
A1X02	06/18/85	09:30	00.08	168.396	6.993	1.78	0.011	Some drips missing funnel, big stalactite formed.
A1X02	06/25/85	09:45	00.16	175.406	7.010	1.94	0.023	
A1X02	07/02/85	11:00	00.10	182.458	7.052	2.04	0.014	
A1X02	07/09/85	09:58	00.15	189.415	6.957	2.19	0.022	
A1X02	07/16/85	10:53	00.24	196.453	7.038	2.43	0.034	
A1X02	07/24/85	09:49	00.24	204.409	7.956	2.67	0.030	
A1X02	07/30/85	09:30	00.15	210.396	5.987	2.82	0.025	
A1X02	08/06/85	09:35	00.14	217.399	7.003	2.96	0.020	
A1X02	08/14/85	09:26	00.05	225.393	7.994	3.01	0.006	
A1X02	08/20/85	10:13	00.09	231.426	6.033	3.10	0.015	
A1X02	08/28/85	09:08	00.06	239.381	7.955	3.16	0.008	
A1X02	09/04/85	09:44	00.07	246.406	7.025	3.23	0.010	
A1X02	09/10/85	09:24	00.12	252.392	5.986	3.35	0.020	
A1X02	09/17/85	09:08	00.13	259.381	6.989	3.48	0.019	Some drips missing funnel.
A1X02	09/24/85	09:07	00.17	266.380	6.999	3.65	0.024	
A1X02	10/01/85	09:21	00.14	273.390	7.010	3.79	0.020	
A1X02	10/08/85	12:19	00.16	280.513	7.123	3.95	0.022	Room A1 heaters turned on 10/02/85.
A1X02	10/15/85	09:41	00.12	287.403	6.890	4.07	0.017	
A1X02	10/23/85	09:43	00.19	295.405	8.002	4.26	0.024	
A1X02	10/29/85	11:02	00.12	301.460	6.055	4.38	0.020	
A1X02	11/05/85	08:46	00.12	308.365	6.905	4.50	0.017	
A1X02	11/13/85	09:16	00.13	316.386	8.021	4.63	0.016	Some drips missing funnel.
A1X02	11/21/85	10:45	00.13	324.448	8.062	4.76	0.016	Some drips missing funnel.
A1X02	12/04/85	14:07	00.14	337.588	13.140	4.90	0.011	
A1X02	12/10/85	10:31	00.08	343.438	5.850	4.98	0.014	
A1X02	12/17/85	13:56	00.03	350.581	7.143	5.01	0.004	
A1X02	01/03/86	09:40	00.01	367.403	16.822	5.02	0.001	Some drips missing funnel.
A1X02	01/23/86	10:10	00.06	387.424	20.021	5.08	0.003	New, larger funnel since 01/17.
A1X02	01/31/86	11:05	00.23	395.462	8.038	5.31	0.029	
A1X02	02/12/86	10:10	00.22	407.424	11.962	5.53	0.018	
A1X02	02/19/86	10:50	00.07	414.451	7.027	5.60	0.010	
A1X02	02/28/86	14:00	00.02	423.583	9.132	5.62	0.002	
A1X02	03/13/86	09:30	00.05	436.396	12.813	5.67	0.004	
A1X02	03/26/86	09:20	00.05	449.389	12.993	5.72	0.004	
A1X02	04/02/86	09:00	00.08	456.375	6.986	5.80	0.011	
A1X02	04/16/86	11:30	00.10	470.479	14.104	5.90	0.007	
A1X02	04/24/86	09:35	00.05	478.399	7.920	5.95	0.006	
A1X02	04/30/86	10:10	00.07	484.424	6.025	6.02	0.012	
A1X02	05/06/86	09:40	00.16	490.403	5.979	6.18	0.027	
A1X02	05/13/86	09:25	00.02	497.392	6.989	6.20	0.003	
A1X02	05/20/86	10:16	00.04	504.428	7.036	6.24	0.006	
A1X02	05/27/86	15:05	00.15	511.628	7.200	6.39	0.021	
A1X02	06/03/86	09:28	00.13	518.394	6.766	6.52	0.019	
A1X02	06/10/86	10:50	00.10	525.451	7.057	6.62	0.014	
A1X02	06/17/86	09:59	00.12	532.416	6.965	6.74	0.017	
A1X02	06/24/86	10:10	00.25	539.424	7.008	6.99	0.036	
A1X02	07/01/86	12:44	00.23	546.531	7.107	7.22	0.032	
A1X02	07/08/86	10:05	00.11	553.420	6.889	7.33	0.016	
A1X02	07/16/86	09:54	00.25	561.413	7.993	7.58	0.031	
A1X02	07/22/86	09:26	00.16	567.393	5.980	7.74	0.027	
A1X02	07/29/86	10:05	00.26	574.420	7.027	8.00	0.037	
A1X02	08/05/86	10:19	00.22	581.430	7.010	8.22	0.031	

A1X02	08/12/86	09:58	00.28	588.415	6.985	8.50	0.040	
A1X02	08/19/86	10:38	00.26	595.443	7.028	8.76	0.037	
A1X02	08/26/86	10:07	00.24	602.422	6.979	9.00	0.034	
A1X02	09/04/86	10:01	00.35	611.417	8.995	9.35	0.039	
A1X02	09/09/86	10:25	00.17	616.434	5.017	9.52	0.034	
A1X02	09/16/86	09:35	00.27	623.399	6.965	9.79	0.039	
A1X02	09/23/86	09:39	00.26	630.402	7.003	10.05	0.037	
A1X02	10/01/86	11:39	00.24	638.485	8.083	10.29	0.030	
A1X02	10/08/86	10:32	00.17	645.439	6.954	10.46	0.024	
A1X02	10/14/86	10:53	00.13	651.453	6.014	10.59	0.022	
A1X02	11/05/86	10:30	0.30	673.438	21.985	10.89	0.014	
A1X02	11/20/86	11:43	00.11	688.488	15.050	11.00	0.007	
A1X02	12/31/86	12:10	00.14	729.507	41.019	11.14	0.003	Low readings from 11/20/86 to 6/20/87 may be due to blockage in collecting system.
A1X02	02/03/87	12:16	NA	763.000	33.493	11.14	0.000	
A1X02	03/06/87	11:55	0.05	794.497	64.990	11.19	0.001	
A1X02	03/30/87	11:55	0.01	818.497	24.000	11.20	0.000	Tubing plugged, unable to open.
A1X02	05/07/87	10:45	0.01	856.448	1.000	11.21	0.000	Tubing plugged, unable to open.
A1X02	06/30/87	12:00	1.58	910.500	92.003	12.79	0.017	Removed metal funnel, which was plugged. Most of the brine collected was in the funnel. Installed a large plastic funnel.
A1X02	07/28/87	11:45	0.85	938.490	27.990	13.64	0.030	
A1X02	09/01/87	11:55	0.94	973.497	35.007	14.58	0.027	
A1X02	10/20/87	10:59	1.84	1022.46	48.963	16.42	0.038	
A1X02	11/19/87	10:30	1.09	1052.44	29.980	17.51	0.036	
A1X02	01/04/88	11:05	3.73	1098.46	46.020	21.24	0.081	
A1X02	02/08/88	13:17	1.65	1133.55	35.090	22.89	0.047	
A1X02	03/30/88	12:20	4.86	1184.51	50.960	27.75	0.095	
A1X02	06/14/88	09:00	5.15	1260.38	75.870	32.90	0.068	Removed to provide room for further collection.
A1X02	07/12/88	09:30	1.11	1288.40	28.020	34.01	0.040	
A1X02	09/15/88	11:00	0.18	1353.46	0.000	34.19	0.000	Not fully evacuated. Do not use for calculation.
A1X02	09/27/88	08:30	3.00	1365.35	76.950	37.19	0.041	Used 3.18 liters for calculation (0.18 om 9/15 + 3.00 on 9/27).
A1X02	12/13/88	09:30	2.50	1442.40	77.050	39.69	0.032	

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
A2X01	07/25/84	00:00	NA	0.000	0.000	0.00	0.000	Room A2 completed.
A2X01	02/09/85	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 2/04/85 to 2/09/85.
A2X01	02/19/85	13:20	NA	49.556	1.000	0.00	0.000	Moist muck. First entry.
A2X01	03/07/85	09:30	00.29	65.396	16.840	0.29	0.017	Lots of muck, some oil.
A2X01	03/12/85	11:30	00.62	70.479	5.083	0.91	0.122	Brine and muck.
A2X01	03/20/85	13:04	00.52	78.544	8.065	1.43	0.064	
A2X01	03/26/85	11:02	00.38	84.460	5.916	1.81	0.064	
A2X01	04/02/85	11:58	00.36	91.499	7.039	2.17	0.051	
A2X01	04/10/85	11:53	00.36	99.495	7.996	2.53	0.045	Some muck included.
A2X01	04/17/85	11:10	00.27	106.465	6.970	2.80	0.039	
A2X01	04/23/85	10:30	00.24	112.438	5.973	3.04	0.040	
A2X01	04/30/85	13:50	00.29	119.576	7.138	3.33	0.041	
A2X01	05/07/85	08:45	00.25	126.365	6.789	3.58	0.037	
A2X01	05/14/85	09:40	00.24	133.403	7.038	3.82	0.034	
A2X01	05/21/85	12:08	00.24	140.506	7.103	4.06	0.034	
A2X01	05/29/85	09:00	00.26	148.375	7.869	4.32	0.033	
A2X01	06/04/85	09:35	00.20	154.399	6.024	4.52	0.033	
A2X01	06/11/85	09:15	00.23	161.385	6.986	4.75	0.033	
A2X01	06/18/85	09:15	00.23	168.385	7.000	4.98	0.033	
A2X01	06/25/85	09:15	00.23	175.385	7.000	5.21	0.033	
A2X01	07/02/85	11:00	00.23	182.458	7.073	5.44	0.033	
A2X01	07/09/85	09:29	00.22	189.395	6.937	5.66	0.032	
A2X01	07/16/85	10:30	00.23	196.438	7.043	5.89	0.033	Brine effervesces.
A2X01	07/24/85	09:39	00.24	204.402	7.964	6.13	0.030	
A2X01	07/30/85	08:55	00.19	210.372	5.970	6.32	0.032	
A2X01	08/06/85	09:21	00.21	217.390	7.018	6.53	0.030	
A2X01	08/14/85	09:05	00.25	225.378	7.988	6.78	0.031	
A2X01	08/20/85	09:50	00.19	231.410	6.032	6.97	0.031	
A2X01	08/28/85	08:45	00.21	239.365	7.955	7.18	0.026	Valved leaked, some brine drained back down hole.
A2X01	09/04/85	09:21	00.25	246.390	7.025	7.43	0.036	
A2X01	09/10/85	09:09	00.18	252.381	5.991	7.61	0.030	
A2X01	09/17/85	08:50	00.21	259.368	6.987	7.82	0.030	
A2X01	09/24/85	08:48	00.21	266.367	6.999	8.03	0.030	
A2X01	10/01/85	09:12	00.21	273.383	7.016	8.24	0.030	
A2X01	10/08/85	12:57	00.21	280.540	7.157	8.45	0.029	Room A2 heaters turned on 10/02/85.
A2X01	10/15/85	09:20	00.20	287.389	6.849	8.65	0.029	
A2X01	10/23/85	09:32	00.22	295.397	8.008	8.87	0.027	
A2X01	10/29/85	11:20	00.15	301.472	6.075	9.02	0.025	
A2X01	11/05/85	08:28	00.21	308.353	6.881	9.23	0.031	
A2X01	11/13/85	09:00	00.23	316.375	8.022	9.46	0.029	
A2X01	11/21/85	10:15	00.23	324.427	8.052	9.69	0.029	
A2X01	11/26/85	09:40	00.14	329.403	4.976	9.83	0.028	
A2X01	12/04/85	13:45	00.20	337.573	8.170	10.03	0.024	
A2X01	12/10/85	10:56	00.16	343.456	5.883	10.19	0.027	
A2X01	12/17/85	13:39	00.21	350.569	7.113	10.40	0.030	
A2X01	01/03/86	09:30	00.47	367.396	16.827	10.87	0.028	
A2X01	01/08/86	09:50	00.15	372.410	5.014	11.02	0.030	
A2X01	01/16/86	09:20	00.22	380.389	7.979	11.24	0.028	
A2X01	01/23/86	09:40	00.19	387.403	7.014	11.43	0.027	
A2X01	01/31/86	10:45	00.25	395.448	8.045	11.68	0.031	
A2X01	02/12/86	09:40	00.34	407.403	11.955	12.02	0.028	
A2X01	02/19/86	14:20	00.12	414.597	7.194	12.14	0.017	Suction soil probe was used, some fluid was left in hole.
A2X01	02/28/86	14:30	00.20	423.604	9.007	12.34	0.022	Soil suction probe was used, some fluid left in hole.
A2X01	03/04/86	09:00	00.15	427.375	3.771	12.49	0.040	
A2X01	03/06/86	09:30	00.07	429.396	2.021	12.56	0.035	Two days accumulation.
A2X01	03/13/86	09:00	00.15	436.375	6.979	12.71	0.021	
A2X01	03/26/86	09:05	00.15	449.378	13.003	12.76	0.011	Partial evacuation, brine left in hole.
A2X01	04/02/86	08:40	00.32	456.361	6.983	13.08	0.046	
A2X01	04/08/86	08:50	00.19	462.368	6.007	13.27	0.032	
A2X01	04/16/86	10:45	00.15	470.448	8.080	13.42	0.019	
A2X01	04/24/86	09:20	00.24	478.389	7.941	13.66	0.030	Removed suction probe.
A2X01	04/30/86	09:55	00.20	484.413	6.024	13.86	0.033	Resumed sampling with bailer.
A2X01	05/06/86	09:25	00.13	490.392	5.979	13.99	0.022	
A2X01	05/13/86	09:10	00.20	497.382	6.990	14.19	0.029	
A2X01	05/20/86	09:45	00.20	504.406	7.024	14.39	0.028	
A2X01	05/27/86	14:45	00.20	511.615	7.209	14.59	0.028	
A2X01	06/03/86	09:10	00.19	518.382	6.767	14.78	0.028	
A2X01	06/10/86	10:34	00.19	525.440	7.058	14.97	0.027	
A2X01	06/17/86	09:38	00.19	532.401	6.961	15.16	0.027	

A2X01	06/24/86	09:55	00.18	539.413	7.012	15.34	0.026	
A2X01	07/01/86	12:17	00.19	546.512	7.099	15.53	0.027	
A2X01	07/08/86	09:37	00.19	553.401	6.889	15.72	0.028	
A2X01	07/16/86	09:37	00.18	561.401	8.000	15.90	0.022	
A2X01	07/22/86	09:10	00.18	567.382	5.981	16.08	0.030	
A2X01	07/29/86	09:50	00.18	574.410	7.028	16.26	0.026	
A2X01	08/05/86	10:03	00.13	581.419	7.009	16.39	0.019	
A2X01	08/12/86	09:40	00.18	588.403	6.984	16.57	0.026	
A2X01	08/19/86	10:20	00.18	595.431	7.028	16.75	0.026	
A2X01	08/26/86	09:51	00.17	602.410	6.979	16.92	0.024	
A2X01	09/04/86	09:41	00.15	611.403	8.993	17.07	0.017	
A2X01	09/09/86	10:50	00.16	616.451	5.048	17.23	0.032	
A2X01	09/16/86	09:17	00.22	623.387	6.936	17.45	0.032	
A2X01	09/23/86	09:25	00.17	630.392	7.005	17.62	0.024	
A2X01	10/01/86	11:21	00.32	638.473	8.081	17.94	0.040	
A2X01	10/08/86	10:10	00.17	645.424	6.951	18.11	0.024	
A2X01	10/14/86	10:36	00.17	651.442	6.018	18.28	0.028	
A2X01	11/05/86	10:10	0.51	673.424	21.982	18.79	0.023	
A2X01	11/20/86	11:05	00.29	688.462	15.038	19.08	0.019	
A2X01	12/31/86	11:25	00.96	729.476	41.014	20.04	0.023	
A2X01	02/03/87	11:30	00.80	763.479	34.003	20.84	0.024	
A2X01	03/06/87	11:50	0.77	794.493	31.014	21.61	0.025	
A2X01	03/30/87	11:55	0.62	818.503	24.010	22.23	0.026	
A2X01	05/07/87	10:06	0.90	856.421	37.918	23.13	0.024	
A2X01	06/17/87	11:15	1.05	897.469	41.048	24.18	0.026	
A2X01	07/28/87	12:15	1.10	938.510	41.041	25.28	0.027	
A2X01	09/01/87	11:30	0.87	973.479	34.969	26.15	0.025	
A2X01	10/20/87	10:34	1.14	1022.44	48.961	27.29	0.023	
A2X01	11/19/87	10:10	0.70	1052.42	29.980	27.99	0.023	
A2X01	01/04/88	10:45	1.43	1098.45	46.030	29.42	0.031	
A2X01	02/08/88	12:45	0.96	1133.53	35.080	30.38	0.027	
A2X01	03/30/88	12:00	1.23	1184.50	50.970	31.61	0.024	
A2X01	05/12/88	10:30	0.83	1227.44	42.940	32.44	0.019	
A2X01	07/12/88	10:00	1.51	1288.42	60.980	33.95	0.025	
A2X01	09/27/88	08:15	1.56	1365.34	76.920	35.51	0.020	Suction hose came off, some brine drained back down hole.
A2X01	12/13/88	09:10	1.61	1442.38	77.040	37.12	0.021	Orange color.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
A2X02	07/25/84	00:00	NA	0.000	0.000	0.00	0.000	Room A2 completed.
A2X02	02/19/85	13:20	NA	49.556	1.000	0.00	0.000	Uphole drilled 2/11/85 to 2/20/85, installed collecting device.
A2X02	03/07/85	09:30	00.34	65.396	16.840	0.34	0.020	Moist area 1.5 ft. around the collar.
A2X02	03/12/85	11:30	00.21	70.479	5.083	0.55	0.041	Back wet, 5 ft diameter.
A2X02	03/20/85	13:04	00.31	78.544	8.065	0.86	0.038	
A2X02	03/26/85	11:02	00.14	84.460	5.916	1.00	0.024	
A2X02	04/02/85	11:58	00.12	91.499	7.039	1.12	0.017	Significant salt buildup. 4' dia. wet spot on back.
A2X02	04/10/85	11:53	00.11	99.495	7.996	1.23	0.014	Reset collecting device.
A2X02	04/23/85	10:30	00.01	112.438	12.943	1.24	0.001	
A2X02	05/07/85	08:41	NA	126.362	13.924	1.24	0.000	Some drips missing funnel.
A2X02	05/14/85	09:40	NA	133.403	20.965	1.24	0.000	Some drips missing funnel.
A2X02	07/09/85	09:25	00.05	189.392	76.954	1.29	0.001	
A2X02	07/16/85	10:23	00.06	196.433	7.041	1.35	0.009	
A2X02	07/24/85	09:33	00.02	204.398	7.965	1.37	0.003	
A2X02	08/06/85	09:22	00.01	217.390	12.992	1.38	0.001	
A2X02	08/28/85	08:35	00.01	239.358	21.968	1.39	0.000	Some drips missing funnel.
A2X02	09/04/85	09:18	00.08	246.387	7.029	1.47	0.011	
A2X02	09/10/85	09:04	00.02	252.378	5.991	1.49	0.003	
A2X02	09/17/85	08:55	00.02	259.372	6.994	1.51	0.003	
A2X02	10/15/85	09:17	00.02	287.387	28.015	1.53	0.001	Room A2 heaters turned on 10/02/85.
A2X02	01/31/86	10:40	00.05	395.444	108.057	1.58	0.000	
A2X02	02/12/86	09:40	00.02	407.403	11.959	1.60	0.002	
A2X02	03/13/86	09:00	00.01	436.375	28.972	1.61	0.000	
A2X02	03/26/86	09:05	00.07	449.378	13.003	1.68	0.005	
A2X02	04/02/86	08:40	00.10	456.361	6.983	1.78	0.014	High reading probably due to unplugging temporary blockage in collecting tube on 3/26/86.
A2X02	04/16/86	10:45	00.09	470.448	14.087	1.87	0.006	
A2X02	04/24/86	09:20	00.02	478.389	7.941	1.89	0.003	
A2X02	04/30/86	09:55	00.02	484.413	6.024	1.91	0.003	
A2X02	05/06/86	09:25	00.02	490.392	5.979	1.93	0.003	
A2X02	05/13/86	09:10	NA	497.382	6.990	1.93	0.000	Trace collected.
A2X02	05/20/86	09:45	NA	504.406	7.024	1.93	0.000	Trace collected.
A2X02	06/03/86	09:10	NA	518.382	21.000	1.93	0.000	Trace collected.
A2X02	06/10/86	10:34	NA	525.440	28.058	1.93	0.000	Trace collected.
A2X02	06/17/86	09:38	00.01	532.401	35.019	1.94	0.000	
A2X02	06/24/86	09:50	00.35	539.410	7.009	2.29	0.050	Very humid air. High reading probably due to unplugging of temporary blockage in collecting tube on 6/17/86.
A2X02	07/01/86	12:15	00.28	546.510	7.100	2.57	0.039	
A2X02	07/08/86	09:27	00.17	553.394	6.884	2.74	0.025	
A2X02	07/16/86	09:33	00.14	561.398	8.004	2.88	0.017	
A2X02	07/22/86	09:09	00.05	567.381	5.983	2.93	0.008	
A2X02	07/29/86	09:50	00.12	574.410	7.029	3.05	0.017	
A2X02	08/05/86	09:59	00.07	581.416	7.006	3.12	0.010	
A2X02	08/12/86	09:40	00.12	588.403	6.987	3.24	0.017	
A2X02	08/19/86	10:20	00.11	595.431	7.028	3.35	0.016	
A2X02	08/26/86	09:50	00.07	602.410	6.979	3.42	0.010	
A2X02	09/04/86	09:40	00.11	611.403	8.993	3.53	0.012	
A2X02	09/09/86	10:48	00.06	616.450	5.047	3.59	0.012	
A2X02	09/16/86	09:15	00.08	623.385	6.935	3.67	0.012	
A2X02	09/23/86	09:23	00.07	630.391	7.006	3.74	0.010	
A2X02	10/01/86	11:10	00.09	638.465	8.074	3.83	0.011	
A2X02	10/08/86	10:08	00.05	645.422	6.957	3.88	0.007	
A2X02	10/14/86	10:35	00.03	651.441	6.019	3.91	0.005	
A2X02	11/05/86	10:08	0.10	673.422	21.981	4.01	0.005	
A2X02	11/20/86	11:03	00.10	688.460	15.038	4.11	0.007	
A2X02	12/31/86	11:20	00.40	729.472	41.012	4.51	0.010	
A2X02	02/03/87	11:25	00.11	763.476	34.004	4.62	0.003	
A2X02	03/06/87	11:50	0.05	794.493	31.017	4.67	0.002	
A2X02	03/30/87	12:02	0.03	818.501	24.008	4.70	0.001	
A2X02	05/07/87	10:04	0.50	856.419	37.918	5.20	0.013	
A2X02	07/28/87	12:15	0.12	938.510	82.091	5.32	0.001	
A2X02	09/01/87	11:30	0.00	973.479	34.969	5.32	0.000	Dry.
A2X02	10/20/87	10:34	0.00	1022.44	48.961	5.32	0.000	Dry.
A2X02	11/19/87	10:00	0.00	1052.42	29.980	5.32	0.000	Dry.
A2X02	01/04/88	10:45	0.00	1098.45	46.030	5.32	0.000	Dry.
A2X02	02/08/88	12:45	0.00	1133.53	35.080	5.32	0.000	Dry.
A2X02	03/30/88	12:00	0.00	1184.50	50.970	5.32	0.000	Dry.
A2X02	07/12/88	10:00	0.00	1288.42	103.920	5.32	0.000	Dry.

A2X02	09/27/88	08:15	0.04	1365.34	76.920	5.36	0.001	
A2X02	12/13/88	09:10	0	1442.38	77.040	5.36	0.000	Dry.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
A3X01	11/06/84	00:00	NA	0.000	0.000	0.00	0.000	Room A3 completed.
A3X01	01/14/85	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 12/20/85 to 1/14/85.
A3X01	02/05/85	11:10	NA	35.465	1.000	0.00	0.000	Moist muck at the bottom.
A3X01	02/19/85	13:40	00.30	49.569	15.104	0.30	0.020	Some oil. First time collected.
A3X01	02/26/85	13:20	00.23	56.556	6.987	0.53	0.033	Brine and oil.
A3X01	03/07/85	09:45	00.26	65.406	8.850	0.79	0.029	
A3X01	03/12/85	11:45	00.17	70.490	5.084	0.96	0.033	
A3X01	03/20/85	13:14	00.19	78.551	8.061	1.15	0.024	Valved leaked, some brine drained back down hole.
A3X01	03/26/85	11:12	00.22	84.467	5.916	1.37	0.037	
A3X01	04/02/85	12:00	00.21	91.500	7.033	1.58	0.030	
A3X01	04/10/85	12:00	00.23	99.500	8.000	1.81	0.029	
A3X01	04/17/85	11:20	00.20	106.472	6.972	2.01	0.029	
A3X01	04/23/85	10:41	00.16	112.445	5.973	2.17	0.027	
A3X01	04/30/85	13:35	00.20	119.566	7.121	2.37	0.028	
A3X01	05/07/85	08:55	00.20	126.372	6.806	2.57	0.029	
A3X01	05/14/85	09:56	00.17	133.414	7.042	2.74	0.024	
A3X01	05/21/85	12:00	00.20	140.500	7.086	2.94	0.028	
A3X01	05/29/85	09:25	00.21	148.392	7.892	3.15	0.027	
A3X01	06/04/85	09:55	00.16	154.413	6.021	3.31	0.027	
A3X01	06/11/85	09:25	00.18	161.392	6.979	3.49	0.026	
A3X01	06/18/85	09:27	00.18	168.394	7.002	3.67	0.026	
A3X01	06/25/85	09:30	00.19	175.396	7.002	3.86	0.027	
A3X01	07/02/85	11:00	00.19	182.458	7.062	4.05	0.027	
A3X01	07/09/85	09:50	00.17	189.410	6.952	4.22	0.024	
A3X01	07/16/85	10:50	00.18	196.451	7.041	4.40	0.026	Brine effervesces.
A3X01	07/24/85	09:47	00.21	204.408	7.957	4.61	0.026	
A3X01	07/30/85	09:30	00.15	210.396	5.988	4.76	0.025	
A3X01	08/06/85	09:30	00.17	217.396	7.000	4.93	0.024	
A3X01	08/14/85	09:21	00.20	225.390	7.994	5.13	0.025	
A3X01	08/20/85	10:08	00.16	231.422	6.032	5.29	0.027	
A3X01	08/28/85	09:05	00.21	239.378	7.956	5.50	0.026	
A3X01	09/04/85	09:29	00.17	246.395	7.017	5.67	0.024	
A3X01	09/10/85	09:20	00.15	252.389	5.994	5.82	0.025	
A3X01	09/17/85	09:06	00.16	259.379	6.990	5.98	0.023	
A3X01	09/24/85	09:03	00.17	266.377	6.998	6.15	0.024	
A3X01	10/01/85	09:18	00.18	273.387	7.010	6.33	0.026	
A3X01	10/08/85	12:35	00.18	280.524	7.137	6.51	0.025	Room A3 heaters turned on 10/02/85.
A3X01	10/15/85	09:35	00.16	287.399	6.875	6.67	0.023	
A3X01	10/23/85	09:40	00.19	295.403	8.004	6.86	0.024	
A3X01	10/29/85	11:11	00.14	301.466	6.063	7.00	0.023	
A3X01	11/05/85	08:42	00.16	308.362	6.896	7.16	0.023	
A3X01	11/13/85	09:30	00.19	316.396	8.034	7.35	0.024	
A3X01	11/21/85	10:30	00.19	324.438	8.042	7.54	0.024	
A3X01	11/26/85	09:55	00.10	329.413	4.975	7.64	0.020	
A3X01	12/04/85	14:03	00.18	337.585	8.172	7.82	0.022	
A3X01	12/10/85	10:46	00.14	343.449	5.864	7.96	0.024	
A3X01	12/17/85	13:55	00.14	350.580	7.131	8.10	0.020	
A3X01	01/03/86	10:00	00.39	367.417	16.837	8.49	0.023	
A3X01	01/08/86	10:10	00.11	372.424	5.007	8.60	0.022	
A3X01	01/16/86	09:35	00.18	380.399	7.975	8.78	0.023	
A3X01	01/23/86	10:00	00.15	387.417	7.018	8.93	0.021	
A3X01	01/31/86	10:55	00.18	395.455	8.038	9.11	0.022	
A3X01	02/12/86	10:00	00.27	407.417	11.962	9.38	0.023	
A3X01	02/19/86	10:40	00.15	414.444	7.027	9.53	0.021	
A3X01	02/28/86	14:20	00.22	423.597	9.153	9.75	0.024	
A3X01	03/06/86	09:50	00.14	429.410	5.813	9.89	0.024	
A3X01	03/13/86	09:20	00.15	436.389	6.979	10.04	0.021	
A3X01	03/26/86	09:15	00.30	449.385	12.996	10.34	0.023	
A3X01	04/02/86	08:50	00.16	456.368	6.983	10.50	0.023	
A3X01	04/08/86	09:05	00.14	462.378	6.010	10.64	0.023	
A3X01	04/16/86	11:25	00.18	470.476	8.098	10.82	0.022	
A3X01	04/24/86	09:30	00.18	478.396	7.920	11.00	0.023	
A3X01	04/30/86	10:00	00.14	484.417	6.021	11.14	0.023	
A3X01	05/06/86	09:35	00.14	490.399	5.982	11.28	0.023	
A3X01	05/13/86	09:20	00.15	497.389	6.990	11.43	0.021	
A3X01	05/20/86	10:10	00.15	504.424	7.035	11.58	0.021	
A3X01	05/27/86	15:00	00.16	511.625	7.201	11.74	0.022	
A3X01	06/03/86	09:20	00.15	518.389	6.764	11.89	0.022	
A3X01	06/10/86	10:42	00.16	525.446	7.057	12.05	0.023	
A3X01	06/17/86	09:51	00.12	532.410	6.964	12.17	0.017	
A3X01	06/24/86	10:05	00.16	539.420	7.010	12.33	0.023	

A3X01	07/01/86	12:35	00.16	546.524	7.104	12.49	0.023	
A3X01	07/08/86	09:57	00.15	553.415	6.891	12.64	0.022	
A3X01	07/16/86	09:47	00.19	561.408	7.993	12.83	0.024	
A3X01	07/22/86	09:23	00.14	567.391	5.983	12.97	0.023	
A3X01	07/29/86	10:00	00.14	574.417	7.026	13.11	0.020	
A3X01	08/05/86	10:15	00.18	581.427	7.010	13.29	0.026	
A3X01	08/12/86	09:50	00.16	588.410	6.983	13.45	0.023	
A3X01	08/19/86	10:35	00.16	595.441	7.031	13.61	0.023	
A3X01	08/26/86	10:00	00.15	602.417	6.976	13.76	0.022	
A3X01	09/04/86	09:52	00.20	611.411	8.994	13.96	0.022	
A3X01	09/09/86	10:35	00.12	616.441	5.030	14.08	0.024	
A3X01	09/16/86	09:29	00.14	623.395	6.954	14.22	0.020	
A3X01	09/23/86	09:36	00.18	630.400	7.005	14.40	0.026	
A3X01	10/01/86	11:30	00.19	638.479	8.079	14.59	0.024	
A3X01	10/08/86	10:24	00.14	645.433	6.954	14.73	0.020	
A3X01	10/14/86	10:47	00.12	651.449	6.016	14.85	0.020	
A3X01	11/05/86	10:20	0.52	673.431	21.982	15.37	0.024	
A3X01	11/20/86	11:33	00.33	688.481	15.050	15.70	0.022	
A3X01	12/31/86	11:45	00.88	729.490	41.009	16.58	0.021	
A3X01	02/03/87	12:00	00.73	763.500	34.010	17.31	0.021	
A3X01	03/06/87	11:45	0.68	794.490	30.990	17.99	0.022	
A3X01	03/30/87	12:00	0.55	818.500	24.010	18.54	0.023	
A3X01	05/07/87	10:39	0.80	856.444	37.944	19.34	0.021	
A3X01	06/17/87	11:25	0.89	897.476	41.032	20.23	0.022	
A3X01	07/28/87	12:02	0.92	938.501	41.025	21.15	0.022	
A3X01	09/01/87	11:45	0.77	973.490	34.989	21.92	0.022	
A3X01	10/20/87	10:55	1.10	1022.45	48.960	23.02	0.022	
A3X01	11/19/87	10:20	0.66	1052.43	29.980	23.68	0.022	
A3X01	01/04/88	11:00	1.01	1098.46	46.030	24.69	0.022	
A3X01	02/08/88	13:30	0.67	1133.56	35.100	25.36	0.019	
A3X01	03/30/88	12:10	1.02	1184.51	50.950	26.38	0.020	
A3X01	05/12/88	10:20	0.88	1227.43	42.920	27.26	0.021	
A3X01	07/12/88	09:40	1.28	1288.40	60.970	28.54	0.021	
A3X01	09/27/88	08:20		1365.35	0.000	28.54	0.000	Cannot be sampled. Room has bad back.
A3X01	12/13/88	09:25	3.35	1442.39	153.990	31.89	0.022	

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
A3X02	11/06/84	00:00	NA	0.000	0.000	0.00	0.000	Room A3 completed.
A3X02	01/22/85	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 1/15/85 to 1/22/85.
A3X02	02/05/85	11:10	NA	35.465	1.000	0.00	0.000	No drips noticed.
A3X02	02/19/85	13:40	00.11	49.569	15.104	0.11	0.007	First time collected.
A3X02	02/26/85	13:20	00.11	56.556	6.987	0.22	0.016	Wet spot within 1.5 ft. radius.
A3X02	03/07/85	09:45	00.21	65.406	8.850	0.43	0.024	Moist area on back, approximately 1 ft radius.
A3X02	03/12/85	11:45	00.11	70.490	5.084	0.54	0.022	Wet spot on back 3 ft diameter.
A3X02	03/20/85	13:14	00.01	78.551	8.061	0.55	0.001	
A3X02	03/26/85	11:12	00.28	84.467	5.916	0.83	0.047	Tube found plugged. Brine in tubing.
A3X02	04/02/85	12:00	00.08	91.500	7.033	0.91	0.011	
A3X02	04/10/85	12:02	00.05	99.501	8.001	0.96	0.006	Tube plugged.
A3X02	04/17/85	11:20	00.11	106.472	6.971	1.07	0.016	
A3X02	04/23/85	10:40	00.09	112.444	5.972	1.16	0.015	
A3X02	04/30/85	13:29	00.12	119.562	7.118	1.28	0.017	
A3X02	05/07/85	08:50	00.13	126.368	6.806	1.41	0.019	
A3X02	05/14/85	09:53	00.13	133.412	7.044	1.54	0.018	
A3X02	05/21/85	11:55	00.13	140.497	7.085	1.67	0.018	
A3X02	05/29/85	09:20	00.14	148.389	7.892	1.81	0.018	
A3X02	06/04/85	09:50	00.10	154.410	6.021	1.91	0.017	
A3X02	06/11/85	09:20	00.13	161.389	6.979	2.04	0.019	
A3X02	06/18/85	09:25	00.12	168.392	7.003	2.16	0.017	
A3X02	06/25/85	09:25	00.13	175.392	7.000	2.29	0.019	
A3X02	07/02/85	11:00	00.10	182.458	7.066	2.39	0.014	
A3X02	07/09/85	09:44	00.02	189.406	6.948	2.41	0.003	
A3X02	07/16/85	10:46	00.02	196.449	7.043	2.43	0.003	
A3X02	07/24/85	09:45	00.19	204.406	7.957	2.62	0.024	High volume probably due to unplugging temporary blockage in collecting tube on 7/16/85.
A3X02	07/30/85	09:25	00.08	210.392	5.986	2.70	0.013	
A3X02	08/06/85	09:28	00.08	217.394	7.002	2.78	0.011	
A3X02	08/14/85	09:10	00.10	225.382	7.988	2.88	0.013	
A3X02	08/20/85	10:00	00.08	231.417	6.035	2.96	0.013	
A3X02	08/28/85	08:58	00.09	239.374	7.957	3.05	0.011	
A3X02	09/04/85	09:26	00.09	246.393	7.019	3.14	0.013	
A3X02	09/10/85	09:14	00.08	252.385	5.992	3.22	0.013	
A3X02	09/17/85	09:05	00.09	259.378	6.993	3.31	0.013	
A3X02	09/24/85	09:03	00.08	266.377	6.999	3.39	0.011	
A3X02	10/01/85	09:15	00.07	273.385	7.008	3.46	0.010	
A3X02	10/08/85	12:33	00.09	280.523	7.138	3.55	0.013	Room A3 heaters turned on 10/02/85.
A3X02	10/15/85	09:31	00.06	287.397	6.874	3.61	0.009	
A3X02	10/23/85	09:37	00.07	295.401	8.004	3.68	0.009	
A3X02	10/29/85	11:09	00.08	301.465	6.064	3.76	0.013	
A3X02	11/05/85	08:39	00.04	308.360	6.895	3.80	0.006	
A3X02	11/13/85	09:28	00.08	316.394	8.034	3.88	0.010	
A3X02	11/21/85	10:25	00.05	324.434	8.040	3.93	0.006	
A3X02	12/04/85	13:56	00.10	337.581	13.147	4.03	0.008	
A3X02	12/10/85	10:42	00.05	343.446	5.865	4.08	0.009	
A3X02	12/17/85	13:50	00.03	350.576	7.130	4.11	0.004	
A3X02	01/03/86	10:20	00.13	367.417	16.841	4.24	0.008	
A3X02	01/08/86	10:10	00.03	372.424	5.007	4.27	0.006	
A3X02	01/16/86	09:35	00.05	380.399	7.975	4.32	0.006	
A3X02	01/31/86	10:55	00.01	395.455	15.056	4.33	0.001	Trace <00.01 liters of brine.
A3X02	04/24/86	09:30	00.01	478.396	82.941	4.34	0.000	
A3X02	05/06/86	09:35	00.02	490.399	12.003	4.36	0.002	
A3X02	05/27/86	15:00	NA	511.625	21.226	4.36	0.000	Trace.
A3X02	06/03/86	09:20	00.03	518.389	27.990	4.39	0.001	
A3X02	06/10/86	10:42	NA	525.446	7.057	4.39	0.000	Trace.
A3X02	06/17/86	09:51	NA	532.410	14.021	4.39	0.000	Trace.
A3X02	07/01/86	12:32	00.03	546.522	28.133	4.42	0.001	
A3X02	07/08/86	09:57	00.01	553.415	6.893	4.43	0.001	
A3X02	07/29/86	10:00	NA	574.417	21.002	4.43	0.000	Trace.
A3X02	08/12/86	09:50	NA	588.410	34.995	4.43	0.000	Dry.
A3X02	08/19/86	10:33	NA	595.440	42.025	4.43	0.000	Dry.
A3X02	09/04/86	09:50	NA	611.410	57.995	4.43	0.000	Trace.
A3X02	09/23/86	09:33	00.00	630.398	76.983	4.43	0.000	Dry.
A3X02	10/01/86	11:28	NA	638.478	8.080	4.43	0.000	Dry.
A3X02	10/08/86	10:22	NA	645.432	6.954	4.43	0.000	Dry.
A3X02	10/14/86	10:44	00.00	651.447	6.015	4.43	0.000	Dry.
A3X02	11/05/86	10:25	NA	673.431	27.999	4.43	0.000	Dry.
A3X02	11/20/86	11:30	NA	688.479	43.047	4.43	0.000	Dry.
A3X02	12/31/86	11:45	NA	729.490	84.058	4.43	0.000	Dry.

A3X02	02/03/87	12:02	NA	763.000	117.568	4.43	0.000	Dry.
A3X02	03/06/87	11:45	NA	794.490	149.058	4.43	0.000	Dry.
A3X02	03/30/87	12:00	0.00	818.500	24.010	4.43	0.000	Dry.
A3X02	05/07/87	10:39	0.00	856.444	61.954	4.43	0.000	Dry.
A3X02	07/28/87	12:02	0.00	938.501	144.011	4.43	0.000	Dry.
A3X02	09/01/87	11:48	0.00	973.492	34.991	4.43	0.000	Dry.
A3X02	10/20/87	10:50	0.00	1022.45	48.958	4.43	0.000	Dry.
A3X02	11/19/87	10:20	0.00	1052.43	29.980	4.43	0.000	Dry.
A3X02	01/04/88	11:00	0.00	1098.46	46.030	4.43	0.000	Dry.
A3X02	02/08/88	13:30	0.00	1133.56	35.100	4.43	0.000	Dry.
A3X02	03/30/88	12:10	0.00	1184.51	50.950	4.43	0.000	Dry.
A3X02	07/12/88	09:40	0.00	1288.40	103.890	4.43	0.000	Dry.
A3X02	09/27/88	08:25	0.00	1365.35	76.950	4.43	0.000	Dry.
A3X02	12/13/88	09:25	0	1442.39	77.040	4.43	0.000	Dry.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTPA1	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPA1	07/16/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled, open from 0 to 5.1 ft.
BTPA1	08/12/86	12:00	NA	588.500	1.000	0.00	0.000	Dry.
BTPA1	08/19/86	12:12	NA	595.508	8.008	0.00	0.000	Dry.
BTPA1	08/26/86	11:27	NA	602.477	14.977	0.00	0.000	Dry.
BTPA1	09/04/86	11:33	NA	611.481	23.981	0.00	0.000	Dry.
BTPA1	09/09/86	13:22	NA	616.557	29.057	0.00	0.000	Dry.
BTPA1	09/16/86	11:01	NA	623.459	35.959	0.00	0.000	Dry.
BTPA1	09/23/86	11:06	NA	630.463	42.963	0.00	0.000	Dry.
BTPA1	10/01/86	08:49	NA	638.367	50.867	0.00	0.000	Dry.
BTPA1	10/08/86	13:26	NA	645.560	58.060	0.00	0.000	Dry.
BTPA1	10/14/86	13:05	NA	651.545	64.045	0.00	0.000	Dry.
BTPA1	11/05/86	12:30	NA	673.521	86.021	0.00	0.000	Probe removed, not sampled.
BTPA1	11/20/86	NA:	NA	688.000	100.500	0.00	0.000	
BTPA1	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPA1	12/30/86	NA:	NA	728.000	140.500	0.00	0.000	
BTPA1	03/06/87	10:10	NA	794.424	206.924	0.00	0.000	Covered with muck, not able to sample.
BTPA1	06/18/87	09:45	1.33	898.406	246.861	1.33	0.005	Floor may have been watered for dust control.
BTPA1	09/10/87	14:30	0.03	982.604	84.198	1.36	0.000	Possible contamination by water spread to control dust.
BTPA1	10/20/87	09:48	0.00	1022.41	39.806	1.36	0.000	Dry. No suction.
BTPA1	11/19/87	09:15	0.05	1052.39	29.980	1.41	0.002	
BTPA1	01/04/88	09:40	0.03	1098.40	46.010	1.44	0.001	
BTPA1	02/09/88	10:10	0.02	1134.42	36.020	1.46	0.001	
BTPA1	03/29/88	09:40	0.03	1183.40	48.980	1.49	0.001	
BTPA1	07/12/88	11:00	0.06	1288.46	105.060	1.55	0.001	
BTPA1	09/15/88	10:45	0.00	1353.45	64.990	1.55	0.000	Dry.
BTPA1	09/27/88	11:45	0.03	1365.49	12.040	1.58	0.002	
BTPA1	12/02/88	13:00	0	1431.54	66.050	1.58	0.000	Sampler removed. Hole dry. Last time sampled for BSEP, hole capped.

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Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTPA2	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPA2	07/29/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 7/16/86 to 7/29/86, open from 5.4 to 9.1 ft.
BTPA2	08/12/86	12:00	00.01	588.500	1.000	0.01	0.000	First time collected. Probe did not keep vacuum, brine remained in hole.
BTPA2	08/19/86	12:12	00.10	595.508	7.008	0.11	0.014	
BTPA2	08/26/86	11:28	00.04	602.478	6.970	0.15	0.006	
BTPA2	09/04/86	11:35	00.04	611.483	9.005	0.19	0.004	
BTPA2	09/09/86	13:23	00.03	616.558	5.075	0.22	0.006	
BTPA2	09/16/86	11:00	00.03	623.458	6.900	0.25	0.004	
BTPA2	09/23/86	11:07	00.03	630.463	7.005	0.28	0.004	
BTPA2	10/01/86	08:50	00.03	638.368	7.905	0.31	0.004	
BTPA2	10/08/86	13:27	00.02	645.560	7.192	0.33	0.003	
BTPA2	10/14/86	13:12	00.03	651.550	5.990	0.36	0.005	
BTPA2	11/05/86	12:30	NA	673.521	21.971	0.36	0.000	Probe removed, not sampled.
BTPA2	11/20/86	NA:	NA	688.000	36.450	0.36	0.000	
BTPA2	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPA2	12/30/86	NA:	NA	728.000	76.450	0.36	0.000	
BTPA2	03/06/87	10:10	NA	794.424	142.874	0.36	0.000	Covered with muck, not able to sample.
BTPA2	06/18/87	09:30	0.43	898.396	246.846	0.79	0.002	Floor may have been watered for dust control. Hole contaminated with PVC pieces.
BTPA2	09/10/87	14:20	0.29	982.597	84.201	1.08	0.003	Possible contamination by water spread to control dust.
BTPA2	10/20/87	09:50	0.01	1022.41	39.813	1.09	0.000	
BTPA2	11/19/87	09:20	0.05	1052.39	29.980	1.14	0.002	
BTPA2	01/04/88	09:40	0.06	1098.40	46.010	1.20	0.001	
BTPA2	02/09/88	10:10	0.10	1134.42	36.020	1.30	0.003	
BTPA2	03/29/88	09:43	0.27	1183.40	48.980	1.57	0.006	
BTPA2	07/12/88	11:00	0.87	1288.46	105.060	2.44	0.008	
BTPA2	09/15/88	10:35	0.16	1353.44	0.000	2.60	0.000	Not fully evacuated. Don't use for calculation. Sampled for bacteriology.
BTPA2	09/27/88	11:50	0.91	1365.49	77.030	3.51	0.014	Used 1.07 liters for calculation (0.16 on 9/15 + 0.91 on 9/27).
BTPA2	12/02/88	13:20	0.05	1431.56	66.070	3.56	0.001	Sampler removed. Last time sampled for BSEP, hole capped.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTPA3	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPA3	07/30/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 7/15/86 to 7/30/86, open from 10.3 to 14.0 ft.
BTPA3	08/12/86	12:05	NA	588.503	1.000	0.00	0.000	Dry.
BTPA3	08/19/86	12:12	Trace	595.508	8.005	0.00	0.000	Lysimeter installed 8/20/86.
BTPA3	08/26/86	11:29	00.03	602.478	14.975	0.03	0.000	First time collected, some fluid left in hole.
BTPA3	09/04/86	11:35	00.13	611.483	9.005	0.16	0.014	
BTPA3	09/09/86	13:24	00.03	616.558	5.075	0.19	0.006	
BTPA3	09/16/86	11:01	00.04	623.459	6.901	0.23	0.006	
BTPA3	09/23/86	11:08	00.04	630.464	7.005	0.27	0.006	
BTPA3	10/01/86	08:53	00.05	638.370	7.906	0.32	0.006	
BTPA3	10/08/86	13:29	00.02	645.562	7.192	0.34	0.003	
BTPA3	10/14/86	13:14	00.04	651.551	5.989	0.38	0.007	
BTPA3	11/05/86	12:30	NA	673.521	21.970	0.38	0.000	Probe removed, not sampled.
BTPA3	11/20/86	NA:	NA	688.000	36.449	0.38	0.000	
BTPA3	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPA3	12/30/86	NA:	NA	728.000	76.449	0.38	0.000	
BTPA3	03/06/87	10:10	NA	794.424	142.873	0.38	0.000	Covered with muck, not able to sample.
BTPA3	06/18/87	09:15	0.62	898.385	246.834	1.00	0.003	Floor may have been watered for dust control. Hole contaminated with PVC pieces.
BTPA3	09/10/87	14:10	0.07	982.590	84.205	1.07	0.001	Possible contamination by water spread to control dust.
BTPA3	10/20/87	09:55	Trace	1022.41	39.820	1.07	0.000	Brine not saved, zero amount left in collecting containter.
BTPA3	11/19/87	09:20	0.08	1052.39	29.980	1.15	0.003	
BTPA3	01/04/88	09:40	Trace	1098.40	46.010	1.15	0.000	
BTPA3	02/09/88	10:15	0.00	1134.43	36.030	1.15	0.000	Dry.
BTPA3	03/29/88	09:44	0.00	1183.41	48.980	1.15	0.000	Dry.
BTPA3	07/12/88	11:10	0.00	1288.47	105.060	1.15	0.000	Dry.
BTPA3	09/15/88	10:40	Trace	1353.44	64.970	1.15	0.000	
BTPA3	09/27/88	11:55	0.00	1365.50	12.060	1.15	0.000	Dry.
BTPA3	12/02/88	13:50	0.70	1431.58	66.080	1.85	0.010	Partial evacuation. Sampler removed, considerable brine left in hole. Last time sampled for BSEP. Hole capped.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTPA4	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPA4	07/03/86	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled, open from 0 to 4.6 ft.
BTPA4	08/12/86	12:05	NA	588.503	1.000	0.00	0.000	Dry.
BTPA4	08/19/86	12:11	NA	595.508	8.005	0.00	0.000	Dry.
BTPA4	08/26/86	11:25	NA	602.476	14.973	0.00	0.000	Dry.
BTPA4	09/04/86	11:31	NA	611.480	23.977	0.00	0.000	Dry.
BTPA4	09/09/86	13:25	NA	616.559	29.056	0.00	0.000	Dry.
BTPA4	09/16/86	10:59	NA	623.458	35.955	0.00	0.000	Dry.
BTPA4	09/23/86	10:59	NA	630.458	42.955	0.00	0.000	Dry.
BTPA4	10/01/86	08:38	NA	638.360	50.857	0.00	0.000	Dry.
BTPA4	10/08/86	13:20	NA	645.556	58.053	0.00	0.000	Dry.
BTPA4	10/14/86	13:00	NA	651.542	64.039	0.00	0.000	Dry.
BTPA4	11/05/86	12:41	NA	673.528	86.025	0.00	0.000	Dry.
BTPA4	11/20/86	NA:	NA	688.000	100.497	0.00	0.000	
BTPA4	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPA4	12/30/86	NA:	NA	728.000	140.497	0.00	0.000	
BTPA4	03/06/87	10:15	NA	794.427	206.924	0.00	0.000	Dry.
BTPA4	03/30/87	10:35	0.00	818.441	90.441	0.00	0.000	Dry.
BTPA4	05/07/87	12:46	0.00	856.532	128.532	0.00	0.000	Dry.
BTPA4	06/17/87	09:30	0.00	897.396	169.396	0.00	0.000	Dry.
BTPA4	07/28/87	09:39	0.00	938.402	210.402	0.00	0.000	Dry.
BTPA4	10/20/87	09:11	0.00	1022.38	83.978	0.00	0.000	Dry.
BTPA4	01/04/88	09:55	0.00	1098.41	76.030	0.00	0.000	Dry.
BTPA4	02/09/88	10:15	0.00	1134.43	36.020	0.00	0.000	Dry.
BTPA4	03/29/88	09:44	0.00	1183.41	48.980	0.00	0.000	Dry.
BTPA4	07/12/88	11:10	0.00	1288.47	105.060	0.00	0.000	Dry.
BTPA4	09/27/88	11:55	0.00	1365.50	77.030	0.00	0.000	Dry. Last time sampled for BSEP.

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BTPA5	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPA5	07/03/86	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled, open from 0 to 5.3 ft.
BTPA5	08/12/86	12:05	NA	588.503	1.000	0.00	0.000	Dry.
BTPA5	08/19/86	12:11	NA	595.508	8.005	0.00	0.000	Dry.
BTPA5	08/26/86	11:25	NA	602.476	14.973	0.00	0.000	Dry.
BTPA5	09/04/86	11:31	NA	611.480	23.977	0.00	0.000	Dry.
BTPA5	09/09/86	13:26	NA	616.560	29.057	0.00	0.000	Dry.
BTPA5	09/16/86	10:59	NA	623.458	35.955	0.00	0.000	Dry.
BTPA5	09/23/86	11:00	NA	630.458	42.955	0.00	0.000	Dry.
BTPA5	10/01/86	08:39	NA	638.360	50.857	0.00	0.000	Dry.
BTPA5	10/08/86	13:20	NA	645.556	58.053	0.00	0.000	Dry.
BTPA5	10/14/86	13:00	NA	651.542	64.039	0.00	0.000	Dry.
BTPA5	11/05/86	12:41	NA	673.528	86.025	0.00	0.000	Dry.
BTPA5	11/20/86	NA:	NA	688.000	100.497	0.00	0.000	
BTPA5	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPA5	12/30/86	NA:	NA	728.000	140.497	0.00	0.000	
BTPA5	03/06/87	10:15	NA	794.427	206.924	0.00	0.000	Looks dry.
BTPA5	03/30/87	10:35	0.00	818.441	90.441	0.00	0.000	Dry.
BTPA5	05/07/87	12:47	0.00	856.533	128.533	0.00	0.000	Dry.
BTPA5	06/17/87	09:31	0.00	897.397	169.397	0.00	0.000	Dry.
BTPA5	07/28/87	09:39	0.00	938.402	210.402	0.00	0.000	Dry.
BTPA5	10/20/87	09:12	0.00	1022.38	83.978	0.00	0.000	Dry.
BTPA5	01/04/88	10:00	0.00	1098.42	76.040	0.00	0.000	Dry.
BTPA5	02/09/88	10:20	0.00	1134.43	36.010	0.00	0.000	Dry.
BTPA5	03/29/88	09:44	0.00	1183.41	48.980	0.00	0.000	Dry.
BTPA5	07/12/88	11:10	0.00	1288.47	105.060	0.00	0.000	Dry.
BTPA5	09/27/88	11:55	0.00	1365.50	77.030	0.00	0.000	Dry. Last time sampled for BSEP.

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Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTPB1	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPB1	07/17/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 7/17/86, open from 0 to 5.1 ft.
BTPB1	08/12/86	12:10	NA	588.507	1.000	0.00	0.000	Dry.
BTPB1	08/19/86	12:16	NA	595.511	8.004	0.00	0.000	Dry.
BTPB1	08/26/86	11:27	NA	602.477	14.970	0.00	0.000	Dry.
BTPB1	09/04/86	11:33	NA	611.481	23.974	0.00	0.000	Dry.
BTPB1	09/09/86	13:27	NA	616.560	29.053	0.00	0.000	Dry.
BTPB1	09/16/86	11:01	NA	623.459	35.952	0.00	0.000	Dry.
BTPB1	09/23/86	11:06	NA	630.463	42.956	0.00	0.000	Dry.
BTPB1	10/01/86	08:48	NA	638.367	50.860	0.00	0.000	Dry.
BTPB1	10/08/86	13:26	NA	645.560	58.053	0.00	0.000	Dry.
BTPB1	10/14/86	13:05	NA	651.545	64.038	0.00	0.000	Dry.
BTPB1	11/05/86	12:42	NA	673.529	86.022	0.00	0.000	Probe removed, not sampled.
BTPB1	11/20/86	NA:	NA	688.000	100.493	0.00	0.000	
BTPB1	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPB1	12/30/86	NA:	NA	728.000	140.493	0.00	0.000	
BTPB1	03/06/87	10:15	NA	794.427	206.920	0.00	0.000	Covered with muck, not able to sample.
BTPB1	06/18/87	10:00	0.42	898.417	246.872	0.42	0.002	Floor may have been watered for dust control.
BTPB1	09/10/87	13:55	0.03	982.580	84.163	0.45	0.000	Possible contamination by water spread to control dust.
BTPB1	10/20/87	09:32	0.39	1022.40	39.820	0.84	0.010	
BTPB1	11/19/87	09:25	0.90	1052.39	29.990	1.74	0.030	
BTPB1	01/04/88	09:50	0.68	1098.41	46.020	2.42	0.015	
BTPB1	02/09/88	10:25	0.71	1134.43	36.020	3.13	0.020	
BTPB1	03/29/88	09:50	0.55	1183.41	48.980	3.68	0.011	
BTPB1	07/12/88	11:20	0.65	1288.47	105.060	4.33	0.006	
BTPB1	09/27/88	12:00	0.50	1365.50	77.030	4.83	0.006	Last time sampled for BSEP.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTPB2	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPB2	07/30/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 7/18/86 to 7/30/86, open from 5.9 to 9.6 ft.
BTPB2	08/12/86	12:10	Trace	588.507	1.000	0.00	0.000	Not evacuated, installed lysimeter.
BTPB2	08/19/86	12:16	00.03	595.511	8.004	0.03	0.000	First time collected, some brine left in hole.
BTPB2	08/26/86	11:25	00.13	602.476	6.965	0.16	0.019	
BTPB2	09/04/86	11:45	00.01	611.490	9.014	0.17	0.001	Some brine left in hole.
BTPB2	09/09/86	13:28	00.01	616.561	5.071	0.18	0.002	
BTPB2	09/16/86	11:02	00.08	623.460	6.899	0.26	0.012	
BTPB2	09/23/86	11:13	00.01	630.467	7.007	0.27	0.001	Some brine left in hole.
BTPB2	10/01/86	09:03	00.02	638.377	7.910	0.29	0.003	
BTPB2	10/08/86	13:36	00.10	645.567	7.190	0.39	0.014	
BTPB2	10/14/86	13:15	00.03	651.552	5.985	0.42	0.005	
BTPB2	11/05/86	12:42	NA	673.529	21.977	0.42	0.000	Probe removed, not sampled.
BTPB2	11/20/86	NA:	NA	688.000	36.448	0.42	0.000	
BTPB2	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPB2	12/30/86	NA:	NA	728.000	76.448	0.42	0.000	
BTPB2	03/06/87	10:15	NA	794.427	142.875	0.42	0.000	Covered with muck, not able to sample.
BTPB2	06/18/87	09:00	0.56	898.375	246.823	0.98	0.002	Floor may have been watered for dust control. Hole is contaminated with PVC pieces.
BTPB2	09/10/87	13:45	0.15	982.573	84.198	1.13	0.002	Possible contamination by water spread to control dust.
BTPB2	10/20/87	09:40	0.00	1022.40	39.827	1.13	0.000	Dry. No suction.
BTPB2	11/19/87	09:30	0.14	1052.40	30.000	1.27	0.005	
BTPB2	01/04/88	09:50	0.06	1098.41	46.010	1.33	0.001	
BTPB2	02/09/88	10:25	0.00	1134.43	36.020	1.33	0.000	Dry.
BTPB2	03/29/88	09:53	0.14	1183.41	48.980	1.47	0.003	
BTPB2	07/12/88	11:25	0.01	1288.48	105.070	1.48	0.000	
BTPB2	09/27/88	12:10	0.07	1365.51	77.030	1.55	0.001	Last time sampled for BSEP.

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BTPB3	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPB3	08/01/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 7/17/86 to 8/01/86, open from 10.0 to 13.3 ft.
BTPB3	08/12/86	12:15	NA	588.510	1.000	0.00	0.000	Dry.
BTPB3	08/19/86	12:10	Trace	595.507	7.997	0.00	0.000	
BTPB3	08/26/86	11:25	NA	602.476	14.966	0.00	0.000	Could not keep vacuum, brine present and left in hole.
BTPB3	09/04/86	11:40	00.09	611.486	23.976	0.09	0.000	
BTPB3	09/09/86	13:31	00.01	616.563	5.077	0.10	0.002	
BTPB3	09/16/86	11:05	00.02	623.462	6.899	0.12	0.003	
BTPB3	09/23/86	11:16	00.02	630.469	7.007	0.14	0.003	
BTPB3	10/01/86	09:00	00.01	638.375	7.906	0.15	0.001	
BTPB3	10/08/86	13:32	00.02	645.564	7.189	0.17	0.003	
BTPB3	10/14/86	13:17	00.02	651.553	5.989	0.19	0.003	
BTPB3	11/05/86	12:42	NA	673.529	21.976	0.19	0.000	Probe removed, not sampled.
BTPB3	11/20/86	NA:	NA	688.000	36.447	0.19	0.000	Not sampled.
BTPB3	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPB3	12/30/86	NA:	NA	728.000	76.447	0.19	0.000	Not sampled.
BTPB3	03/06/87	10:15	NA	794.427	142.874	0.19	0.000	Covered with muck, not sampled.
BTPB3	06/18/87	08:50	0.22	898.368	246.815	0.41	0.001	Floor may have been watered for dust control. Hole is contaminated with PVC pieces.
BTPB3	09/10/87	13:35	0.12	982.566	84.198	0.53	0.001	Possible contamination by water spread to control dust.
BTPB3	10/20/87	09:41	0.02	1022.40	39.834	0.55	0.001	
BTPB3	11/19/87	09:35	0.04	1052.40	30.000	0.59	0.001	
BTPB3	01/04/88	09:50	0.01	1098.41	46.010	0.60	0.000	
BTPB3	02/09/88	10:30	0.01	1134.44	36.030	0.61	0.000	
BTPB3	03/29/88	09:55	0.03	1183.41	48.970	0.64	0.001	
BTPB3	07/12/88	11:25	0.05	1288.48	105.070	0.69	0.000	
BTPB3	09/27/88	12:10	0.00	1365.51	77.030	0.69	0.000	Dry. Last time sampled for BSEP.

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BTPB4	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPB4	08/05/86	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 7/02/86 to 8/05/86, open from 6.8 to 9.75 ft.
BTPB4	08/12/86	12:15	NA	588.510	1.000	0.00	0.000	Dry.
BTPB4	08/19/86	12:10	NA	595.507	7.997	0.00	0.000	Salt crystals forming, dry.
BTPB4	08/26/86	11:25	NA	602.476	14.966	0.00	0.000	Dry.
BTPB4	09/04/86	11:32	NA	611.481	23.971	0.00	0.000	Some droplets at collar.
BTPB4	09/09/86	13:17	NA	616.553	29.043	0.00	0.000	Dry.
BTPB4	09/16/86	10:59	NA	623.458	35.948	0.00	0.000	Dry.
BTPB4	09/23/86	11:01	NA	630.459	42.949	0.00	0.000	Dry.
BTPB4	10/01/86	08:41	NA	638.362	50.852	0.00	0.000	Dry.
BTPB4	10/08/86	13:21	NA	645.556	58.046	0.00	0.000	
BTPB4	10/14/86	13:00	NA	651.542	64.032	0.00	0.000	Dry.
BTPB4	11/05/86	12:43	NA	673.530	86.020	0.00	0.000	Dry.
BTPB4	11/20/86	NA:	NA	688.000	100.490	0.00	0.000	
BTPB4	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPB4	12/30/86	NA:	NA	728.000	140.490	0.00	0.000	
BTPB4	03/06/87	10:15	NA	794.427	206.917	0.00	0.000	Dry.
BTPB4	03/30/87	10:35	0.00	818.441	24.014	0.00	0.000	Dry, moisture in casing.
BTPB4	05/07/87	12:48	0.00	856.533	62.106	0.00	0.000	Dry.
BTPB4	06/17/87	09:32	0.00	897.397	102.970	0.00	0.000	Damp.
BTPB4	07/28/87	09:35	0.00	938.399	143.972	0.00	0.000	Trace, not collected.
BTPB4	09/01/87	09:40	0.00	973.403	76.006	0.00	0.000	Damp.
BTPB4	10/20/87	09:13	0.00	1022.38	48.977	0.00	0.000	Dry.
BTPB4	11/19/87	09:05	0.00	1052.38	30.000	0.00	0.000	Dry.
BTPB4	01/04/88	10:00	0.00	1098.42	46.040	0.00	0.000	Dry.
BTPB4	02/09/88	10:35	0.00	1134.44	36.020	0.00	0.000	Dry.
BTPB4	03/29/88	09:55	0.00	1183.41	48.970	0.00	0.000	Dry.
BTPB4	07/12/88	11:30	0.00	1288.48	105.070	0.00	0.000	Dry.
BTPB4	09/27/88	12:10	0.00	1365.51	77.030	0.00	0.000	Dry. Last time sampled for BSEP.

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BTPB5	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPB5	08/05/86	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 7/02/86 to 8/05/86, open from 6.3 to 10.3 ft.
BTPB5	08/12/86	12:15	NA	588.510	1.000	0.00	0.000	Dry.
BTPB5	08/19/86	12:10	NA	595.507	7.997	0.00	0.000	Dry.
BTPB5	08/26/86	11:25	NA	602.476	14.966	0.00	0.000	Dry.
BTPB5	09/04/86	11:32	NA	611.481	23.971	0.00	0.000	Dry.
BTPB5	09/09/86	13:18	NA	616.554	29.044	0.00	0.000	Dry.
BTPB5	09/16/86	10:59	NA	623.458	35.948	0.00	0.000	Dry.
BTPB5	09/23/86	11:02	NA	630.460	42.950	0.00	0.000	Dry.
BTPB5	10/01/86	08:42	NA	638.363	50.853	0.00	0.000	Dry.
BTPB5	10/08/86	13:21	NA	645.556	58.046	0.00	0.000	
BTPB5	10/14/86	13:00	NA	651.542	64.032	0.00	0.000	Dry.
BTPB5	11/05/86	12:42	NA	673.529	86.019	0.00	0.000	Dry.
BTPB5	11/20/86	NA:	NA	688.000	100.490	0.00	0.000	
BTPB5	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPB5	12/30/86	NA:	NA	728.000	140.490	0.00	0.000	
BTPB5	03/06/87	10:15	NA	794.427	206.917	0.00	0.000	Damp, salt stalactite on collar.
BTPB5	03/30/87	10:30	0.00	818.438	24.011	0.00	0.000	Dry, moisture in casing.
BTPB5	05/07/87	12:49	0.00	856.534	62.107	0.00	0.000	Damp.
BTPB5	06/17/87	09:33	0.00	897.398	102.971	0.00	0.000	Dry.
BTPB5	07/28/87	09:33	0.00	938.398	143.971	0.00	0.000	Trace, not collected. 14" stalactite formed from collar.
BTPB5	09/01/87	09:35	0.01	973.399	76.001	0.01	0.000	Clay in cup.
BTPB5	10/20/87	09:17	0.02	1022.39	48.991	0.03	0.000	
BTPB5	11/19/87	09:10	0.00	1052.38	29.990	0.03	0.000	Dry.
BTPB5	01/04/88	10:05	0.00	1098.42	46.040	0.03	0.000	Dry.
BTPB5	02/09/88	10:45	0.00	1134.45	36.030	0.03	0.000	Dry.
BTPB5	03/29/88	09:55	0.00	1183.41	48.960	0.03	0.000	Dry.
BTPB5	07/12/88	11:30	0.05	1288.48	105.070	0.08	0.000	
BTPB5	09/27/88	12:10	0.00	1365.51	77.030	0.08	0.000	Dry. Last time sampled for BSEP.

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BTPC1	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPC1	07/18/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 7/18/86, open from 0 to 5.0 ft.
BTPC1	08/12/86	12:20	NA	588.514	1.000	0.00	0.000	Dry.
BTPC1	08/19/86	12:10	NA	595.507	7.993	0.00	0.000	Dry.
BTPC1	08/26/86	11:27	NA	602.477	14.963	0.00	0.000	Dry.
BTPC1	09/04/86	11:33	NA	611.481	23.967	0.00	0.000	Dry.
BTPC1	09/09/86	13:19	NA	616.555	29.041	0.00	0.000	Dry.
BTPC1	09/16/86	11:01	NA	623.459	35.945	0.00	0.000	Dry.
BTPC1	09/23/86	11:07	NA	630.463	42.949	0.00	0.000	Dry.
BTPC1	10/01/86	08:42	NA	638.363	50.849	0.00	0.000	Dry.
BTPC1	10/08/86	13:26	NA	645.560	58.046	0.00	0.000	
BTPC1	10/14/86	13:05	NA	651.545	64.031	0.00	0.000	Dry.
BTPC1	11/05/86	12:45	NA	673.531	86.017	0.00	0.000	Probe removed, not collected.
BTPC1	11/20/86	NA:	NA	688.000	100.486	0.00	0.000	Not collected.
BTPC1	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPC1	12/30/86	NA:	NA	728.000	140.486	0.00	0.000	Not collected.
BTPC1	03/06/87	10:10	NA	794.424	206.910	0.00	0.000	Covered with muck, not collected.
BTPC1	06/18/87	10:15	0.28	898.427	246.882	0.28	0.001	Floor may have been watered for dust control.
BTPC1	09/10/87	13:25	2.01	982.559	84.132	2.29	0.024	Possible contamination by water spread to control dust.
BTPC1	10/20/87	09:24	0.22	1022.39	39.831	2.51	0.006	
BTPC1	11/19/87	09:40	0.91	1052.40	30.010	3.42	0.030	
BTPC1	01/04/88	09:55	0.69	1098.41	46.010	4.11	0.015	
BTPC1	02/09/88	10:45	0.77	1134.45	36.040	4.88	0.021	
BTPC1	03/29/88	10:00	0.57	1183.42	48.970	5.45	0.012	
BTPC1	07/12/88	11:35	0.67	1288.48	105.060	6.12	0.006	
BTPC1	09/15/88	10:30	0.17	1353.44	0.000	6.29	0.000	Not fully evacuated. Don't use for calculation. Sampled for bacteriology.
BTPC1	09/27/88	12:15	0.75	1365.51	77.030	7.04	0.012	Used 0.92 liters for calculation (0.17 on 9/15 + 0.75 on 9/27). Last time sampled for BSEP.

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BTPC2	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPC2	08/01/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 7/18/86 to 8/01/86, open from 5.5 to 9.8 ft.
BTPC2	08/12/86	12:20	Trace	588.514	1.000	0.00	0.000	Not evacuated, installed lysimeter.
BTPC2	08/19/86	12:10	NA	595.507	7.993	0.00	0.000	Lysimeter did not hold vacuum, some brine left in hole.
BTPC2	08/26/86	11:29	00.09	602.478	14.964	0.09	0.000	First time sampled.
BTPC2	09/04/86	11:33	00.01	611.481	9.003	0.10	0.001	Some fluid left in hole.
BTPC2	09/09/86	13:35	00.04	616.566	5.085	0.14	0.008	
BTPC2	09/16/86	11:08	00.04	623.464	6.898	0.18	0.006	
BTPC2	09/23/86	11:18	00.03	630.471	7.007	0.21	0.004	
BTPC2	10/01/86	09:04	00.02	638.378	7.907	0.23	0.003	
BTPC2	10/08/86	13:36	00.01	645.567	7.189	0.24	0.001	
BTPC2	10/14/86	13:20	00.02	651.556	5.989	0.26	0.003	
BTPC2	11/05/86	12:45	NA	673.531	21.975	0.26	0.000	Probe removed, not collected.
BTPC2	11/20/86	NA:	NA	688.000	36.444	0.26	0.000	Not collected.
BTPC2	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPC2	12/30/86	NA:	NA	728.000	76.444	0.26	0.000	Not collected.
BTPC2	03/06/87	10:10	NA	794.424	142.868	0.26	0.000	Covered with muck, not collected.
BTPC2	06/18/87	08:40	0.42	898.361	246.805	0.68	0.002	Floor may have been watered for dust control. Hole is contaminated with PVC pieces.
BTPC2	09/10/87	13:15	0.29	982.552	84.191	0.97	0.003	Installed lysimeter.
BTPC2	10/20/87	09:27	0.19	1022.39	39.838	1.16	0.005	
BTPC2	11/19/87	09:43	0.29	1052.40	30.010	1.45	0.010	
BTPC2	01/04/88	09:55	0.06	1098.41	46.010	1.51	0.001	
BTPC2	02/09/88	11:00	0.07	1134.46	36.050	1.58	0.002	
BTPC2	03/29/88	10:02	0.10	1183.42	48.960	1.68	0.002	
BTPC2	07/12/88	11:35	0.07	1288.48	105.060	1.75	0.001	
BTPC2	09/27/88	12:25	0.38	1365.52	77.040	2.13	0.005	Last time sampled for BSEP.

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BTPC3	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPC3	08/01/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 7/18/86 to 8/01/86, open from 10.0 to 14.4 ft.
BTPC3	08/12/86	12:20	NA	588.514	1.000	0.00	0.000	Dry.
BTPC3	08/19/86	12:10	Trace	595.507	7.993	0.00	0.000	
BTPC3	08/26/86	11:27	NA	602.477	14.963	0.00	0.000	Installed suction probe.
BTPC3	09/04/86	11:30	NA	611.479	23.965	0.00	0.000	No vacuum, some brine left in hole.
BTPC3	09/09/86	13:38	NA	616.568	29.054	0.00	0.000	Dry.
BTPC3	09/16/86	11:10	NA	623.465	35.951	0.00	0.000	Dry.
BTPC3	09/23/86	11:25	00.18	630.476	42.962	0.18	0.000	First time collected.
BTPC3	10/01/86	09:06	Trace	638.379	7.903	0.18	0.000	
BTPC3	10/08/86	13:38	00.01	645.568	15.092	0.19	0.001	
BTPC3	10/14/86	13:21	00.02	651.556	5.988	0.21	0.003	
BTPC3	11/05/86	12:45	NA	673.531	21.975	0.21	0.000	Probe removed, not collected.
BTPC3	11/20/86	NA:	NA	688.000	36.444	0.21	0.000	Not collected.
BTPC3	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPC3	12/30/86	NA:	NA	728.000	76.444	0.21	0.000	Not collected.
BTPC3	03/06/87	10:10	NA	794.424	142.868	0.21	0.000	Covered with muck, not collected.
BTPC3	06/18/87	08:30	0.15	898.354	246.798	0.36	0.001	Floor may have been watered for dust control. Hole contaminated with PVC pieces.
BTPC3	10/20/87	09:30	0.00	1022.40	124.046	0.36	0.000	Dry.
BTPC3	11/19/87	09:45	0.03	1052.41	30.010	0.39	0.001	
BTPC3	01/04/88	09:55	0.01	1098.41	46.000	0.40	0.000	
BTPC3	02/09/88	11:00	Trace	1134.46	36.050	0.40	0.000	
BTPC3	03/29/88	10:02	0.00	1183.42	48.960	0.40	0.000	Dry.
BTPC3	07/12/88	11:35	Trace	1288.48	105.060	0.40	0.000	
BTPC3	09/10/88	13:07	0.03	1348.55	60.070	0.43	0.000	Installed lysimeter.
BTPC3	09/27/88	12:25	0.02	1365.52	16.970	0.45	0.001	Last time sampled for BSEP.

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BTPC4	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPC4	08/05/86	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 7/02/86 to 8/05/86, open from 13.9 to 17.6 ft.
BTPC4	08/12/86	12:25	00.01	588.517	1.000	0.01	0.000	Installed funnel.
BTPC4	08/19/86	12:09	00.20	595.506	6.989	0.21	0.029	
BTPC4	08/26/86	11:25	00.11	602.476	6.970	0.32	0.016	
BTPC4	09/04/86	11:29	00.15	611.478	9.002	0.47	0.017	
BTPC4	09/09/86	13:20	00.07	616.556	5.078	0.54	0.014	
BTPC4	09/16/86	10:57	00.07	623.456	6.900	0.61	0.010	
BTPC4	09/23/86	10:57	00.08	630.456	7.000	0.69	0.011	
BTPC4	10/01/86	08:46	00.09	638.365	7.909	0.78	0.011	
BTPC4	10/08/86	13:24	00.10	645.558	7.193	0.88	0.014	
BTPC4	10/14/86	13:00	00.08	651.542	5.984	0.96	0.013	
BTPC4	11/05/86	12:45	0.22	673.531	21.989	1.18	0.010	
BTPC4	11/20/86	NA:	NA	688.000	14.469	1.18	0.000	
BTPC4	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPC4	12/30/86	10:07	00.55	728.422	54.891	1.73	0.010	Many salt crystals in sample.
BTPC4	02/04/87	10:15	00.20	764.427	36.005	1.93	0.006	
BTPC4	03/06/87	10:15	0.41	794.427	30.000	2.34	0.014	
BTPC4	03/30/87	10:30	0.14	818.438	24.011	2.48	0.006	
BTPC4	05/07/87	12:50	0.29	856.535	38.097	2.77	0.008	
BTPC4	06/17/87	09:34	0.35	897.399	40.864	3.12	0.009	
BTPC4	07/01/87	11:20	0.12	911.472	14.073	3.24	0.009	
BTPC4	07/28/87	09:35	0.15	938.399	26.927	3.39	0.006	
BTPC4	09/01/87	09:40	0.27	973.403	35.004	3.66	0.008	
BTPC4	10/20/87	09:20	0.30	1022.39	48.987	3.96	0.006	
BTPC4	11/19/87	09:15	0.13	1052.39	30.000	4.09	0.004	
BTPC4	01/04/88	10:05	0.15	1098.42	46.030	4.24	0.003	
BTPC4	02/08/88	11:00	0.18	1133.46	35.040	4.42	0.005	
BTPC4	03/29/88	10:05	0.25	1183.42	49.960	4.67	0.005	
BTPC4	07/12/88	11:40	0.50	1288.49	105.070	5.17	0.005	
BTPC4	09/15/88	10:30	0.18	1353.44	0.000	5.35	0.000	Not fully evacuated. Don't use for calculation. Sampled for bacteriology.
BTPC4	09/27/88	12:30	0.07	1365.52	77.030	5.42	0.003	Used 0.25 liters for calculation (0.18 on 9/15 + 0.07 on 9/27). Last time sampled for BSEP.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTPC5	09/04/85	00:00	NA	0.000	0.000	0.00	0.000	Alcove at S1620/W170 excavated.
BTPC5	08/05/86	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 6/30/86 to 8/05/86, open from 14.0 to 18.2 ft.
BTPC5	08/12/86	12:25	NA	588.517	1.000	0.00	0.000	Dry.
BTPC5	08/19/86	12:10	NA	595.507	7.990	0.00	0.000	Dry.
BTPC5	08/26/86	11:25	NA	602.476	14.959	0.00	0.000	Dry.
BTPC5	09/04/86	11:30	NA	611.479	23.962	0.00	0.000	Hole is dripping.
BTPC5	09/09/86	13:21	NA	616.556	29.039	0.00	0.000	Dry.
BTPC5	09/16/86	10:58	Trace	623.457	35.940	0.00	0.000	
BTPC5	09/23/86	10:58	NA	630.457	42.940	0.00	0.000	Drops missing cup.
BTPC5	10/01/86	08:45	Trace	638.365	50.848	0.00	0.000	4" stalactite on SE corner of collar - from outside casing.
BTPC5	10/08/86	13:22	NA	645.557	58.040	0.00	0.000	Stalactite on outside of casing, damp inside of casing.
BTPC5	10/14/86	13:00	Trace	651.542	64.025	0.00	0.000	Two 1/4 mm drops.
BTPC5	11/05/86	12:41	Trace	673.528	86.011	0.00	0.000	Few drops in cup. Stalactite on cup bottom.
BTPC5	11/20/86	NA:	NA	688.000	100.483	0.00	0.000	
BTPC5	12/12/86	00:00	NA	0.000	0.000	0.00	0.000	W170 drift extended southward from this alcove on 12/12/86. Drift completed to S1950 on 1/10/87.
BTPC5	12/30/86	NA:	NA	728.000	140.483	0.00	0.000	
BTPC5	03/06/87	10:15	NA	794.427	206.910	0.00	0.000	Dry, salt buildup outside cup.
BTPC5	03/30/87	10:30	0.00	818.438	24.011	0.00	0.000	Dry, moisture in casing.
BTPC5	05/07/87	12:51	0.00	856.535	62.108	0.00	0.000	Damp.
BTPC5	06/17/87	09:35	0.00	897.399	102.972	0.00	0.000	Damp.
BTPC5	07/28/87	09:31	0.00	938.397	143.970	0.00	0.000	Trace, not collected.
BTPC5	09/01/87	09:35	0.01	973.399	76.000	0.01	0.000	Clay in cup.
BTPC5	10/20/87	09:18	Trace	1022.39	48.991	0.01	0.000	
BTPC5	11/19/87	09:10	0.00	1052.38	29.990	0.01	0.000	Dry.
BTPC5	01/04/88	10:05	0.00	1098.42	46.040	0.01	0.000	Dry.
BTPC5	02/08/88	11:00	0.00	1133.46	35.040	0.01	0.000	Dry.
BTPC5	03/29/88	10:05	0.00	1183.42	49.960	0.01	0.000	Dry.
BTPC5	07/12/88	11:45	0.05	1288.49	105.070	0.06	0.000	
BTPC5	09/27/88	12:35	Trace	1365.52	77.030	0.06	0.000	Last time sampled for BSEP.

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BTR01	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR01	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 1 ft deep, above clay seam near back.
BTR01	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Installed suction probe and sealed opening.
BTR01	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Dry.
BTR01	03/06/86	11:40	NA	429.486	3.087	0.00	0.000	Slightly wet.
BTR01	03/13/86	11:00	NA	436.458	10.059	0.00	0.000	Wet.
BTR01	03/26/86	11:15	NA	449.469	23.070	0.00	0.000	Wet.
BTR01	04/02/86	10:35	NA	456.441	30.042	0.00	0.000	Slightly wet.
BTR01	04/08/86	10:45	NA	462.448	36.049	0.00	0.000	Dry.
BTR01	04/16/86	13:00	NA	470.542	44.143	0.00	0.000	
BTR01	04/24/86	11:05	NA	478.462	52.063	0.00	0.000	
BTR01	04/30/86	11:40	NA	484.486	58.087	0.00	0.000	Dry.
BTR01	05/06/86	11:00	NA	490.458	64.059	0.00	0.000	Dry.
BTR01	05/13/86	10:20	NA	497.431	71.032	0.00	0.000	Dry.
BTR01	05/20/86	11:30	NA	504.479	78.080	0.00	0.000	Dry.
BTR01	05/27/86	12:15	NA	511.510	85.111	0.00	0.000	Salt crust developing in bottom of hole.
BTR01	06/03/86	11:05	NA	518.462	92.063	0.00	0.000	Damp.
BTR01	06/10/86	12:15	NA	525.510	99.111	0.00	0.000	Dry.
BTR01	06/17/86	11:25	NA	532.476	106.077	0.00	0.000	Dry.
BTR01	06/24/86	11:50	NA	539.493	113.094	0.00	0.000	Moist.
BTR01	07/01/86	11:30	NA	546.479	120.080	0.00	0.000	Dry.
BTR01	07/08/86	11:30	NA	553.479	127.080	0.00	0.000	Wet clay in hole.
BTR01	07/16/86	11:48	Trace	561.492	135.093	0.00	0.000	
BTR01	07/22/86	11:00	NA	567.458	141.059	0.00	0.000	Damp.
BTR01	07/29/86	11:30	NA	574.479	148.080	0.00	0.000	Dry.
BTR01	08/05/86	12:01	NA	581.501	155.102	0.00	0.000	Dry.
BTR01	08/12/86	09:00	NA	588.375	161.976	0.00	0.000	Dry.
BTR01	08/19/86	12:27	NA	595.519	169.120	0.00	0.000	Dry.
BTR01	08/26/86	12:00	NA	602.500	176.101	0.00	0.000	Dry.
BTR01	09/04/86	12:08	NA	611.506	185.107	0.00	0.000	Damp.
BTR01	09/09/86	12:30	NA	616.521	190.122	0.00	0.000	Dry.
BTR01	09/16/86	11:16	NA	623.469	197.070	0.00	0.000	Dry.
BTR01	09/23/86	11:35	NA	630.483	204.084	0.00	0.000	Dry.
BTR01	10/01/86	08:25	NA	638.351	211.952	0.00	0.000	Dry.
BTR01	10/08/86	13:47	NA	645.574	219.175	0.00	0.000	Not pumped last week.
BTR01	10/14/86	10:00	NA	651.417	225.018	0.00	0.000	Pumped only, no collection.
BTR01	11/05/86	12:55	NA	673.538	247.139	0.00	0.000	Dry.
BTR01	11/20/86	14:49	NA	688.617	262.218	0.00	0.000	Dry.
BTR01	12/30/86	09:38	NA	728.401	302.002	0.00	0.000	Dry, no vacuum.
BTR01	03/06/87	09:45	NA	794.406	368.007	0.00	0.000	Dry, salt buildup outside cup. No vacuum.
BTR01	03/30/87	10:00	0.00	818.417	24.011	0.00	0.000	Dry.
BTR01	06/17/87	09:00	0.00	897.375	102.969	0.00	0.000	Dry.
BTR01	07/28/87	09:47	0.00	938.408	144.002	0.00	0.000	Dry.
BTR01	09/01/87	09:10	0.00	973.382	34.974	0.00	0.000	Dry.
BTR01	10/20/87	08:50	0.00	1022.37	48.988	0.00	0.000	Dry.
BTR01	11/19/87	08:31	0.00	1052.35	29.980	0.00	0.000	Dry.
BTR01	01/04/88	09:10	0.00	1098.38	46.030	0.00	0.000	Dry.
BTR01	02/09/88	09:30	0.00	1134.40	36.020	0.00	0.000	Dry.
BTR01	03/29/88	09:15	0.00	1183.39	48.990	0.00	0.000	Dry.
BTR01	07/12/88	10:30	0.00	1288.44	105.050	0.00	0.000	Dry.
BTR01	09/27/88	11:15	0.00	1365.47	77.030	0.00	0.000	Dry. Last time sampled for BSEP.

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BTR02	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR02	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 3.2 ft deep, above clay seam near back.
BTR02	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Installed suction probe and sealed opening.
BTR02	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Wet at bottom.
BTR02	03/06/86	11:40	NA	429.486	3.087	0.00	0.000	Slight brine accumulation.
BTR02	03/13/86	11:00	00.01	436.458	10.059	0.01	0.001	Clay squeezing into hole.
BTR02	03/26/86	11:30	00.05	449.479	13.021	0.06	0.004	Lots of clay squeezing into hole.
BTR02	04/02/86	10:35	00.01	456.441	6.962	0.07	0.001	Clay squeezing into hole.
BTR02	04/08/86	10:45	00.09	462.448	6.007	0.16	0.015	
BTR02	04/16/86	13:00	00.01	470.542	8.094	0.17	0.001	
BTR02	04/24/86	11:05	00.01	478.462	7.920	0.18	0.001	
BTR02	04/30/86	11:40	Trace	484.486	6.024	0.18	0.000	
BTR02	05/06/86	11:00	Trace	490.458	11.996	0.18	0.000	
BTR02	05/13/86	10:20	Trace	497.431	18.969	0.18	0.000	Approximate 0.005 liters.
BTR02	05/20/86	11:30	Trace	504.479	26.017	0.18	0.000	
BTR02	05/27/86	12:15	00.01	511.510	33.048	0.19	0.000	Clay squeezing into hole.
BTR02	06/03/86	11:05	Trace	518.462	6.952	0.19	0.000	
BTR02	06/10/86	12:15	Trace	525.510	14.000	0.19	0.000	
BTR02	06/17/86	11:25	Trace	532.476	20.966	0.19	0.000	
BTR02	06/24/86	11:50	NA	539.493	27.983	0.19	0.000	Approximate 0.05 liters.
BTR02	07/01/86	11:30	00.01	546.479	34.969	0.20	0.000	
BTR02	07/08/86	11:32	00.01	553.481	7.002	0.21	0.001	Wet clay.
BTR02	07/16/86	11:49	00.01	561.492	8.011	0.22	0.001	
BTR02	07/22/86	11:00	00.01	567.458	5.966	0.23	0.002	
BTR02	07/29/86	11:31	00.01	574.480	7.022	0.24	0.001	
BTR02	08/05/86	12:02	00.01	581.501	7.021	0.25	0.001	
BTR02	08/12/86	09:00	Trace	588.375	6.874	0.25	0.000	
BTR02	08/19/86	12:28	00.01	595.519	14.018	0.26	0.001	
BTR02	08/26/86	12:01	00.01	602.501	6.982	0.27	0.001	
BTR02	09/04/86	12:08	Trace	611.506	9.005	0.27	0.000	0.005 liters, lots of clay.
BTR02	09/09/86	12:30	00.01	616.521	14.020	0.28	0.001	
BTR02	09/16/86	11:17	Trace	623.470	6.949	0.28	0.000	Clay.
BTR02	09/23/86	11:36	Trace	630.483	13.962	0.28	0.000	Up to 0.005 liters.
BTR02	10/01/86	08:26	00.01	638.351	21.830	0.29	0.000	
BTR02	10/08/86	13:47	Trace	645.574	7.223	0.29	0.000	Small amount of brine poured out.
BTR02	10/14/86	10:00	NA	651.417	13.066	0.29	0.000	Pumped only, no collection.
BTR02	11/05/86	12:56	0.01	673.539	35.188	0.30	0.000	Blocked by vent pipe, not sampled.
BTR02	11/20/86	14:29	NA	688.603	15.064	0.30	0.000	Blocked by vent pipe, not sampled.
BTR02	12/30/86	09:39	00.02	728.402	54.863	0.32	0.000	Vacuum.
BTR02	03/06/87	09:45	0.01	794.406	66.004	0.33	0.000	
BTR02	03/30/87	10:01	0.00	818.417	24.011	0.33	0.000	Trace.
BTR02	06/17/87	09:01	0.01	897.376	102.970	0.34	0.000	
BTR02	07/28/87	09:50	0.01	938.410	41.034	0.35	0.000	
BTR02	09/01/87	09:12	0.01	973.383	34.973	0.36	0.000	
BTR02	10/20/87	08:51	0.01	1022.37	48.987	0.37	0.000	
BTR02	11/19/87	08:31	0.01	1052.35	29.980	0.38	0.000	
BTR02	01/04/88	09:10	0.01	1098.38	46.030	0.39	0.000	
BTR02	02/09/88	09:30	0.01	1134.40	36.020	0.40	0.000	
BTR02	03/29/88	09:17	0.01	1183.39	48.990	0.41	0.000	
BTR02	07/12/88	10:30	Trace	1288.44	105.050	0.41	0.000	
BTR02	09/27/88	11:15	0.01	1365.47	77.030	0.42	0.000	
BTR02	12/02/88	12:40	0	1431.53	66.060	0.42	0.000	Dry. Sampler removed. Last time sampled for BSEP.

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BTR03	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR03	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 3.3 ft deep, above clay seam near back.
BTR03	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Brine accumulation at the bottom.
BTR03	03/06/86	11:40	NA	429.486	3.087	0.00	0.000	Brine accumulation.
BTR03	03/13/86	11:00	NA	436.458	10.059	0.00	0.000	Brine and clay.
BTR03	03/26/86	11:30	NA	449.479	23.080	0.00	0.000	Brine and clay in hole.
BTR03	04/02/86	10:35	NA	456.441	30.042	0.00	0.000	Brine left in hole.
BTR03	04/08/86	10:45	NA	462.448	36.049	0.00	0.000	Trace.
BTR03	04/16/86	13:00	NA	470.542	44.143	0.00	0.000	Installed suction probe.
BTR03	04/24/86	11:05	NA	478.462	52.063	0.00	0.000	No vacuum.
BTR03	04/30/86	11:40	Trace	484.486	58.087	0.00	0.000	
BTR03	05/06/86	11:00	Trace	490.458	64.059	0.00	0.000	
BTR03	05/13/86	10:20	Trace	497.431	71.032	0.00	0.000	Approximate 0.005 liters.
BTR03	05/20/86	11:30	NA	504.479	78.080	0.00	0.000	Dry.
BTR03	05/27/86	12:15	00.02	511.510	85.111	0.02	0.000	
BTR03	06/03/86	11:10	00.05	518.465	6.955	0.07	0.007	
BTR03	06/10/86	12:15	Trace	525.510	7.045	0.07	0.000	
BTR03	06/17/86	11:30	Trace	532.479	14.014	0.07	0.000	
BTR03	06/24/86	11:55	Trace	539.497	21.032	0.07	0.000	A few drops.
BTR03	07/01/86	11:30	Trace	546.479	28.014	0.07	0.000	
BTR03	07/08/86	11:34	00.01	553.482	7.003	0.08	0.001	
BTR03	07/16/86	11:50	00.01	561.493	8.011	0.09	0.001	
BTR03	07/22/86	11:00	Trace	567.458	5.965	0.09	0.000	
BTR03	07/29/86	11:32	NA	574.481	12.988	0.09	0.000	A few drops.
BTR03	08/05/86	12:03	00.01	581.502	20.009	0.10	0.000	
BTR03	08/12/86	09:00	Trace	588.375	6.873	0.10	0.000	A few drops.
BTR03	08/19/86	12:29	Trace	595.520	14.018	0.10	0.000	
BTR03	08/26/86	12:02	Trace	602.501	20.999	0.10	0.000	
BTR03	09/04/86	12:09	Trace	611.506	30.004	0.10	0.000	A few drops.
BTR03	09/09/86	12:30	Trace	616.521	35.019	0.10	0.000	
BTR03	09/16/86	11:18	Trace	623.471	41.969	0.10	0.000	Clay squeezed into hole.
BTR03	09/23/86	11:37	Trace	630.484	48.982	0.10	0.000	
BTR03	10/01/86	08:26	00.01	638.351	56.849	0.11	0.000	
BTR03	10/08/86	13:48	Trace	645.575	7.224	0.11	0.000	Inside of tube is damp.
BTR03	10/14/86	10:00	NA	651.417	13.066	0.11	0.000	Pumped only, no collection.
BTR03	10/14/86	10:00	NA	651.417	13.066	0.11	0.000	Pumped only, no collection.
BTR03	11/05/86	12:57	NA	673.540	35.189	0.11	0.000	Damp, blocked by vent pipe, not sampled.
BTR03	11/20/86	13:29	NA	688.562	50.211	0.11	0.000	Blocked by vent pipe, not sampled.
BTR03	12/30/86	09:40	NA	728.403	90.052	0.11	0.000	Damp, vacuum. Hole appears dry, clay squeezing into it.
BTR03	03/06/87	09:45	0.03	794.406	156.055	0.14	0.000	
BTR03	03/30/87	10:02	0.01	818.418	24.012	0.15	0.000	
BTR03	06/17/87	09:02	0.02	897.376	78.958	0.17	0.000	
BTR03	07/28/87	09:50	0.02	938.410	41.034	0.19	0.000	
BTR03	09/01/87	09:12	0.03	973.383	34.973	0.22	0.001	
BTR03	10/20/87	08:52	0.03	1022.37	48.987	0.25	0.001	
BTR03	11/19/87	08:35	0.02	1052.36	29.990	0.27	0.001	
BTR03	01/04/88	09:15	0.02	1098.39	46.030	0.29	0.000	
BTR03	02/09/88	09:30	0.02	1134.40	36.010	0.31	0.001	
BTR03	03/29/88	09:18	0.01	1183.39	48.990	0.32	0.000	
BTR03	07/12/88	10:30	0.01	1288.44	105.050	0.33	0.000	
BTR03	09/27/88	11:15	0.04	1365.47	77.030	0.37	0.001	
BTR03	12/02/88	12:40	0.02	1431.53	66.060	0.39	0.000	Dry. Sampler removed. Last time sampled for BSEP.

WIPP BRINE SAMPLING AND EVALUATION PROGRAM
Appendix A for the 1988 BSEP Report
Data through December 31, 1988

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTR04	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR04	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 0.95 ft deep, in halite in upper third of rib.
BTR04	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Installed suction probe and sealed opening.
BTR04	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Dry.
BTR04	03/06/86	11:40	NA	429.486	3.087	0.00	0.000	Dry.
BTR04	03/13/86	11:00	NA	436.458	10.059	0.00	0.000	Dry, salt incrustations forming.
BTR04	03/26/86	11:30	NA	449.479	23.080	0.00	0.000	Dry.
BTR04	04/02/86	10:35	NA	456.441	30.042	0.00	0.000	Dry.
BTR04	04/08/86	10:45	NA	462.448	36.049	0.00	0.000	Dry.
BTR04	04/16/86	13:00	NA	470.542	44.143	0.00	0.000	Dry.
BTR04	04/24/86	11:05	NA	478.462	52.063	0.00	0.000	
BTR04	04/30/86	11:40	NA	484.486	58.087	0.00	0.000	
BTR04	05/06/86	11:00	NA	490.458	64.059	0.00	0.000	Dry.
BTR04	05/13/86	10:25	NA	497.434	71.035	0.00	0.000	Dry.
BTR04	05/20/86	11:30	NA	504.479	78.080	0.00	0.000	Dry.
BTR04	05/27/86	12:15	NA	511.510	85.111	0.00	0.000	Damp inside of lysimeter.
BTR04	06/03/86	11:15	NA	518.469	92.070	0.00	0.000	Dry.
BTR04	06/10/86	12:20	NA	525.514	99.115	0.00	0.000	Dry.
BTR04	06/17/86	11:30	NA	532.479	106.080	0.00	0.000	
BTR04	06/24/86	12:00	NA	539.500	113.101	0.00	0.000	
BTR04	07/01/86	11:30	NA	546.479	120.080	0.00	0.000	Damp.
BTR04	07/08/86	11:36	NA	553.483	127.084	0.00	0.000	Dry.
BTR04	07/16/86	11:53	NA	561.495	135.096	0.00	0.000	Dry.
BTR04	07/22/86	11:00	NA	567.458	141.059	0.00	0.000	Dry.
BTR04	07/29/86	11:33	NA	574.481	148.082	0.00	0.000	Dry.
BTR04	08/05/86	12:04	NA	581.503	155.104	0.00	0.000	
BTR04	08/12/86	09:00	NA	588.375	161.976	0.00	0.000	
BTR04	08/19/86	12:30	NA	595.521	169.122	0.00	0.000	Dry.
BTR04	08/26/86	12:03	NA	602.502	176.103	0.00	0.000	Dry.
BTR04	09/04/86	12:09	NA	611.506	185.107	0.00	0.000	Dry.
BTR04	09/09/86	12:30	NA	616.521	190.122	0.00	0.000	Dry.
BTR04	09/16/86	11:16	NA	623.469	197.070	0.00	0.000	Dry.
BTR04	09/23/86	11:38	NA	630.485	204.086	0.00	0.000	Dry.
BTR04	10/01/86	08:26	NA	638.351	211.952	0.00	0.000	Dry.
BTR04	10/08/86	13:48	NA	645.575	219.176	0.00	0.000	Not pumed last week.
BTR04	11/05/86	12:58	NA	673.540	247.141	0.00	0.000	No clamp.
BTR04	11/20/86	14:29	NA	688.603	262.204	0.00	0.000	No clamp, installed new clamp today.
BTR04	12/30/86	07:41	NA	728.320	301.921	0.00	0.000	Dry, no vacuum.
BTR04	03/06/87	09:50	NA	794.410	368.011	0.00	0.000	Dry, no vacuum.
BTR04	03/30/87	10:03	0.00	818.419	24.009	0.00	0.000	Dry.
BTR04	06/17/87	09:03	0.00	897.377	102.967	0.00	0.000	Dry.
BTR04	07/28/87	09:45	0.00	938.406	143.996	0.00	0.000	Dry.
BTR04	09/01/87	09:15	0.00	973.385	34.979	0.00	0.000	Dry.
BTR04	10/20/87	08:54	0.00	1022.37	48.985	0.00	0.000	Dry.
BTR04	11/19/87	08:35	0.00	1052.36	29.990	0.00	0.000	Dry.
BTR04	01/04/88	09:15	0.00	1098.39	46.030	0.00	0.000	Dry.
BTR04	02/09/88	09:35	0.00	1134.40	36.010	0.00	0.000	Dry.
BTR04	03/29/88	09:20	0.00	1183.39	48.990	0.00	0.000	Dry.
BTR04	07/12/88	10:30	0.00	1288.44	105.050	0.00	0.000	Dry.
BTR04	09/27/88	11:20	0.00	1365.47	77.030	0.00	0.000	Dry.
BTR04	12/02/88	12:41	0	1431.53	66.060	0.00	0.000	Dry. Sampler removed. Last time sampled for BSEP.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTR05	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR05	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 3.0 ft deep, in halite in upper third of rib.
BTR05	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Salt knobs forming l.6' from collar, slightly wet.
BTR05	03/06/86	11:40	NA	429.486	3.087	0.00	0.000	Dry.
BTR05	03/13/86	11:00	NA	436.458	10.059	0.00	0.000	Dry.
BTR05	03/26/86	11:30	NA	449.479	23.080	0.00	0.000	Dry.
BTR05	04/02/86	10:35	NA	456.441	30.042	0.00	0.000	Salt knobs.
BTR05	04/08/86	10:45	NA	462.448	36.049	0.00	0.000	Little accumulation.
BTR05	04/16/86	13:00	NA	470.542	44.143	0.00	0.000	Installed suction probe.
BTR05	04/24/86	11:05	NA	478.462	52.063	0.00	0.000	
BTR05	04/30/86	11:40	Trace	484.486	58.087	0.00	0.000	
BTR05	05/06/86	11:00	Trace	490.458	64.059	0.00	0.000	
BTR05	05/13/86	10:25	Trace	497.434	71.035	0.00	0.000	A few drops.
BTR05	05/20/86	11:30	Trace	504.479	78.080	0.00	0.000	
BTR05	05/27/86	12:15	Trace	511.510	85.111	0.00	0.000	
BTR05	06/03/86	11:20	Trace	518.472	92.073	0.00	0.000	
BTR05	06/10/86	12:20	Trace	525.514	99.115	0.00	0.000	
BTR05	06/17/86	11:30	Trace	532.479	106.080	0.00	0.000	
BTR05	06/24/86	12:00	Trace	539.500	113.101	0.00	0.000	
BTR05	07/01/86	11:30	00.01	546.479	6.979	0.01	0.001	
BTR05	07/08/86	11:38	Trace	553.485	7.006	0.01	0.000	
BTR05	07/16/86	11:54	00.01	561.496	15.017	0.02	0.001	
BTR05	07/22/86	11:00	Trace	567.458	5.962	0.02	0.000	
BTR05	07/29/86	11:34	00.01	574.482	12.986	0.03	0.001	
BTR05	08/05/86	12:05	Trace	581.503	7.021	0.03	0.000	
BTR05	08/12/86	09:00	Trace	588.375	13.893	0.03	0.000	A few drops.
BTR05	08/19/86	12:31	Trace	595.522	21.040	0.03	0.000	A few drops.
BTR05	08/26/86	12:04	Trace	602.503	28.021	0.03	0.000	A few drops.
BTR05	09/04/86	12:09	Trace	611.506	37.024	0.03	0.000	
BTR05	09/09/86	12:30	Trace	616.521	42.039	0.03	0.000	
BTR05	09/16/86	11:19	Trace	623.472	48.990	0.03	0.000	
BTR05	09/23/86	11:38	Trace	630.485	56.003	0.03	0.000	
BTR05	10/01/86	08:27	Trace	638.352	63.870	0.03	0.000	
BTR05	10/08/86	13:49	Trace	645.576	71.094	0.03	0.000	Inside tube slightly damp.
BTR05	10/14/86	10:00	NA	651.417	76.935	0.03	0.000	Pumped only, no collection.
BTR05	11/05/86	12:59	0.02	673.541	99.059	0.05	0.000	
BTR05	11/20/86	14:30	NA	688.604	114.122	0.05	0.000	Trace.
BTR05	12/30/86	09:42	00.01	728.404	54.863	0.06	0.000	No vacuum.
BTR05	03/06/87	09:50	0.01	794.410	66.006	0.07	0.000	
BTR05	03/30/87	10:04	0.00	818.419	24.009	0.07	0.000	Trace.
BTR05	06/17/87	09:04	0.01	897.378	102.968	0.08	0.000	
BTR05	07/28/87	09:51	0.02	938.410	41.032	0.10	0.000	
BTR05	09/01/87	09:15	0.02	973.385	34.975	0.12	0.001	
BTR05	10/20/87	08:55	0.01	1022.37	48.985	0.13	0.000	
BTR05	11/19/87	08:35	Trace	1052.36	29.990	0.13	0.000	
BTR05	01/04/88	09:15	Damp	1098.39	46.030	0.13	0.000	Water standing in back of hole, 3 stalactites in hole.
BTR05	02/09/88	09:35	0.00	1134.40	36.010	0.13	0.000	Dry.
BTR05	03/29/88	09:22	0.00	1183.39	48.990	0.13	0.000	Dry.
BTR05	07/12/88	10:30	Trace	1288.44	105.050	0.13	0.000	
BTR05	09/27/88	11:20	Trace	1365.47	77.030	0.13	0.000	
BTR05	12/02/88	12:42	0	1431.53	66.060	0.13	0.000	Dry. Sampler removed. Last time sampled for BSEP.

WIPP BRINE SAMPLING AND EVALUATION PROGRAM
Appendix A for the 1988 BSEP Report
Data through December 31, 1988

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTR06	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR06	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 3.0 ft deep, in halite in upper third of rib.
BTR06	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Salt incrustation forming 0.6'from collar.
BTR06	03/06/86	11:40	NA	429.486	3.087	0.00	0.000	Wet at the bottom.
BTR06	03/13/86	11:00	NA	436.458	10.059	0.00	0.000	Brine, installed suction probe.
BTR06	03/26/86	11:30	00.01	449.479	23.080	0.01	0.000	Trace.
BTR06	04/02/86	10:45	NA	456.448	6.969	0.01	0.000	Trace, estimated 0.005 liter.
BTR06	04/08/86	10:45	00.01	462.448	12.969	0.02	0.001	Trace.
BTR06	04/16/86	13:00	Trace	470.542	8.094	0.02	0.000	
BTR06	04/24/86	11:05	Trace	478.462	16.014	0.02	0.000	
BTR06	04/30/86	11:40	Trace	484.486	22.038	0.02	0.000	
BTR06	05/06/86	11:00	Trace	490.458	28.010	0.02	0.000	
BTR06	05/13/86	10:25	Trace	497.434	34.986	0.02	0.000	A few drops.
BTR06	05/20/86	11:30	Trace	504.479	42.031	0.02	0.000	
BTR06	05/27/86	12:15	Trace	511.510	49.062	0.02	0.000	Salt knobs on side of hole.
BTR06	06/03/86	11:20	Trace	518.472	56.024	0.02	0.000	A few drops.
BTR06	06/10/86	12:20	Trace	525.514	63.066	0.02	0.000	
BTR06	06/17/86	11:35	Trace	532.483	70.035	0.02	0.000	
BTR06	06/24/86	12:05	Trace	539.503	77.055	0.02	0.000	A few droplets.
BTR06	07/01/86	11:30	Trace	546.479	84.031	0.02	0.000	
BTR06	07/08/86	11:40	Trace	553.486	91.038	0.02	0.000	A few drops.
BTR06	07/16/86	11:55	Trace	561.497	99.049	0.02	0.000	
BTR06	07/22/86	11:00	Trace	567.458	105.010	0.02	0.000	
BTR06	07/29/86	11:35	00.01	574.483	112.035	0.03	0.000	
BTR06	08/05/86	12:06	00.01	581.504	7.021	0.04	0.001	
BTR06	08/12/86	09:00	Trace	588.375	6.871	0.04	0.000	
BTR06	08/19/86	12:32	Trace	595.522	14.018	0.04	0.000	A few drops.
BTR06	08/26/86	12:05	Trace	602.503	20.999	0.04	0.000	
BTR06	09/04/86	12:09	Trace	611.506	30.002	0.04	0.000	
BTR06	09/09/86	12:30	Trace	616.521	35.017	0.04	0.000	A few drops.
BTR06	09/16/86	11:20	Trace	623.472	41.968	0.04	0.000	
BTR06	09/23/86	11:39	Trace	630.485	48.981	0.04	0.000	
BTR06	10/01/86	08:28	Trace	638.353	56.849	0.04	0.000	
BTR06	10/08/86	13:50	Trace	645.576	64.072	0.04	0.000	Small amount poured out.
BTR06	10/14/86	10:00	NA	651.417	69.913	0.04	0.000	Pumped only, no collection.
BTR06	11/05/86	13:00	0.01	673.542	92.038	0.05	0.000	
BTR06	11/20/86	14:30	NA	688.604	15.062	0.05	0.000	Trace.
BTR06	12/30/86	09:43	Trace	728.405	54.863	0.05	0.000	No vacuum.
BTR06	03/06/87	09:50	Trace	794.410	120.868	0.05	0.000	
BTR06	03/30/87	10:05	0.00	818.420	24.010	0.05	0.000	Inside of tube wet.
BTR06	06/17/87	09:05	0.00	897.378	102.968	0.05	0.000	Trace in tube.
BTR06	07/28/87	09:52	0.01	938.411	144.001	0.06	0.000	
BTR06	09/01/87	09:17	Trace	973.387	34.976	0.06	0.000	
BTR06	10/20/87	08:56	Trace	1022.37	48.983	0.06	0.000	
BTR06	11/19/87	08:40	Damp	1052.36	29.990	0.06	0.000	
BTR06	01/04/88	09:15	0.00	1098.39	46.030	0.06	0.000	Dry. 4-5 stalactites at end of hole.
BTR06	02/09/88	09:35	0.00	1134.40	36.010	0.06	0.000	Dry.
BTR06	03/29/88	09:23	0.00	1183.39	48.990	0.06	0.000	Dry.
BTR06	07/12/88	10:30	0.00	1288.44	105.050	0.06	0.000	Dry.
BTR06	09/27/88	11:25	Trace	1365.48	77.040	0.06	0.000	
BTR06	12/02/88	12:43	0	1431.53	66.050	0.06	0.000	Dry. Sampler removed. Last time sampled for BSEP.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTR07	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR07	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 1.1 ft deep, just above the orange band.
BTR07	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Installed suction probe and sealed opening.
BTR07	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Wet.
BTR07	03/06/86	11:40	NA	429.486	3.087	0.00	0.000	Wet, some brine at the bottom.
BTR07	03/13/86	11:00	NA	436.458	10.059	0.00	0.000	Brine at the end of hole.
BTR07	03/26/86	11:30	NA	449.479	23.080	0.00	0.000	Brine in small hole in end.
BTR07	04/02/86	10:45	NA	456.448	30.049	0.00	0.000	Trace in hole.
BTR07	04/08/86	10:45	NA	462.448	36.049	0.00	0.000	Salt knobs.
BTR07	04/16/86	13:00	NA	470.542	44.143	0.00	0.000	Wet.
BTR07	04/24/86	11:05	NA	478.462	52.063	0.00	0.000	Wet.
BTR07	04/30/86	11:40	NA	484.486	58.087	0.00	0.000	Wet, lots of salt knobs.
BTR07	05/06/86	11:00	NA	490.458	64.059	0.00	0.000	Wet.
BTR07	05/13/86	10:30	NA	497.438	71.039	0.00	0.000	Moist.
BTR07	05/20/86	11:30	NA	504.479	78.080	0.00	0.000	Moist.
BTR07	05/27/86	12:15	NA	511.510	85.111	0.00	0.000	Damp inside of lysimeter.
BTR07	06/03/86	11:25	NA	518.476	92.077	0.00	0.000	Salt knobs.
BTR07	06/10/86	12:25	NA	525.517	99.118	0.00	0.000	Dry.
BTR07	06/17/86	11:35	NA	532.483	106.084	0.00	0.000	Damp.
BTR07	06/24/86	12:05	NA	539.503	113.104	0.00	0.000	
BTR07	07/01/86	11:30	NA	546.479	120.080	0.00	0.000	Damp.
BTR07	07/08/86	11:42	Trace	553.488	127.089	0.00	0.000	Two drops in probe.
BTR07	07/16/86	11:58	NA	561.499	135.100	0.00	0.000	Trace.
BTR07	07/22/86	11:00	NA	567.458	141.059	0.00	0.000	Damp.
BTR07	07/29/86	11:40	NA	574.486	148.087	0.00	0.000	Moist inside probe.
BTR07	08/05/86	12:07	NA	581.505	155.106	0.00	0.000	
BTR07	08/12/86	09:30	NA	588.396	161.997	0.00	0.000	Dry.
BTR07	08/19/86	12:33	NA	595.523	169.124	0.00	0.000	Dry.
BTR07	08/26/86	12:06	NA	602.504	176.105	0.00	0.000	Dry.
BTR07	09/04/86	12:09	NA	611.506	185.107	0.00	0.000	Dry.
BTR07	09/09/86	12:30	Trace	616.521	190.122	0.00	0.000	A few drops.
BTR07	09/16/86	11:25	Trace	623.476	197.077	0.00	0.000	
BTR07	09/23/86	11:44	NA	630.489	204.090	0.00	0.000	Moisture in lysimeter.
BTR07	10/01/86	08:29	NA	638.353	211.954	0.00	0.000	Damp.
BTR07	10/08/86	13:54	NA	645.579	219.180	0.00	0.000	Damp, nothing pours out.
BTR07	10/14/86	10:00	NA	651.417	225.018	0.00	0.000	Pumped only, no collection.
BTR07	11/05/86	13:01	NA	673.542	247.143	0.00	0.000	Damp.
BTR07	11/20/86	14:35	NA	688.608	262.209	0.00	0.000	Damp.
BTR07	12/30/86	09:44	NA	728.406	302.007	0.00	0.000	Dry, no vacuum.
BTR07	03/06/87	09:50	NA	794.410	368.011	0.00	0.000	Dry.
BTR07	03/30/87	10:06	0.00	818.421	24.011	0.00	0.000	Dry.
BTR07	06/17/87	09:06	0.00	897.379	102.969	0.00	0.000	Dry.
BTR07	07/28/87	09:44	0.00	938.406	143.996	0.00	0.000	Damp, none collected.
BTR07	09/01/87	09:17	0.00	973.387	76.008	0.00	0.000	Dry.
BTR07	10/20/87	09:03	0.00	1022.38	48.993	0.00	0.000	Dry.
BTR07	11/19/87	08:40	0.00	1052.36	29.980	0.00	0.000	Dry.
BTR07	01/04/88	09:20	0.00	1098.39	46.030	0.00	0.000	Dry.
BTR07	02/09/88	09:40	0.00	1134.40	36.010	0.00	0.000	Dry.
BTR07	03/29/88	09:24	0.00	1183.39	48.990	0.00	0.000	Dry.
BTR07	07/12/88	10:30	0.00	1288.44	105.050	0.00	0.000	Dry.
BTR07	09/27/88	11:25	0.00	1365.48	77.040	0.00	0.000	Dry.
BTR07	12/02/88	12:44	0	1431.53	66.050	0.00	0.000	Dry. Sampler removed. Last time sampled for BSEP.

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Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTR08	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR08	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 3.1 ft deep, just above the orange band.
BTR08	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Installed suction probe and sealed opening.
BTR08	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Trace removed.
BTR08	03/06/86	11:40	00.12	429.486	3.087	0.12	0.039	
BTR08	03/13/86	11:00	00.04	436.458	6.972	0.16	0.006	
BTR08	03/26/86	11:30	00.05	449.479	13.021	0.21	0.004	
BTR08	04/02/86	10:45	00.02	456.448	6.969	0.23	0.003	
BTR08	04/08/86	10:53	00.02	462.453	6.005	0.25	0.003	
BTR08	04/16/86	13:00	Trace	470.542	8.089	0.25	0.000	Estimated 0.022 liters.
BTR08	04/24/86	11:05	00.02	478.462	16.009	0.27	0.001	
BTR08	04/30/86	12:20	00.01	484.514	6.052	0.28	0.002	
BTR08	05/06/86	11:00	00.01	490.458	5.944	0.29	0.002	
BTR08	05/13/86	10:35	00.01	497.441	6.983	0.30	0.001	
BTR08	05/20/86	11:30	00.01	504.479	7.038	0.31	0.001	
BTR08	05/27/86	12:15	00.03	511.510	7.031	0.34	0.004	
BTR08	06/03/86	11:25	00.01	518.476	6.966	0.35	0.001	
BTR08	06/10/86	12:25	00.02	525.517	7.041	0.37	0.003	
BTR08	06/17/86	11:35	00.03	532.483	6.966	0.40	0.004	
BTR08	06/24/86	12:05	00.03	539.503	7.020	0.43	0.004	
BTR08	07/01/86	11:30	00.02	546.479	6.976	0.45	0.003	
BTR08	07/08/86	11:44	00.02	553.489	7.010	0.47	0.003	
BTR08	07/16/86	11:59	00.03	561.499	8.010	0.50	0.004	
BTR08	07/22/86	11:00	00.03	567.458	5.959	0.53	0.005	
BTR08	07/29/86	11:41	00.03	574.487	7.029	0.56	0.004	
BTR08	08/05/86	12:08	00.03	581.506	7.019	0.59	0.004	
BTR08	08/12/86	09:30	00.03	588.396	6.890	0.62	0.004	
BTR08	08/19/86	12:34	00.04	595.524	7.128	0.66	0.006	
BTR08	08/26/86	12:07	00.06	602.505	6.981	0.72	0.009	
BTR08	09/04/86	12:05	00.14	611.503	8.998	0.86	0.016	
BTR08	09/09/86	12:30	00.10	616.521	5.018	0.96	0.020	
BTR08	09/16/86	11:26	00.11	623.476	6.955	1.07	0.016	
BTR08	09/23/86	11:45	00.11	630.490	7.014	1.18	0.016	
BTR08	10/01/86	08:30	00.11	638.354	7.864	1.29	0.014	
BTR08	10/08/86	13:55	00.08	645.580	7.226	1.37	0.011	
BTR08	10/14/86	10:00	NA	651.417	5.837	1.37	0.000	Pumped only, no collection.
BTR08	11/05/86	13:02	0.32	673.543	27.963	1.69	0.011	
BTR08	11/20/86	14:35	00.15	688.608	15.065	1.84	0.010	
BTR08	12/30/86	09:45	00.39	728.406	39.798	2.23	0.010	
BTR08	02/03/87	10:26	00.34	763.435	35.029	2.57	0.010	
BTR08	03/06/87	10:00	0.25	794.417	30.982	2.82	0.008	
BTR08	03/30/87	10:07	0.21	818.422	24.005	3.03	0.008	
BTR08	06/17/87	09:07	0.43	897.380	78.958	3.46	0.005	
BTR08	07/28/87	10:03	0.32	938.419	41.039	3.78	0.008	
BTR08	09/01/87	09:20	0.11	973.389	34.970	3.89	0.003	
BTR08	10/20/87	09:07	0.10	1022.38	48.991	3.99	0.002	
BTR08	11/19/87	08:45	0.08	1052.36	29.980	4.07	0.003	
BTR08	01/04/88	09:20	0.04	1098.39	46.030	4.11	0.001	
BTR08	02/09/88	09:40	0.05	1134.40	36.010	4.16	0.001	
BTR08	03/29/88	09:25	Trace	1183.39	48.990	4.16	0.000	
BTR08	07/12/88	10:50	0.00	1288.45	105.060	4.16	0.000	Dry.
BTR08	09/27/88	11:30	Trace	1365.48	77.030	4.16	0.000	
BTR08	12/02/88	12:45	0	1431.53	66.050	4.16	0.000	Dry. Sampler removed. Last time sampled for BSEP.

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BTR09	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR09	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 3.1 ft deep, just above the orange band.
BTR09	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Installed suction probe and sealed opening.
BTR09	03/04/86	09:35	00.01	427.399	1.000	0.01	0.000	First time sampled. Some brine left in hole.
BTR09	03/06/86	11:40	00.02	429.486	2.087	0.03	0.010	Salt crusts, some brine left in hole.
BTR09	03/13/86	11:00	00.08	436.458	6.972	0.11	0.011	Some brine left in hole.
BTR09	03/26/86	11:30	00.19	449.479	13.021	0.30	0.015	
BTR09	04/02/86	10:45	00.07	456.448	6.969	0.37	0.010	
BTR09	04/08/86	10:53	00.06	462.453	6.005	0.43	0.010	
BTR09	04/16/86	13:00	00.08	470.542	8.089	0.51	0.010	Some brine left in hole.
BTR09	04/24/86	11:30	00.08	478.479	7.937	0.59	0.010	
BTR09	04/30/86	12:20	00.07	484.514	6.035	0.66	0.012	
BTR09	05/06/86	11:37	00.07	490.484	5.970	0.73	0.012	
BTR09	05/13/86	10:45	00.06	497.448	6.964	0.79	0.009	
BTR09	05/20/86	11:30	00.05	504.479	7.031	0.84	0.007	
BTR09	05/27/86	12:15	00.06	511.510	7.031	0.90	0.009	
BTR09	06/03/86	11:30	00.05	518.479	6.969	0.95	0.007	
BTR09	06/10/86	12:25	00.07	525.517	7.038	1.02	0.010	
BTR09	06/17/86	11:40	00.07	532.486	6.969	1.09	0.010	
BTR09	06/24/86	12:10	00.07	539.507	7.021	1.16	0.010	
BTR09	07/01/86	11:40	00.08	546.486	6.979	1.24	0.011	
BTR09	07/08/86	11:46	00.07	553.490	7.004	1.31	0.010	
BTR09	07/16/86	12:00	00.08	561.500	8.010	1.39	0.010	
BTR09	07/22/86	11:00	00.06	567.458	5.958	1.45	0.010	
BTR09	07/29/86	11:42	00.07	574.488	7.030	1.52	0.010	
BTR09	08/05/86	12:09	00.08	581.506	7.018	1.60	0.011	
BTR09	08/12/86	09:30	00.07	588.396	6.890	1.67	0.010	
BTR09	08/19/86	12:35	Trace	595.524	7.128	1.67	0.000	Brine left in hole.
BTR09	08/26/86	12:08	00.13	602.506	14.110	1.80	0.009	One weeks collection.
BTR09	09/04/86	12:00	00.01	611.500	8.994	1.81	0.001	Brine left in hole.
BTR09	09/09/86	12:30	00.09	616.521	5.021	1.90	0.018	
BTR09	09/16/86	11:27	00.13	623.477	6.956	2.03	0.019	
BTR09	09/23/86	11:46	00.08	630.490	7.013	2.11	0.011	
BTR09	10/01/86	08:31	00.08	638.355	7.865	2.19	0.010	
BTR09	10/08/86	13:56	00.07	645.581	7.226	2.26	0.010	
BTR09	10/14/86	10:00	NA	651.417	5.836	2.26	0.000	Pumped only, no collection.
BTR09	11/05/86	13:03	0.25	673.544	27.963	2.51	0.009	
BTR09	11/20/86	14:35	00.11	688.608	15.064	2.62	0.007	
BTR09	12/30/86	09:46	00.27	728.407	39.799	2.89	0.007	
BTR09	02/03/87	10:25	00.21	763.434	35.027	3.10	0.006	
BTR09	03/06/87	10:00	0.15	794.417	30.983	3.25	0.005	
BTR09	03/30/87	10:08	0.12	818.422	24.025	3.37	0.005	
BTR09	06/17/87	09:08	0.28	897.381	78.939	3.65	0.004	
BTR09	07/28/87	10:02	0.11	938.418	41.037	3.76	0.003	
BTR09	09/01/87	09:22	0.11	973.390	34.972	3.87	0.003	
BTR09	10/20/87	09:08	0.12	1022.38	48.990	3.99	0.002	
BTR09	11/19/87	08:45	0.09	1052.36	29.980	4.08	0.003	
BTR09	12/16/87	10:00		1079.42	0.000	4.08	0.000	Hose and clamp for lysimeter are missing. Probably happened late 12/14/87 or on 12/16/87.
BTR09	01/04/88	09:20	0.00	1098.39	46.030	4.08	0.000	Dry. Installed new plug, old plug gone 12/13/87.
BTR09	02/09/88	09:45	0.03	1134.41	36.020	4.11	0.001	
BTR09	03/29/88	09:27	0.07	1183.39	48.980	4.18	0.001	
BTR09	07/12/88	10:50	0.06	1288.45	105.060	4.24	0.001	
BTR09	09/27/88	11:35	0.00	1365.48	77.030	4.24	0.000	Dry.
BTR09	12/02/88	12:46	0	1431.53	66.050	4.24	0.000	Dry. Sampler removed. Last time sampled for BSEP.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTR10	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR10	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 1.2 ft deep, approximately 2.5 ft above floor.
BTR10	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Installed suction probe and sealed opening.
BTR10	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Dry.
BTR10	03/06/86	11:40	NA	429.486	3.087	0.00	0.000	Damp.
BTR10	03/13/86	11:00	NA	436.458	10.059	0.00	0.000	Dry.
BTR10	03/26/86	11:30	NA	449.479	23.080	0.00	0.000	Dry.
BTR10	04/02/86	11:00	NA	456.458	30.059	0.00	0.000	
BTR10	04/08/86	10:53	NA	462.453	36.054	0.00	0.000	Dry.
BTR10	04/16/86	13:00	NA	470.542	44.143	0.00	0.000	Wet.
BTR10	04/24/86	11:30	NA	478.479	52.080	0.00	0.000	
BTR10	04/30/86	12:20	NA	484.514	58.115	0.00	0.000	Dry.
BTR10	05/06/86	11:37	NA	490.484	64.085	0.00	0.000	Dry.
BTR10	05/13/86	10:45	NA	497.448	71.049	0.00	0.000	Dry.
BTR10	05/20/86	11:30	NA	504.479	78.080	0.00	0.000	Dry
BTR10	05/27/86	12:15	NA	511.510	85.111	0.00	0.000	Dry.
BTR10	06/03/86	11:30	NA	518.479	92.080	0.00	0.000	Dry.
BTR10	06/10/86	12:30	NA	525.521	99.122	0.00	0.000	Dry.
BTR10	06/17/86	11:40	NA	532.486	106.087	0.00	0.000	
BTR10	06/24/86	12:10	NA	539.507	113.108	0.00	0.000	
BTR10	07/01/86	11:40	NA	546.486	6.979	0.00	0.000	Dry.
BTR10	07/08/86	11:48	NA	553.492	13.985	0.00	0.000	Dry.
BTR10	07/16/86	12:01	NA	561.501	21.994	0.00	0.000	Trace.
BTR10	07/22/86	11:00	NA	567.458	27.951	0.00	0.000	Dry.
BTR10	07/29/86	11:43	NA	574.488	34.981	0.00	0.000	Dry.
BTR10	08/05/86	12:10	NA	581.507	42.000	0.00	0.000	
BTR10	08/12/86	09:30	NA	588.396	48.889	0.00	0.000	Dry.
BTR10	08/19/86	12:36	NA	595.525	56.018	0.00	0.000	Dry.
BTR10	08/26/86	12:09	NA	602.506	62.999	0.00	0.000	Dry.
BTR10	09/04/86	12:05	NA	611.503	71.996	0.00	0.000	Dry.
BTR10	09/09/86	12:30	NA	616.521	77.014	0.00	0.000	Dry.
BTR10	09/16/86	11:27	NA	623.477	83.970	0.00	0.000	Dry.
BTR10	09/23/86	11:47	NA	630.491	90.984	0.00	0.000	Dry.
BTR10	10/01/86	08:32	NA	638.356	98.849	0.00	0.000	Dry.
BTR10	10/08/86	13:57	Dry.	645.581	106.074	0.00	0.000	Inside tube dry.
BTR10	10/14/86	10:00	NA	651.417	111.910	0.00	0.000	Pumped only, no collection.
BTR10	11/05/86	13:04	NA	673.544	134.037	0.00	0.000	Dry.
BTR10	11/20/86	14:36	NA	688.608	149.101	0.00	0.000	Dry.
BTR10	12/30/86	09:47	NA	728.408	188.901	0.00	0.000	Dry, no vacuum.
BTR10	03/06/87	09:55	NA	794.413	254.906	0.00	0.000	Dry, no vacuum.
BTR10	03/30/87	10:09	0.00	818.423	24.010	0.00	0.000	Dry.
BTR10	06/17/87	09:09	0.00	897.381	102.968	0.00	0.000	Dry.
BTR10	07/28/87	09:44	0.00	938.406	143.993	0.00	0.000	Dry.
BTR10	09/01/87	09:23	0.00	973.391	34.985	0.00	0.000	Dry.
BTR10	10/20/87	09:04	0.00	1022.38	48.989	0.00	0.000	Dry.
BTR10	11/19/87	08:45	0.00	1052.36	29.980	0.00	0.000	Dry.
BTR10	01/04/88	09:25	0.00	1098.39	46.030	0.00	0.000	Dry.
BTR10	02/09/88	09:45	0.00	1134.41	36.020	0.00	0.000	Dry.
BTR10	03/29/88	09:30	0.00	1183.40	48.990	0.00	0.000	Dry.
BTR10	07/12/88	10:50	0.00	1288.45	105.050	0.00	0.000	Dry.
BTR10	09/27/88	11:35	0.00	1365.48	77.030	0.00	0.000	Dry. No clamp.
BTR10	12/02/88	12:47	0	1431.53	66.050	0.00	0.000	Dry. Sampler removed. Last time sampled for BSEP

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BTR11	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR11	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 3.05 ft deep, approximately 2.5 ft above floor.
BTR11	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Installed suction probe and sealed opening.
BTR11	03/04/86	09:35	NA	427.399	1.000	0.00	0.000	Some brine accumulation at bottom.
BTR11	03/06/86	11:40	NA	429.486	3.087	0.00	0.000	Trace, estimated 0.005 liters.
BTR11	03/13/86	11:00	00.01	436.458	10.059	0.01	0.001	First time sampled.
BTR11	03/26/86	11:30	00.01	449.479	13.021	0.02	0.001	Trace.
BTR11	04/02/86	11:00	NA	456.458	6.979	0.02	0.000	Small accumulation of brine at bottom.
BTR11	04/08/86	10:59	00.01	462.458	12.979	0.03	0.001	
BTR11	04/16/86	13:00	Trace	470.542	8.084	0.03	0.000	
BTR11	04/24/86	11:30	Trace	478.479	16.021	0.03	0.000	
BTR11	04/30/86	12:20	NA	484.514	22.056	0.03	0.000	
BTR11	05/06/86	11:37	Trace	490.484	28.026	0.03	0.000	
BTR11	05/13/86	10:40	Trace	497.444	34.986	0.03	0.000	A few drops.
BTR11	05/20/86	11:30	Trace	504.479	42.021	0.03	0.000	
BTR11	05/27/86	12:15	00.05	511.510	49.052	0.08	0.001	
BTR11	06/03/86	11:35	Trace	518.483	6.973	0.08	0.000	
BTR11	06/10/86	12:30	Trace	525.521	14.011	0.08	0.000	
BTR11	06/17/86	11:40	Trace	532.486	20.976	0.08	0.000	
BTR11	06/24/86	12:10	Trace	539.507	27.997	0.08	0.000	A few drops.
BTR11	07/01/86	11:40	Trace	546.486	34.976	0.08	0.000	
BTR11	07/08/86	11:50	NA	553.493	41.983	0.08	0.000	Plug missing from collecting device.
BTR11	07/16/86	12:02	Trace	561.501	49.991	0.08	0.000	
BTR11	07/22/86	11:00	Trace	567.458	55.948	0.08	0.000	
BTR11	07/29/86	11:44	00.01	574.489	62.979	0.09	0.000	
BTR11	08/05/86	12:11	Trace	581.508	7.019	0.09	0.000	
BTR11	08/12/86	09:30	Trace	588.396	13.907	0.09	0.000	
BTR11	08/19/86	12:37	Trace	595.526	21.037	0.09	0.000	
BTR11	08/26/86	12:10	Trace	602.507	28.018	0.09	0.000	
BTR11	09/04/86	12:05	00.01	611.503	37.014	0.10	0.000	Trace.
BTR11	09/09/86	12:30	Trace	616.521	5.018	0.10	0.000	
BTR11	09/16/86	11:28	Trace	623.478	11.975	0.10	0.000	
BTR11	09/23/86	11:48	Trace	630.492	18.989	0.10	0.000	A few drops.
BTR11	10/01/86	08:33	Trace	638.356	26.853	0.10	0.000	
BTR11	10/08/86	13:58	Trace	645.582	34.079	0.10	0.000	Inside tube is damp.
BTR11	10/14/86	10:00	NA	651.417	39.914	0.10	0.000	Pumped only, no collection.
BTR11	11/05/86	13:05	Trace	673.545	62.042	0.10	0.000	Estimated 0.005 liters.
BTR11	11/20/86	14:37	NA	688.609	77.106	0.10	0.000	Trace.
BTR11	12/30/86	09:48	NA	728.408	116.905	0.10	0.000	Damp, no vacuum.
BTR11	03/06/87	09:55	NA	794.413	182.910	0.10	0.000	Dry, no vacuum.
BTR11	03/30/87	10:10	0.00	818.424	24.011	0.10	0.000	Dry.
BTR11	06/17/87	09:10	0.00	897.382	102.969	0.10	0.000	Dry.
BTR11	07/28/87	10:00	0.00	938.417	144.004	0.10	0.000	Dry.
BTR11	09/01/87	09:25	0.00	973.392	34.975	0.10	0.000	Dry.
BTR11	10/20/87	09:05	0.00	1022.38	48.988	0.10	0.000	Dry.
BTR11	11/19/87	08:50	0.00	1052.37	29.990	0.10	0.000	Dry.
BTR11	01/04/88	09:25	0.00	1098.39	46.020	0.10	0.000	Dry.
BTR11	02/09/88	09:45	0.00	1134.41	36.020	0.10	0.000	Dry.
BTR11	03/29/88	09:30	0.00	1183.40	48.990	0.10	0.000	Dry.
BTR11	07/12/88	10:50	0.00	1288.45	105.050	0.10	0.000	Dry.
BTR11	09/27/88	11:35	0.00	1365.48	77.030	0.10	0.000	Dry.
BTR11	12/02/88	12:48	0	1431.53	66.050	0.10	0.000	Dry. Sampler removed. Last time sampled for BSEP.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BTR12	01/31/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated.
BTR12	02/27/86	00:00	NA	0.000	0.000	0.00	0.000	Hole drilled in north rib, 3.05 ft deep, approximately 2.5 ft above floor.
BTR12	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Installed suction probe and sealed opening.
BTR12	03/04/86	10:30	NA	427.438	1.000	0.00	0.000	Some brine accumulation at bottom of hole.
BTR12	03/06/86	11:40	NA	429.486	3.048	0.00	0.000	Some brine accumulation.
BTR12	03/13/86	11:30	NA	436.479	10.041	0.00	0.000	Suction probe installed and sealed opening. Some brine in bottom of hole.
BTR12	03/26/86	11:30	00.01	449.479	23.041	0.01	0.000	First time sampled. Trace.
BTR12	04/02/86	11:00	NA	456.458	6.979	0.01	0.000	Small accumulation at bottom.
BTR12	04/08/86	10:53	NA	462.453	12.974	0.01	0.000	Brine at the bottom.
BTR12	04/16/86	13:35	NA	470.566	21.087	0.01	0.000	Left brine in hole.
BTR12	04/24/86	11:30	NA	478.479	29.000	0.01	0.000	
BTR12	04/30/86	12:20	NA	484.514	35.035	0.01	0.000	Wet.
BTR12	05/06/86	11:20	Trace	490.472	40.993	0.01	0.000	
BTR12	05/13/86	10:40	Trace	497.444	47.965	0.01	0.000	Three droplets only.
BTR12	05/20/86	11:30	Trace	504.479	55.000	0.01	0.000	
BTR12	05/27/86	12:15	Trace	511.510	62.031	0.01	0.000	
BTR12	06/03/86	11:35	Trace	518.483	69.004	0.01	0.000	A few drops.
BTR12	06/10/86	12:30	NA	525.521	76.042	0.01	0.000	Dry, plug had been removed.
BTR12	06/17/86	11:40	Trace	532.486	83.007	0.01	0.000	
BTR12	06/24/86	12:10	Trace	539.507	90.028	0.01	0.000	A few drops.
BTR12	07/01/86	11:40	NA	546.486	97.007	0.01	0.000	Dry.
BTR12	07/08/86	11:52	NA	553.494	104.015	0.01	0.000	Wet.
BTR12	07/16/86	12:03	Trace	561.502	112.023	0.01	0.000	Small pool at end of hole.
BTR12	07/22/86	11:00	NA	567.458	117.979	0.01	0.000	Damp.
BTR12	07/29/86	11:45	NA	574.490	125.011	0.01	0.000	Small pool at back.
BTR12	08/05/86	12:12	NA	581.508	132.029	0.01	0.000	Small pool at back.
BTR12	08/12/86	09:30	NA	588.396	138.917	0.01	0.000	Dry, not sealed.
BTR12	08/19/86	12:38	NA	595.526	146.047	0.01	0.000	Dry, no vacuum.
BTR12	08/26/86	12:11	NA	602.508	153.029	0.01	0.000	Not sealed, dry.
BTR12	09/04/86	12:05	Trace	611.503	162.024	0.01	0.000	A few drops.
BTR12	09/09/86	12:30	Trace	616.521	167.042	0.01	0.000	
BTR12	09/16/86	11:29	Trace	623.478	173.999	0.01	0.000	
BTR12	09/23/86	11:48	Trace	630.492	181.013	0.01	0.000	A few drops.
BTR12	10/01/86	08:34	Trace	638.357	188.878	0.01	0.000	
BTR12	10/08/86	13:59	Trace	645.583	196.104	0.01	0.000	Inside of tube is damp.
BTR12	10/14/86	10:00	NA	651.417	201.938	0.01	0.000	Pumped only, no collection.
BTR12	11/05/86	13:06	Trace	673.546	224.067	0.01	0.000	Estimated 0.001 liters.
BTR12	11/20/86	14:38	00.00	688.610	239.131	0.01	0.000	Trace.
BTR12	12/30/86	09:47	NA	728.408	39.798	0.01	0.000	Damp, no vacuum.
BTR12	03/06/87	10:00	NA	794.417	105.807	0.01	0.000	Dry, no vacuum.
BTR12	03/30/87	10:11	0.00	818.424	24.007	0.01	0.000	Dry.
BTR12	06/17/87	09:11	0.00	897.383	102.966	0.01	0.000	Dry.
BTR12	07/28/87	10:01	0.00	938.417	144.000	0.01	0.000	Dry.
BTR12	09/01/87	09:30	0.00	973.396	34.979	0.01	0.000	Dry.
BTR12	10/20/87	09:06	0.00	1022.38	48.984	0.01	0.000	Dry.
BTR12	11/19/87	08:50	0.00	1052.37	29.990	0.01	0.000	Dry.
BTR12	01/04/88	09:25	0.00	1098.39	46.020	0.01	0.000	Dry.
BTR12	02/09/88	09:50	0.00	1134.41	36.020	0.01	0.000	Dry.
BTR12	03/29/88	09:30	0.00	1183.40	48.990	0.01	0.000	Dry.
BTR12	07/12/88	10:50	0.00	1288.45	105.050	0.01	0.000	Dry.
BTR12	09/27/88	11:35	0.00	1365.48	77.030	0.01	0.000	Dry.
BTR12	12/02/88	12:49	0	1431.53	66.050	0.01	0.000	Dry. Sampler removed. Last time sampled for BSEP.

WIPP BRINE SAMPLING AND EVALUATION PROGRAM
Appendix A for the 1988 BSEP Report
Data through December 31, 1988

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BX01	06/02/84	00:00	NA	0.000	0.000	0.00	0.000	Room B completed.
BX01	01/27/85	00:00	NA	0.000	1.000	0.00	0.000	Downhole drilled 1/24/85 to 1/27/85. Wet core and brine encountered 1/26/85 at 35 to 36.5 feet.
BX01	02/05/85	11:00	00.39	35.458	11.041	0.39	0.035	First time collected.
BX01	02/11/85	12:00	00.72	41.500	6.042	1.11	0.119	
BX01	02/19/85	13:00	00.70	49.542	8.042	1.81	0.087	
BX01	02/26/85	12:45	00.61	56.531	6.989	2.42	0.087	
BX01	03/07/85	09:15	00.70	65.385	8.854	3.12	0.079	
BX01	03/12/85	11:45	00.41	70.490	5.105	3.53	0.080	
BX01	03/20/85	12:50	00.61	78.535	8.045	4.14	0.076	
BX01	03/26/85	10:45	00.45	84.448	5.913	4.59	0.076	
BX01	04/02/85	11:44	00.51	91.489	7.041	5.10	0.072	
BX01	04/10/85	11:38	00.55	99.485	7.996	5.65	0.069	
BX01	04/17/85	11:00	00.45	106.458	6.973	6.10	0.065	
BX01	04/23/85	10:05	00.38	112.420	5.962	6.48	0.064	Room B heaters turned on 4/23/85.
BX01	05/01/85	11:40	00.46	120.486	8.066	6.94	0.057	
BX01	06/04/85	09:30	02.00	154.396	33.910	8.94	0.059	First check in several weeks.
BX01	07/16/85	10:15	02.34	196.427	42.031	11.28	0.056	Brine effervesces.
BX01	08/26/85	13:56	02.38	237.581	41.154	13.66	0.058	Room temp. 98 degrees F. at collar, l03 F. in center of room.
BX01	10/08/85	12:00	02.27	280.500	42.919	15.93	0.053	
BX01	11/21/85	10:05	02.42	324.420	43.920	18.35	0.055	
BX01	12/04/85	13:35	00.69	337.566	13.146	19.04	0.052	
BX01	01/31/86	10:25	02.95	395.434	57.868	21.99	0.051	
BX01	02/12/86	09:30	00.80	407.396	11.962	22.79	0.067	
BX01	04/16/86	11:00	03.45	470.458	63.062	26.24	0.055	
BX01	04/30/86	09:45	00.73	484.406	13.948	26.97	0.052	
BX01	05/06/86	09:18	00.30	490.387	5.981	27.27	0.050	
BX01	06/10/86	10:20	01.85	525.431	35.044	29.12	0.053	
BX01	08/19/86	10:50	03.21	595.451	70.020	32.33	0.046	
BX01	09/09/86	11:00	01.30	616.458	21.007	33.63	0.062	
BX01	10/01/86	11:08	01.16	638.464	22.006	34.79	0.053	
BX01	11/05/86	10:00	NA	673.417	34.953	34.79	0.000	Not collected.
BX01	11/20/86	10:39	02.40	688.444	49.980	37.19	0.048	
BX01	12/30/86	14:10	01.75	728.590	40.146	38.94	0.044	
BX01	02/03/87	11:00	01.67	763.458	34.868	40.61	0.048	
BX01	03/06/87	11:50	NA	794.493	31.035	40.61	0.000	Room closed, bad back, not sampled.
BX01	10/20/87			1022.00	0.000	40.61	0.000	Room closed, could not sample. No calculation.
BX01	11/16/87	11:10	12.86	1049.47	286.012	53.47	0.045	
BX01	01/04/88			1098.00	0.000	53.47	0.000	Could not sample. Room closed.
BX01	02/08/88	12:35	3.71	1133.52	84.050	57.18	0.044	
BX01	03/29/88	12:00	2.30	1183.50	49.980	59.48	0.046	
BX01	05/12/88	10:44	1.67	1227.45	43.950	61.15	0.038	
BX01	07/12/88	09:50	2.23	1288.41	60.960	63.38	0.037	
BX01	09/27/88	08:00	2.61	1365.33	76.920	65.99	0.034	
BX01	12/13/88	09:00	0	1442.38	0.000	65.99	0.000	Could not sample. Room locked.

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Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
BX02	06/02/84	00:00	NA	0.000	0.000	0.00	0.000	Room B completed.
BX02	02/01/85	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 1/29/85 to 2/01/85.
BX02	02/05/85	11:00	NA	35.458	1.000	0.00	0.000	No drips noticed.
BX02	02/19/85	13:00	NA	49.542	15.084	0.00	0.000	Tubing plugged.
BX02	03/12/85	11:45	NA	70.490	36.032	0.00	0.000	Trace, few drops in jug.
BX02	03/20/85	12:50	00.10	78.535	44.077	0.10	0.002	
BX02	03/26/85	10:45	00.12	84.448	5.913	0.22	0.020	
BX02	04/02/85	11:44	00.10	91.489	7.041	0.32	0.014	
BX02	04/10/85	11:38	00.21	99.485	7.996	0.53	0.026	
BX02	04/17/85	11:00	00.13	106.458	6.973	0.66	0.019	
BX02	04/23/85	10:05	00.01	112.420	5.962	0.67	0.002	Room B heaters turned on 4/23/85. Low reading probably due to partial blockage of collecting tube.
BX02	05/01/85	11:31	00.12	120.480	8.060	0.79	0.015	
BX02	06/04/85	09:25	00.50	154.392	33.912	1.29	0.015	First check in several weeks.
BX02	07/16/85	10:00	00.16	196.417	42.025	1.45	0.004	Changed funnel.
BX02	10/08/85	12:00	00.04	280.500	84.083	1.49	0.000	
BX02	01/17/86	09:00	00.26	381.375	100.875	1.75	0.003	Changed funnel.
BX02	01/31/86	10:15	NA	395.427	14.052	1.75	0.000	
BX02	04/16/86	11:00	NA	470.458	89.083	1.75	0.000	Trace in plastic tube, salt buildup in tube and container.
BX02	08/19/86	10:50	NA	595.451	214.076	1.75	0.000	Dry.
BX02	10/01/86	11:05	00.00	638.462	257.087	1.75	0.000	Dry.
BX02	11/05/86	10:00	NA	673.417	34.955	1.75	0.000	Dry.
BX02	11/20/86	10:37	NA	688.442	49.980	1.75	0.000	Dry.
BX02	12/30/86	14:05	NA	728.587	90.125	1.75	0.000	Dry.
BX02	02/03/87	NA:	NA	763.000	125.538	1.75	0.000	
BX02	03/06/87	11:50	NA	794.493	156.031	1.75	0.000	Room closed, bad back, not sampled.
BX02	10/20/87			1022.00	0.000	1.75	0.000	Room closed, could not sample. No calculation.
BX02	11/16/87	11:10		1049.47	0.000	1.75	0.000	Funnel not hooked up. No collection, no calculation.
BX02	01/04/88			1098.00	0.000	1.75	0.000	Could not sample. Room closed.
BX02	02/08/88	12:35	0.00	1133.52	370.520	1.75	0.000	Dry.
BX02	03/30/88	12:00	0.00	1184.50	50.980	1.75	0.000	Dry.
BX02	07/12/88	09:55	0.00	1288.41	103.910	1.75	0.000	Dry.
BX02	09/27/88	08:10	0.00	1365.34	76.930	1.75	0.000	Dry.
BX02	12/13/88	09:00	0	1442.38	0.000	0.00	0.000	Could not sample. Room locked.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
DH15	03/13/84	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated at N1104/E1688.5.
DH15	03/21/84	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 3/20/84 to 3/21/84.
DH15	05/20/86	00:00	NA	0.000	0.000	0.00	0.000	Collecting funnel and container installed.
DH15	05/27/86	15:00	NA	511.625	1.000	0.00	0.000	Trace of brine. First time collected.
DH15	06/03/86	09:15	00.02	518.385	7.760	0.02	0.003	
DH15	06/10/86	10:40	00.04	525.444	7.059	0.06	0.006	
DH15	06/17/86	09:45	00.03	532.406	6.962	0.09	0.004	
DH15	06/24/86	10:00	00.05	539.417	7.011	0.14	0.007	Lots of clay has fallen down hole and accumulated in collecting container.
DH15	07/01/86	12:30	00.05	546.521	7.104	0.19	0.007	
DH15	07/08/86	09:50	00.05	553.410	6.889	0.24	0.007	
DH15	07/16/86	09:40	00.06	561.403	7.993	0.30	0.008	
DH15	07/22/86	09:15	00.05	567.385	5.982	0.35	0.008	Clay in collecting container.
DH15	07/29/86	09:55	00.05	574.413	7.028	0.40	0.007	
DH15	08/05/86	10:20	00.05	581.431	7.018	0.45	0.007	
DH15	08/12/86	09:45	00.05	588.406	6.975	0.50	0.007	
DH15	08/19/86	10:20	00.05	595.431	7.025	0.55	0.007	
DH15	08/26/86	10:00	00.05	602.417	6.986	0.60	0.007	
DH15	09/04/86	09:50	00.06	611.410	8.993	0.66	0.007	
DH15	09/09/86	11:00	00.03	616.458	5.048	0.69	0.006	
DH15	09/16/86	09:25	00.05	623.392	6.934	0.74	0.007	
DH15	09/23/86	09:30	00.06	630.396	7.004	0.80	0.009	
DH15	10/01/86	11:29	00.06	638.478	8.082	0.86	0.007	
DH15	11/05/86	10:15	0.22	673.427	34.949	1.08	0.006	
DH15	11/20/86	11:28	00.07	688.478	15.051	1.15	0.005	
DH15	12/31/86	11:37	00.18	729.484	41.006	1.33	0.004	
DH15	03/30/87	12:02	0.41	818.501	89.017	1.74	0.005	
DH15	05/07/87	10:22	0.17	856.432	37.931	1.91	0.004	
DH15	06/17/87	11:20	0.21	897.472	41.040	2.12	0.005	
DH15	07/28/87	12:07	0.14	938.505	41.033	2.26	0.003	
DH15	09/01/87	11:35	0.13	973.483	34.978	2.39	0.004	
DH15	09/16/87	10:00		988.417	0.000	2.39	0.000	0.05 liter in jar not removed. No calculation.
DH15	10/20/87	10:45	0.29	1022.45	48.967	2.68	0.006	
DH15	11/19/87	10:15	0.15	1052.43	29.980	2.83	0.005	
DH15	01/04/88	11:00	0.23	1098.46	46.030	3.06	0.005	
DH15	02/08/88	12:40	0.09	1133.53	35.070	3.15	0.003	
DH15	03/30/88	12:10	0.15	1184.51	50.980	3.30	0.003	
DH15	07/12/88	09:50	0.21	1288.41	103.900	3.51	0.002	
DH15	09/27/88	08:20	0.00	1365.35	76.940	3.51	0.000	Dry.
DH15	12/13/88	09:20	0	1442.39	77.040	3.51	0.000	Dry.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
DH35	11/21/84	00:00	NA	0.000	0.000	0.00	0.000	Approximate date this part of Room G was excavated.
DH35	01/27/85	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 1/26/85 to 1/27/85.
DH35	02/05/85	11:15	NA	35.469	1.000	0.00	0.000	Started to drip.
DH35	03/05/85	10:00	00.19	63.417	28.948	0.19	0.007	Salt crystals in container. First time collected.
DH35	03/12/85	10:00	00.17	70.417	7.000	0.36	0.024	Salt crystals in container.
DH35	03/20/85	10:26	00.19	78.435	8.018	0.55	0.024	
DH35	03/26/85	09:45	00.13	84.406	5.971	0.68	0.022	
DH35	04/02/85	10:15	00.15	91.427	7.021	0.83	0.021	Salt crystals in container.
DH35	04/10/85	10:14	00.19	99.426	7.999	1.02	0.024	
DH35	04/23/85	11:46	00.12	112.490	13.064	1.14	0.009	
DH35	04/30/85	11:09	00.16	119.465	6.975	1.30	0.023	Clay in container.
DH35	05/07/85	09:53	00.14	126.412	6.947	1.44	0.020	
DH35	05/14/85	10:48	00.16	133.450	7.038	1.60	0.023	
DH35	05/21/85	10:42	00.15	140.446	6.996	1.75	0.021	
DH35	05/29/85	10:00	00.15	148.417	7.971	1.90	0.019	
DH35	06/11/85	10:10	00.02	161.424	13.007	1.92	0.002	
DH35	07/09/85	11:10	00.06	189.465	28.041	1.98	0.002	
DH35	07/16/85	11:48	00.13	196.492	7.027	2.11	0.019	
DH35	07/24/85	10:37	00.12	204.442	7.950	2.23	0.015	
DH35	07/30/85	10:17	00.08	210.428	5.986	2.31	0.013	Clay in container.
DH35	08/06/85	10:37	00.08	217.442	7.014	2.39	0.011	Clay chunks in container.
DH35	08/14/85	10:53	00.11	225.453	8.011	2.50	0.014	
DH35	08/20/85	11:05	00.09	231.462	6.009	2.59	0.015	
DH35	08/28/85	10:00	00.14	239.417	7.955	2.73	0.018	
DH35	09/04/85	10:30	00.11	246.438	7.021	2.84	0.016	
DH35	09/10/85	10:38	00.11	252.443	6.005	2.95	0.018	
DH35	09/17/85	09:40	00.12	259.403	6.960	3.07	0.017	
DH35	09/24/85	09:48	00.07	266.408	7.005	3.14	0.010	
DH35	10/08/85	10:44	00.08	280.447	14.039	3.22	0.006	
DH35	10/15/85	10:17	00.06	287.428	6.981	3.28	0.009	
DH35	10/29/85	09:42	00.06	301.404	13.976	3.34	0.004	
DH35	11/05/85	09:24	00.08	308.392	6.988	3.42	0.011	
DH35	11/13/85	10:06	00.11	316.421	8.029	3.53	0.014	
DH35	11/21/85	11:32	00.07	324.481	8.060	3.60	0.009	
DH35	11/26/85	11:25	00.05	329.476	4.995	3.65	0.010	Changed collecting container.
DH35	01/23/86	10:40	00.06	387.444	57.968	3.71	0.001	Clay in collecting container. Entry has been restricted since 12/10/85 due to mining activities.
DH35	01/31/86	12:16	00.06	395.511	8.067	3.77	0.007	
DH35	02/12/86	10:55	00.09	407.455	11.944	3.86	0.008	
DH35	02/19/86	11:45	00.07	414.490	7.035	3.93	0.010	
DH35	02/28/86	13:20	00.06	423.556	9.066	3.99	0.007	
DH35	03/06/86	10:45	00.03	429.448	5.892	4.02	0.005	
DH35	03/13/86	10:10	00.07	436.424	6.976	4.09	0.010	
DH35	03/26/86	10:20	NA	449.431	13.007	4.09	0.000	Funnel broken, 5 inch stalactite formed from collar.
DH35	04/02/86	09:40	NA	456.403	19.979	4.09	0.000	Installed new funnel.
DH35	05/27/86	15:45	NA	511.656	75.232	4.09	0.000	Trace of brine.
DH35	06/03/86	10:08	00.01	518.422	81.998	4.10	0.000	
DH35	06/10/86	11:35	00.02	525.483	7.061	4.12	0.003	
DH35	06/17/86	10:58	00.01	532.457	6.974	4.13	0.001	
DH35	06/24/86	10:57	00.02	539.456	6.999	4.15	0.003	
DH35	07/01/86	14:03	00.02	546.585	7.129	4.17	0.003	
DH35	07/08/86	10:37	00.02	553.442	6.857	4.19	0.003	
DH35	07/16/86	10:36	00.03	561.442	8.000	4.22	0.004	
DH35	07/22/86	10:05	NA	567.420	5.978	4.22	0.000	Trace of brine. Cleaned soft clay out of funnel.
DH35	07/29/86	10:35	00.01	574.441	12.999	4.23	0.001	
DH35	08/05/86	11:13	00.03	581.467	7.026	4.26	0.004	
DH35	08/12/86	10:35	00.03	588.441	6.974	4.29	0.004	
DH35	08/19/86	11:35	00.01	595.483	7.042	4.30	0.001	
DH35	08/26/86	10:38	NA	602.443	6.960	4.30	0.000	Trace collected.
DH35	09/04/86	10:40	00.01	611.444	15.961	4.31	0.001	
DH35	09/09/86	10:10	NA	616.424	4.980	4.31	0.000	Trace collected.
DH35	09/16/86	10:13	NA	623.426	11.982	4.31	0.000	Trace collected.
DH35	09/23/86	10:11	NA	630.424	18.980	4.31	0.000	Trace.
DH35	10/01/86	12:16	00.00	638.511	27.067	4.31	0.000	Trace, none collected.
DH35	10/08/86	11:08	NA	645.464	6.953	4.31	0.000	Small amount not collected.
DH35	11/05/86	11:28	NA	673.478	28.014	4.31	0.000	Damp, not collected.
DH35	11/20/86	NA:	NA	688.000	42.536	4.31	0.000	Not sampled, looked dry.

DH35	12/30/86	12:15	NA	728.510	83.046	4.31	0.000	
DH35	02/03/87	NA:	NA	763.000	117.536	4.31	0.000	
DH35	03/06/87	11:25	NA	794.476	149.012	4.31	0.000	Dry.
DH35	03/30/87	11:20	0.00	818.472	23.996	4.31	0.000	Dry.
DH35	05/07/87	11:35	0.00	856.483	62.007	4.31	0.000	Dry.
DH35	06/18/87	12:10	0.00	898.507	104.031	4.31	0.000	Dry.
DH35	07/28/87	11:15	0.00	938.469	143.993	4.31	0.000	Dry.
DH35	09/01/87	10:50	0.00	973.451	34.982	4.31	0.000	Dry.
DH35	10/20/87	11:56	0.00	1022.50	49.049	4.31	0.000	Dry.
DH35	11/19/87	11:30	0.00	1052.48	29.980	4.31	0.000	Dry.
DH35	01/04/88	12:00	0.00	1098.50	46.020	4.31	0.000	Dry.
DH35	02/08/88	11:55	0.00	1133.50	35.000	4.31	0.000	Dry.
DH35	03/29/88	11:40	0.00	1183.49	49.990	4.31	0.000	Dry.
DH35	07/12/88	08:50	0.00	1288.37	104.880	4.31	0.000	Dry.
DH35	09/27/88	10:50	0.00	1365.45	77.080	4.31	0.000	Dry.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
DH36	11/21/84	00:00	NA	0.000	0.000	0.00	0.000	Approximate date this part of Room G excavated.
DH36	01/26/85	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 1/26/85.
DH36	01/28/85	09:00	NA	27.375	1.000	0.00	0.000	Moist muck at the bottom.
DH36	02/05/85	11:15	02.50	35.469	9.094	2.50	0.275	About 1 ft. muck, brine and hydraulic fluid. First time bailed.
DH36	02/11/85	11:00	01.51	41.458	5.989	4.01	0.252	Brine, muck, hydraulic fluid.
DH36	02/19/85	12:10	01.78	49.507	8.049	5.79	0.221	Some muck.
DH36	02/26/85	10:45	01.48	56.448	6.941	7.27	0.213	Brine and muck.
DH36	03/05/85	10:00	01.76	63.417	6.969	9.03	0.253	
DH36	03/12/85	10:00	01.55	70.417	7.000	10.58	0.221	
DH36	03/20/85	10:26	01.59	78.435	8.018	12.17	0.198	
DH36	03/26/85	09:45	01.35	84.406	5.971	13.52	0.226	
DH36	04/02/85	10:15	01.58	91.427	7.021	15.10	0.225	
DH36	04/10/85	10:25	01.71	99.434	8.007	16.81	0.214	
DH36	04/17/85	13:30	01.49	106.562	7.128	18.30	0.209	
DH36	04/23/85	11:46	01.45	112.490	5.928	19.75	0.245	
DH36	04/30/85	11:21	01.49	119.473	6.983	21.24	0.213	
DH36	05/07/85	09:58	01.55	126.415	6.942	22.79	0.223	
DH36	05/14/85	10:54	01.77	133.454	7.039	24.56	0.251	
DH36	05/21/85	10:45	01.61	140.448	6.994	26.17	0.230	
DH36	05/29/85	10:00	01.50	148.417	7.969	27.67	0.188	
DH36	06/04/85	11:33	01.40	154.481	6.064	29.07	0.231	
DH36	06/11/85	11:15	01.55	161.469	6.988	30.62	0.222	
DH36	06/18/85	10:17	01.58	168.428	6.959	32.20	0.227	
DH36	06/25/85	10:40	01.43	175.444	7.016	33.63	0.204	
DH36	07/02/85	11:00	01.59	182.458	7.014	35.22	0.227	
DH36	07/09/85	11:15	01.54	189.469	7.011	36.76	0.220	
DH36	07/16/85	11:50	01.58	196.493	7.024	38.34	0.225	Brine effervesces.
DH36	07/24/85	10:46	01.78	204.449	7.956	40.12	0.224	
DH36	07/30/85	10:20	01.39	210.431	5.982	41.51	0.232	
DH36	08/06/85	10:43	01.70	217.447	7.016	43.21	0.242	
DH36	08/14/85	11:02	01.58	225.460	8.013	44.79	0.197	Valve leaked, some brine drained back down hole.
DH36	08/20/85	11:11	01.42	231.466	6.006	46.21	0.236	
DH36	08/28/85	10:00	01.94	239.417	7.951	48.15	0.244	
DH36	09/04/85	10:32	01.69	246.439	7.022	49.84	0.241	
DH36	09/10/85	10:35	01.41	252.441	6.002	51.25	0.235	
DH36	09/17/85	09:42	01.53	259.404	6.963	52.78	0.220	
DH36	09/24/85	09:50	01.53	266.410	7.006	54.31	0.218	
DH36	10/01/85	09:55	01.58	273.413	7.003	55.89	0.226	
DH36	10/08/85	10:52	01.63	280.453	7.040	57.52	0.232	
DH36	10/15/85	10:30	01.58	287.438	6.985	59.10	0.226	
DH36	10/23/85	10:23	01.82	295.433	7.995	60.92	0.228	
DH36	10/29/85	09:51	01.36	301.410	5.977	62.28	0.228	
DH36	11/05/85	09:27	01.63	308.394	6.984	63.91	0.233	
DH36	11/13/85	10:14	01.79	316.426	8.032	65.70	0.223	
DH36	11/21/85	11:36	01.91	324.483	8.057	67.61	0.237	
DH36	11/26/85	11:30	01.01	329.479	4.996	68.62	0.202	
DH36	12/03/85	13:35	01.50	336.566	7.087	70.12	0.212	
DH36	12/10/85	12:15	01.52	343.510	6.944	71.64	0.219	
DH36	01/23/86	11:00	09.30	387.458	43.948	80.94	0.212	Entry restricted since 12/10/85 due to mining activities.
DH36	01/31/86	12:20	01.38	395.514	8.056	82.32	0.171	
DH36	02/12/86	11:00	03.02	407.458	11.944	85.34	0.253	
DH36	02/19/86	11:45	01.55	414.490	7.032	86.89	0.220	
DH36	02/28/86	13:20	01.85	423.556	9.066	88.74	0.204	
DH36	03/06/86	10:45	01.30	429.448	5.892	90.04	0.221	Volume was estimated.
DH36	03/13/86	10:10	01.50	436.424	6.976	91.54	0.215	
DH36	03/26/86	10:20	02.56	449.431	13.007	94.10	0.197	
DH36	04/02/86	09:40	01.75	456.403	6.972	95.85	0.251	
DH36	04/08/86	09:45	00.97	462.406	6.003	96.82	0.162	
DH36	04/16/86	12:25	01.65	470.517	8.111	98.47	0.203	
DH36	04/24/86	10:20	02.00	478.431	7.914	100.47	0.253	
DH36	04/30/86	10:55	01.21	484.455	6.024	101.68	0.201	
DH36	05/06/86	10:14	01.20	490.426	5.971	102.88	0.201	
DH36	05/13/86	11:13	01.42	497.467	7.041	104.30	0.202	
DH36	05/20/86	11:10	01.50	504.465	6.998	105.80	0.214	
DH36	05/27/86	15:45	01.40	511.656	7.191	107.20	0.195	
DH36	06/03/86	10:10	01.38	518.424	6.768	108.58	0.204	
DH36	06/10/86	11:35	01.24	525.483	7.059	109.82	0.176	Valve leaked, some brine drained back down hole.

DH36	06/17/86	11:00	01.65	532.458	6.975	111.47	0.237	
DH36	06/24/86	11:00	01.45	539.458	7.000	112.92	0.207	
DH36	07/01/86	14:05	01.55	546.587	7.129	114.47	0.217	
DH36	07/08/86	10:45	01.40	553.448	6.861	115.87	0.204	
DH36	07/16/86	10:45	01.76	561.448	8.000	117.63	0.220	
DH36	07/22/86	10:07	01.29	567.422	5.974	118.92	0.216	
DH36	07/29/86	10:40	01.45	574.444	7.022	120.37	0.206	
DH36	08/05/86	11:20	01.46	581.472	7.028	121.83	0.208	
DH36	08/12/86	10:37	01.50	588.442	6.970	123.33	0.215	
DH36	08/19/86	11:35	01.38	595.483	7.041	124.71	0.196	
DH36	08/26/86	10:38	01.49	602.443	6.960	126.20	0.214	Static level not measured.
DH36	09/04/86	10:41	01.70	611.445	9.002	127.90	0.189	
DH36	09/09/86	10:15	01.20	616.427	4.982	129.10	0.241	
DH36	09/16/86	10:20	01.37	623.431	7.004	130.47	0.196	
DH36	09/23/86	10:18	01.40	630.429	6.998	131.87	0.200	
DH36	10/01/86	12:18	01.76	638.513	8.084	133.63	0.218	
DH36	10/08/86	11:10	01.44	645.465	6.952	135.07	0.207	Brine efferveces as it is poured into beaker.
DH36	10/14/86	11:57	01.21	651.498	6.033	136.28	0.201	Static level not measured.
DH36	11/05/86	11:38	4.28	673.485	21.987	140.56	0.195	
DH36	11/20/86	12:35	03.12	688.524	15.039	143.68	0.207	
DH36	12/30/86	12:25	01.72	728.517	0.000	143.68	0.000	Partial evacuation. No calculation. Do not plot or use zero value.
DH36	12/31/86	12:38	6.54	729.526	41.002	151.94	0.201	Calculated using 8.26 liters in 41.002 days (1.72 l. 12/30/86 plus 6.54 l. 12/31/86).
DH36	02/03/87	13:35	06.84	763.566	34.040	158.78	0.201	
DH36	03/06/87	11:20	5.84	794.472	30.906	164.62	0.189	
DH36	03/30/87	11:27	4.95	818.477	24.005	175.41	0.198	
DH36	05/07/87	11:33	6.62	856.481	38.004	182.03	0.174	
DH36	06/17/87	10:45	7.25	897.448	0.000	189.28	0.000	Some brine left in hole, no calculation.
DH36	06/18/87	12:10	0.49	898.507	42.026	189.77	0.184	Original l/day calculation too high due to residual brine left in hole. Recalculated using 7.74 l (7.25 l 6/17/87 plus 0.49 l 6/18/87).
DH36	07/28/87	11:27	7.76	938.477	39.970	197.53	0.194	
DH36	09/01/87	10:50	6.99	973.451	34.974	204.52	0.200	
DH36	10/20/87	11:56	8.58	1022.50	49.049	213.10	0.175	
DH36	11/19/87	11:30	4.19	1052.48	29.980	217.29	0.140	
DH36	01/04/88	11:50	6.74	1098.49	46.010	224.03	0.146	
DH36	02/08/88	11:50	4.90	1133.49	35.000	228.93	0.140	
DH36	03/29/88	11:35	7.25	1183.48	49.990	236.18	0.145	
DH36	05/05/88	09:45	5.01	1220.41	36.930	241.19	0.136	
DH36	05/12/88	09:50	1.30	1227.41	7.000	242.49	0.186	
DH36	07/12/88	08:50	7.90	1288.37	60.960	250.39	0.130	
DH36	07/28/88	10:25	1.50	1304.43	16.060	251.89	0.093	
DH36	08/11/88	10:30	3.66	1318.44	14.010	255.55	0.261	
DH36	08/25/88	09:24	2.05	1332.39	13.950	257.60	0.147	
DH36	09/08/88	14:50		1346.62	0.000	257.60	0.000	Did not sample.
DH36	09/14/88	08:40	2.36	1352.36	19.970	259.96	0.118	Slight orange color.
DH36	09/27/88	10:45	1.30	1365.45	13.090	261.26	0.099	
DH36	12/13/88	10:00	10.63	1442.42	76.970	271.89	0.138	

WIPP BRINE SAMPLING AND EVALUATION PROGRAM
Appendix A for the 1988 BSEP Report
Data through December 31, 1988

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
DH37	12/05/84	00:00	NA	0.000	0.000	0.00	0.000	Approximate date this part of Room G excavated.
DH37	01/26/85	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 1/25/85 to 1/26/85.
DH37	02/05/85	11:15	NA	35.469	1.000	0.00	0.000	Started to drip.
DH37	03/05/85	10:10	00.06	63.424	28.955	0.06	0.002	Stalactite in collecting container.
DH37	03/12/85	10:00	00.06	70.417	6.993	0.12	0.009	Salt crystals in collecting container.
DH37	03/26/85	09:50	NA	84.410	13.993	0.12	0.000	Trace, none collected.
DH37	04/17/85	13:30	00.06	106.562	36.145	0.18	0.002	
DH37	04/23/85	11:41	00.04	112.487	5.925	0.22	0.007	
DH37	04/30/85	10:50	00.03	119.451	6.964	0.25	0.004	
DH37	05/07/85	09:45	00.06	126.406	6.955	0.31	0.009	
DH37	05/14/85	10:37	00.07	133.442	7.036	0.38	0.010	
DH37	05/21/85	10:31	00.06	140.438	6.996	0.44	0.009	
DH37	05/29/85	10:00	00.06	148.417	7.979	0.50	0.008	
DH37	06/04/85	11:22	00.05	154.474	6.057	0.55	0.008	
DH37	06/11/85	10:32	00.05	161.439	6.965	0.60	0.007	
DH37	06/18/85	10:05	00.08	168.420	6.981	0.68	0.011	Stalactites in collecting container.
DH37	06/25/85	10:44	00.05	175.447	7.027	0.73	0.007	
DH37	07/02/85	11:00	00.04	182.458	7.011	0.77	0.006	
DH37	07/09/85	11:00	00.03	189.458	7.000	0.80	0.004	
DH37	07/16/85	11:40	00.06	196.486	7.028	0.86	0.009	
DH37	07/24/85	10:33	00.06	204.440	7.954	0.92	0.008	
DH37	07/30/85	10:11	00.02	210.424	5.984	0.94	0.003	
DH37	08/06/85	10:32	00.01	217.439	7.015	0.95	0.001	
DH37	08/14/85	10:49	00.02	225.451	8.012	0.97	0.002	
DH37	08/20/85	10:56	00.03	231.456	6.005	1.00	0.005	
DH37	08/28/85	09:55	00.04	239.413	7.957	1.04	0.005	
DH37	09/04/85	10:21	00.02	246.431	7.018	1.06	0.003	
DH37	09/10/85	10:14	00.03	252.426	5.995	1.09	0.005	
DH37	09/17/85	09:35	00.02	259.399	6.973	1.11	0.003	
DH37	09/24/85	09:45	00.02	266.406	7.007	1.13	0.003	
DH37	10/01/85	09:50	00.01	273.410	7.004	1.14	0.001	
DH37	10/15/85	10:10	00.01	287.424	14.014	1.15	0.001	
DH37	10/23/85	10:17	00.02	295.428	8.004	1.17	0.002	
DH37	10/29/85	09:35	00.02	301.399	5.971	1.19	0.003	
DH37	07/01/86	14:00	00.02	546.583	245.184	1.21	0.000	
DH37	11/05/86	11:22	NA	673.474	126.891	1.21	0.000	Dry.
DH37	11/20/86	12:25	NA	688.517	141.934	1.21	0.000	Dry, not collected.
DH37	12/30/86	12:00	NA	728.500	181.917	1.21	0.000	
DH37	02/03/87	NA:	NA	763.000	216.417	1.21	0.000	
DH37	03/06/87	11:05	NA	794.462	247.879	1.21	0.000	Dry.
DH37	03/30/87	11:10	0.00	818.465	24.003	1.21	0.000	Dry.
DH37	05/07/87	11:27	0.00	856.477	62.015	1.21	0.000	Dry.
DH37	06/18/87	12:05	0.00	898.503	104.041	1.21	0.000	Dry.
DH37	07/28/87	10:53	0.00	938.453	143.991	1.21	0.000	Dry.
DH37	09/01/87	10:45	0.00	973.448	34.995	1.21	0.000	Dry.
DH37	10/20/87	11:35	0.00	1022.48	49.032	1.21	0.000	Dry.
DH37	11/19/87	11:05	0.00	1052.46	29.980	1.21	0.000	Dry.
DH37	01/04/88	11:35	0.00	1098.48	46.020	1.21	0.000	Dry.
DH37	02/08/88	11:40	0.00	1133.49	35.010	1.21	0.000	Dry.
DH37	03/29/88	11:35	0.00	1183.48	49.990	1.21	0.000	Dry.
DH37	07/12/88	08:50	0.00	1288.37	104.890	1.21	0.000	Dry.
DH37	09/27/88	10:45	0.00	1365.45	77.080	1.21	0.000	Dry.
DH37	12/13/88	09:55	0	1442.41	76.960	1.21	0.000	Dry.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
DH38	12/05/84	00:00	NA	0.000	0.000	0.00	0.000	Approximate date this part of Room G excavated.
DH38	01/26/85	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 1/25/85 to 1/26/85.
DH38	01/28/85	09:00	NA	27.375	1.000	0.00	0.000	Dry.
DH38	02/05/85	11:15	NA	35.469	9.094	0.00	0.000	Wet at bottom.
DH38	02/19/85	12:10	00.80	49.507	23.132	0.80	0.035	Brine and fine muck.
DH38	02/26/85	10:45	01.26	56.448	6.941	2.06	0.182	Brine and fine muck.
DH38	03/05/85	10:00	00.45	63.417	6.969	2.51	0.065	
DH38	03/12/85	10:00	00.39	70.417	7.000	2.90	0.056	
DH38	03/20/85	10:37	00.45	78.442	8.025	3.35	0.056	
DH38	03/26/85	09:50	00.36	84.410	5.968	3.71	0.060	
DH38	04/02/85	10:25	00.41	91.434	7.024	4.12	0.058	Some muck.
DH38	04/10/85	10:31	00.44	99.438	8.004	4.56	0.055	
DH38	04/17/85	13:30	00.41	106.562	7.124	4.97	0.058	
DH38	04/23/85	11:41	00.34	112.487	5.925	5.31	0.057	
DH38	04/30/85	11:05	00.39	119.462	6.975	5.70	0.056	
DH38	05/07/85	09:50	00.42	126.410	6.948	6.12	0.060	
DH38	05/14/85	10:45	00.41	133.448	7.038	6.53	0.058	
DH38	05/21/85	10:35	00.41	140.441	6.993	6.94	0.059	
DH38	05/29/85	11:35	00.47	148.483	8.042	7.41	0.058	
DH38	06/04/85	11:25	00.35	154.476	5.993	7.76	0.058	
DH38	06/11/85	10:35	00.40	161.441	6.965	8.16	0.057	
DH38	06/18/85	10:09	00.39	168.423	6.982	8.55	0.056	
DH38	06/25/85	10:50	00.42	175.451	7.028	8.97	0.060	
DH38	07/02/85	11:00	00.44	182.458	7.007	9.41	0.063	
DH38	07/09/85	11:05	00.43	189.462	7.004	9.84	0.061	
DH38	07/16/85	11:45	00.43	196.490	7.028	10.27	0.061	Brine effervesces.
DH38	07/24/85	10:35	00.49	204.441	7.951	10.76	0.062	
DH38	07/30/85	10:14	00.38	210.426	5.985	11.14	0.063	
DH38	08/06/85	10:34	00.42	217.440	7.014	11.56	0.060	
DH38	08/14/85	10:51	00.49	225.452	8.012	12.05	0.061	
DH38	08/20/85	11:02	00.37	231.460	6.008	12.42	0.062	
DH38	08/28/85	10:00	00.51	239.417	7.957	12.93	0.064	
DH38	09/04/85	10:23	00.44	246.433	7.016	13.37	0.063	
DH38	09/10/85	10:19	00.39	252.430	5.997	13.76	0.065	
DH38	09/17/85	09:37	00.44	259.401	6.971	14.20	0.063	
DH38	09/24/85	09:45	00.44	266.406	7.005	14.64	0.063	
DH38	10/01/85	09:53	00.44	273.412	7.006	15.08	0.063	
DH38	10/08/85	10:38	00.46	280.443	7.031	15.54	0.065	
DH38	10/15/85	10:15	00.44	287.427	6.984	15.98	0.063	
DH38	10/23/85	10:20	00.49	295.431	8.004	16.47	0.061	
DH38	10/29/85	09:40	00.39	301.403	5.972	16.86	0.065	
DH38	11/05/85	09:14	00.43	308.385	6.982	17.29	0.062	
DH38	11/13/85	10:00	00.52	316.417	8.032	17.81	0.065	
DH38	11/21/85	11:29	00.47	324.478	8.061	18.28	0.058	
DH38	11/26/85	11:20	00.33	329.472	4.994	18.61	0.066	
DH38	12/03/85	13:30	00.42	336.562	7.090	19.03	0.059	
DH38	12/10/85	12:30	00.41	343.521	6.959	19.44	0.059	
DH38	01/23/86	11:20	02.70	387.472	43.951	22.14	0.061	Entry restricted since 12/10/85 due to mining activities.
DH38	01/31/86	12:10	00.53	395.507	8.035	22.67	0.066	
DH38	02/12/86	10:50	00.75	407.451	11.944	23.42	0.063	
DH38	02/19/86	11:40	00.43	414.486	7.035	23.85	0.061	
DH38	02/28/86	13:15	00.37	423.552	9.066	24.02	0.019	Lost substantial volume due to break in suction line. Brine flowed back down into hole.
DH38	03/06/86	10:35	00.45	429.441	5.889	24.67	0.110	
DH38	03/13/86	10:05	00.43	436.420	6.979	25.10	0.062	
DH38	03/26/86	10:10	00.59	449.424	13.004	25.69	0.045	
DH38	04/02/86	09:35	00.58	456.399	6.975	26.27	0.083	
DH38	04/08/86	09:40	00.35	462.403	6.004	26.62	0.058	
DH38	04/16/86	12:10	00.50	470.507	8.104	27.12	0.062	
DH38	04/24/86	10:12	00.47	478.425	7.918	27.59	0.059	
DH38	04/30/86	10:50	00.35	484.451	6.026	27.94	0.058	
DH38	05/06/86	10:14	00.31	490.426	5.975	28.25	0.052	
DH38	05/13/86	11:05	00.41	497.462	7.036	28.66	0.058	
DH38	05/20/86	11:05	00.40	504.462	7.000	29.06	0.057	
DH38	05/27/86	15:40	00.38	511.653	7.191	29.44	0.053	
DH38	06/03/86	10:05	00.44	518.420	6.767	29.88	0.065	
DH38	06/10/86	11:22	00.43	525.474	7.054	30.31	0.061	
DH38	06/17/86	10:50	00.37	532.451	6.977	30.68	0.053	
DH38	06/24/86	10:52	00.50	539.453	7.002	31.18	0.071	

DH38	07/01/86	14:01	00.40	546.584	7.131	31.58	0.056	
DH38	07/08/86	10:30	00.38	553.438	6.854	31.96	0.055	
DH38	07/16/86	10:34	00.43	561.440	8.002	32.39	0.054	
DH38	07/22/86	09:58	00.35	567.415	5.975	32.74	0.059	
DH38	07/29/86	10:40	00.38	574.444	7.029	33.12	0.054	
DH38	08/05/86	11:10	00.39	581.465	7.021	33.51	0.056	
DH38	08/12/86	10:30	00.40	588.438	6.973	33.91	0.057	
DH38	08/19/86	11:30	00.41	595.479	7.041	34.32	0.058	
DH38	08/26/86	10:32	00.36	602.439	6.960	34.68	0.052	
DH38	09/04/86	10:35	00.49	611.441	9.002	35.17	0.054	
DH38	09/09/86	10:00	00.30	616.417	4.976	35.47	0.060	
DH38	09/16/86	10:11	00.38	623.424	7.007	35.85	0.054	
DH38	09/23/86	10:10	00.37	630.424	7.000	36.22	0.053	
DH38	10/01/86	12:07	00.43	638.505	8.081	36.65	0.053	
DH38	10/08/86	11:30	00.36	645.479	6.974	37.01	0.052	
DH38	10/14/86	11:45	00.35	651.490	6.011	37.36	0.058	
DH38	11/05/86	11:26	1.10	673.476	21.986	38.46	0.051	
DH38	11/20/86	12:27	00.82	688.519	15.043	39.28	0.055	
DH38	12/30/86	12:15	01.87	728.510	39.991	41.15	0.047	
DH38	02/03/87	13:15	01.72	763.552	35.042	42.87	0.049	
DH38	03/06/87	11:05	1.58	794.462	30.910	44.45	0.051	
DH38	03/30/87	11:13	1.17	818.467	24.005	45.62	0.047	
DH38	05/07/87	11:20	1.89	856.472	38.005	47.51	0.050	
DH38	06/17/87	10:45	1.91	897.448	0.000	49.42	0.000	Some brine left in hole, no calculation.
DH38	06/18/87	12:05	0.16	898.503	42.031	49.58	0.049	Calculated using 2.07 liters (1.91 l. 6/17/87 plus 0.16 l. 6/18/87).
DH38	07/28/87	10:53	1.88	938.453	39.950	51.46	0.047	
DH38	09/01/87	10:45	1.70	973.448	34.995	53.16	0.049	
DH38	10/20/87	11:40	2.29	1022.49	49.042	55.45	0.047	
DH38	11/19/87	11:05	1.42	1052.46	29.970	56.87	0.047	
DH38	01/04/88	11:35	2.05	1098.48	46.020	58.92	0.045	
DH38	02/08/88	11:40	1.48	1133.49	35.010	60.40	0.042	
DH38	03/29/88	11:30	2.10	1183.48	49.990	62.50	0.042	
DH38	05/05/88	09:55	1.70	1220.41	36.930	64.20	0.046	
DH38	05/12/88	11:20	0.31	1227.47	7.060	64.51	0.044	
DH38	07/12/88	08:45	2.44	1288.36	60.890	66.95	0.040	
DH38	07/28/88	10:20	0.88	1304.43	16.070	67.83	0.055	
DH38	09/27/88	10:30	1.92	1365.44	61.010	69.75	0.031	
DH38	12/13/88	09:55	3.45	1442.41	76.970	73.20	0.045	

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DH39	12/13/84	00:00	NA	0.000	0.000	0.00	0.000	Approximate date that part of Room G was excavated.
DH39	01/24/85	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled.
DH39	02/05/85	11:15	NA	35.469	1.000	0.00	0.000	Moist, no stalactites.
DH39	02/26/85	10:25	NA	56.434	21.965	0.00	0.000	Wet, none collected, back wet in 1.5 ft circle.
DH39	03/12/85	10:00	NA	70.417	35.948	0.00	0.000	Trace, salt crystals in container.
DH39	03/26/85	09:55	NA	84.413	49.944	0.00	0.000	Trace, none collected.
DH39	05/07/85	09:37	00.01	126.401	91.932	0.01	0.000	
DH39	05/29/85	11:30	00.03	148.479	22.078	0.04	0.001	Stalactites in sample.
DH39	11/05/86	11:10	NA	673.465	524.986	0.04	0.000	Dry.
DH39	11/20/86	NA:	NA	688.000	539.521	0.04	0.000	Dry, not collected.
DH39	12/30/86	11:45	NA	728.490	580.011	0.04	0.000	
DH39	02/03/87	NA:	NA	763.000	614.521	0.04	0.000	
DH39	03/06/87	11:00	NA	794.458	645.979	0.04	0.000	Dry.
DH39	03/30/87	11:05	0.00	818.462	24.004	0.04	0.000	Dry.
DH39	05/07/87	11:20	0.00	856.472	62.014	0.04	0.000	Dry.
DH39	06/18/87	12:00	0.00	898.500	104.042	0.04	0.000	Dry.
DH39	07/28/87	11:03	0.00	938.460	144.002	0.04	0.000	Dry.
DH39	09/01/87	10:21	0.00	973.431	34.971	0.04	0.000	Dry.
DH39	10/20/87	11:33	0.00	1022.48	49.049	0.04	0.000	Dry.
DH39	11/19/87	11:00	0.00	1052.46	29.980	0.04	0.000	Dry.
DH39	01/04/88	11:35	0.00	1098.48	46.020	0.04	0.000	Dry.
DH39	02/08/88	11:35	0.00	1133.48	35.000	0.04	0.000	Dry.
DH39	03/29/88	11:30	0.00	1183.48	50.000	0.04	0.000	Dry.
DH39	07/12/88	08:45	0.00	1288.36	104.880	0.04	0.000	Dry.
DH39	09/27/88	10:30	0.00	1365.44	77.080	0.04	0.000	Dry.
DH39	12/13/88	09:50	0	1442.41	76.970	0.04	0.000	Dry.

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DH40	12/13/84	00:00	NA	0.000	0.000	0.00	0.000	Approximate date this part of Room G excavated.
DH40	01/25/85	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled 1/24/85 to 1/25/85.
DH40	01/28/85	09:00	NA	27.375	1.000	0.00	0.000	Dry.
DH40	02/05/85	11:15	NA	35.469	9.094	0.00	0.000	Moist at bottom.
DH40	03/12/85	10:10	NA	70.424	44.049	0.00	0.000	Moist muck.
DH40	03/26/85	09:55	NA	84.413	58.038	0.00	0.000	Moist muck.
DH40	04/17/85	13:30	00.98	106.562	80.187	0.98	0.012	Brine, muck, and oil.
DH40	04/23/85	11:33	00.26	112.481	5.919	1.24	0.044	Brine and muck.
DH40	04/30/85	10:49	00.11	119.451	6.970	1.35	0.016	Feel something spongy in bottom of hole.
DH40	05/07/85	09:42	00.10	126.404	6.953	1.45	0.014	
DH40	05/14/85	10:40	00.09	133.444	7.040	1.54	0.013	
DH40	05/21/85	10:26	00.07	140.435	6.991	1.61	0.010	
DH40	05/29/85	11:30	00.08	148.479	8.044	1.69	0.010	
DH40	06/04/85	11:15	00.10	154.469	5.990	1.79	0.017	Contained a lot of salt muck.
DH40	06/11/85	10:30	00.05	161.438	6.969	1.84	0.007	
DH40	06/18/85	10:01	00.09	168.417	6.979	1.93	0.013	
DH40	06/25/85	11:00	00.08	175.458	7.041	2.01	0.011	
DH40	07/02/85	11:00	00.09	182.458	7.000	2.10	0.013	
DH40	07/09/85	10:45	00.12	189.448	6.990	2.22	0.017	
DH40	07/16/85	11:38	00.09	196.485	7.037	2.31	0.013	
DH40	07/24/85	10:31	00.07	204.438	7.953	2.38	0.009	
DH40	07/30/85	10:08	00.07	210.422	5.984	2.45	0.012	
DH40	08/06/85	10:20	00.06	217.431	7.009	2.51	0.009	
DH40	08/14/85	10:43	00.07	225.447	8.016	2.58	0.009	
DH40	08/20/85	10:50	00.05	231.451	6.004	2.63	0.008	
DH40	08/28/85	09:53	00.08	239.412	7.961	2.71	0.010	
DH40	09/04/85	10:18	00.03	246.429	7.017	2.74	0.004	
DH40	09/10/85	10:11	00.04	252.424	5.995	2.78	0.007	
DH40	09/17/85	09:31	00.03	259.397	6.973	2.81	0.004	
DH40	09/24/85	09:40	00.06	266.403	7.006	2.87	0.009	
DH40	10/01/85	09:47	00.06	273.408	7.005	2.93	0.009	
DH40	10/08/85	10:32	00.04	280.439	7.031	2.97	0.006	
DH40	10/15/85	10:05	00.09	287.420	6.981	3.06	0.013	
DH40	10/23/85	10:13	00.04	295.426	8.006	3.10	0.005	
DH40	10/29/85	09:32	00.07	301.397	5.971	3.17	0.012	
DH40	11/05/85	09:10	00.04	308.382	6.985	3.21	0.006	
DH40	11/13/85	09:55	00.07	316.413	8.031	3.28	0.009	
DH40	11/21/85	11:24	00.02	324.475	8.062	3.30	0.002	
DH40	12/03/85	13:20	00.08	336.556	12.081	3.38	0.007	
DH40	12/10/85	12:40	00.04	343.528	6.972	3.42	0.006	
DH40	01/23/86	11:25	00.24	387.476	43.948	3.66	0.005	Entry restricted since 12/10/85 due to mining activities.
DH40	01/31/86	12:10	00.02	395.507	8.031	3.68	0.002	
DH40	02/19/86	11:20	00.14	414.472	18.965	3.82	0.007	
DH40	02/28/86	13:10	00.05	423.549	9.077	3.87	0.006	
DH40	03/13/86	10:00	00.02	436.417	12.868	3.89	0.002	
DH40	04/24/86	10:05	00.13	478.420	42.003	4.02	0.003	
DH40	05/20/86	11:05	00.10	504.462	26.042	4.12	0.004	
DH40	06/03/86	09:58	00.20	518.415	13.953	4.32	0.014	
DH40	09/16/86	10:05	00.34	623.420	105.005	4.66	0.003	Did not collect for several months.
DH40	11/05/86	11:18	0.27	673.471	50.051	4.93	0.005	
DH40	11/20/86	NA:	NA	688.000	14.529	4.93	0.000	Not sampled.
DH40	12/30/86	12:00	00.25	728.500	55.029	5.18	0.005	
DH40	02/03/87	13:00	00.13	763.542	35.042	5.31	0.004	
DH40	03/06/87	10:55	0.09	794.455	30.913	5.40	0.003	
DH40	03/30/87	11:05	0.10	818.462	24.007	5.50	0.004	
DH40	06/18/87	12:00	0.19	898.500	80.038	5.69	0.002	
DH40	09/01/87	10:25	0.16	973.434	74.934	5.85	0.002	
DH40	10/20/87	11:33		1022.48	0.000	5.85	0.000	Not sampled. No calculation.
DH40	11/19/87	11:00		1052.46	0.000	5.85	0.000	Did not collect. No calculation.
DH40	01/04/88	11:35		1098.48	0.000	5.85	0.000	Did not sample.
DH40	02/08/88	11:30	0.55	1133.48	160.046	6.40	0.003	
DH40	03/29/88	11:25	0.14	1183.48	50.000	6.54	0.003	
DH40	05/12/88	11:40	0.20	1227.49	44.010	6.74	0.005	
DH40	07/12/88	08:40	0.15	1288.36	60.870	6.89	0.002	
DH40	09/27/88	10:25	0.21	1365.43	77.070	7.10	0.003	
DH40	12/13/88	09:45	0.12	1442.41	76.980	7.22	0.002	

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Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
DH41	12/30/84	00:00	NA	0.000	0.000	0.00	0.000	Approximate date this part of Room G excavated.
DH41	01/24/85	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 1/23/85 to 1/24/85.
DH41	02/05/85	11:15	NA	35.469	1.000	0.00	0.000	Moist, no stalactites.
DH41	03/26/85	10:05	NA	84.420	49.951	0.00	0.000	Trace, none collected.
DH41	05/07/85	09:21	00.01	126.390	91.921	0.01	0.000	
DH41	05/29/85	10:00	00.01	148.417	22.027	0.02	0.000	Trace.
DH41	07/24/85	10:13	00.01	204.426	56.009	0.03	0.000	
DH41	08/20/85	12:00	00.01	231.500	27.074	0.04	0.000	Trace.
DH41	08/28/85	09:35	00.02	239.399	7.899	0.06	0.003	
DH41	09/17/85	09:20	00.01	259.389	19.990	0.07	0.001	
DH41	02/19/86	11:20	00.05	414.472	155.083	0.12	0.000	Lots of salt crystals and lumps of clay in container.
DH41	11/05/86	11:00	NA	673.458	258.986	0.12	0.000	Dry. Funnel has been removed, salt crust on collar.
DH41	11/20/86	12:07	NA	688.505	274.033	0.12	0.000	Dry.
DH41	12/30/86	12:50	NA	728.535	314.063	0.12	0.000	
DH41	02/03/87	NA:	NA	763.000	348.528	0.12	0.000	
DH41	03/05/87	10:55	NA	793.455	378.983	0.12	0.000	Crusty.
DH41	03/30/87	11:00	0.00	818.458	25.003	0.12	0.000	Dry.
DH41	05/07/87	11:09	0.00	856.465	63.010	0.12	0.000	Dry.
DH41	06/18/87	11:56	0.00	898.497	105.042	0.12	0.000	Dry.
DH41	07/28/87	11:03	0.00	938.460	145.005	0.12	0.000	Dry.
DH41	09/01/87	10:15	0.00	973.427	34.967	0.12	0.000	Dry.
DH41	10/20/87	11:28	0.00	1022.48	49.053	0.12	0.000	Dry.
DH41	11/19/87	10:55	0.00	1052.45	29.970	0.12	0.000	Dry.
DH41	01/04/88	11:35	0.00	1098.48	46.030	0.12	0.000	Dry.
DH41	02/08/88	11:20	0.00	1133.47	34.990	0.12	0.000	Dry.
DH41	03/29/88	11:20	0.00	1183.47	50.000	0.12	0.000	Dry.
DH41	07/12/88	08:40	0.00	1288.36	104.890	0.12	0.000	Dry.
DH41	09/27/88	10:20	0.00	1365.43	77.070	0.12	0.000	Dry.
DH41	12/13/88	09:45	0	1442.41	76.980	0.12	0.000	Dry.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
DH42	12/30/84	00:00	NA	0.000	0.000	0.00	0.000	Approximate date this part of Room G excavated.
DH42	01/23/85	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled.
DH42	01/28/85	09:00	NA	27.375	1.000	0.00	0.000	Moist muck at the bottom.
DH42	02/05/85	11:15	00.27	35.469	9.094	0.27	0.030	First time collected.
DH42	02/11/85	11:00	00.30	41.458	5.989	0.57	0.050	
DH42	02/19/85	13:10	00.33	49.549	8.091	0.90	0.041	
DH42	02/26/85	10:45	00.26	56.448	6.899	1.16	0.038	
DH42	03/05/85	10:00	00.28	63.417	6.969	1.44	0.040	
DH42	03/12/85	10:20	00.25	70.431	7.014	1.69	0.036	
DH42	03/20/85	10:54	00.25	78.454	8.023	1.94	0.031	Valve leaked, some brine drained back down hole.
DH42	03/26/85	10:06	00.28	84.421	5.967	2.22	0.047	
DH42	04/02/85	10:45	00.26	91.448	7.027	2.48	0.037	
DH42	04/10/85	10:45	00.29	99.448	8.000	2.77	0.036	
DH42	04/17/85	13:30	00.24	106.562	7.114	3.01	0.034	
DH42	04/23/85	13:23	00.04	112.558	5.996	3.05	0.007	Significant volume of brine drained back down hole.
DH42	04/30/85	10:31	00.38	119.438	6.880	3.43	0.055	
DH42	05/07/85	09:25	00.33	126.392	6.954	3.76	0.047	
DH42	05/14/85	10:30	00.25	133.438	7.046	4.01	0.035	
DH42	05/21/85	10:17	00.26	140.428	6.990	4.27	0.037	
DH42	05/29/85	10:10	00.30	148.424	7.996	4.57	0.038	
DH42	06/04/85	10:45	00.22	154.448	6.024	4.79	0.037	
DH42	06/11/85	10:10	00.25	161.424	6.976	5.04	0.036	
DH42	06/18/85	09:53	00.25	168.412	6.988	5.29	0.036	
DH42	06/25/85	11:15	00.25	175.469	7.057	5.54	0.035	
DH42	07/02/85	11:00	00.24	182.458	6.989	5.78	0.034	
DH42	07/09/85	10:30	00.25	189.438	6.980	6.03	0.036	
DH42	07/16/85	11:08	00.25	196.464	7.026	6.28	0.036	Brine effervesces.
DH42	07/24/85	10:19	00.28	204.430	7.966	6.56	0.035	
DH42	07/30/85	09:57	00.22	210.415	5.985	6.78	0.037	
DH42	08/06/85	10:13	00.26	217.426	7.011	7.04	0.037	
DH42	08/14/85	10:59	00.27	225.458	8.032	7.31	0.034	
DH42	08/20/85	10:45	00.21	231.448	5.990	7.52	0.035	
DH42	08/28/85	09:45	00.29	239.406	7.958	7.81	0.036	
DH42	09/04/85	10:12	00.25	246.425	7.019	8.06	0.036	
DH42	09/10/85	09:56	00.21	252.414	5.989	8.27	0.035	
DH42	09/17/85	09:26	00.28	259.393	6.979	8.55	0.040	
DH42	09/24/85	09:37	00.24	266.401	7.008	8.79	0.034	
DH42	10/01/85	09:44	00.24	273.406	7.005	9.03	0.034	
DH42	10/08/85	10:25	00.23	280.434	7.028	9.26	0.033	
DH42	10/15/85	10:00	00.23	287.417	6.983	9.49	0.033	
DH42	10/23/85	10:07	00.26	295.422	8.005	9.75	0.032	
DH42	10/29/85	09:16	00.24	301.386	5.964	9.99	0.040	
DH42	11/05/85	09:05	00.22	308.378	6.992	10.21	0.031	
DH42	11/13/85	09:46	00.26	316.407	8.029	10.47	0.032	
DH42	11/21/85	10:53	00.26	324.453	8.046	10.73	0.032	
DH42	11/26/85	10:59	00.16	329.458	5.005	10.89	0.032	
DH42	12/03/85	13:10	00.20	336.549	7.091	11.09	0.028	
DH42	12/10/85	12:50	00.22	343.535	6.986	11.31	0.031	
DH42	01/23/86	11:30	01.32	387.479	43.944	12.63	0.030	Entry restricted since 12/10/85 due to mining activities.
DH42	01/31/86	12:05	00.30	395.503	8.024	12.93	0.037	
DH42	02/12/86	10:35	00.38	407.441	11.938	13.31	0.032	
DH42	02/19/86	11:10	00.22	414.465	7.024	13.53	0.031	
DH42	02/28/86	13:00	00.31	423.542	9.077	13.84	0.034	
DH42	03/06/86	10:30	00.17	429.438	5.896	14.01	0.029	
DH42	03/13/86	09:53	00.21	436.412	6.974	14.22	0.030	
DH42	03/26/86	10:00	00.39	449.417	13.005	14.61	0.030	
DH42	04/02/86	09:25	00.20	456.392	6.975	14.81	0.029	
DH42	04/08/86	09:30	00.20	462.396	6.004	15.01	0.033	
DH42	04/16/86	11:55	00.24	470.497	8.101	15.25	0.030	
DH42	04/24/86	09:55	00.21	478.413	7.916	15.46	0.027	
DH42	04/30/86	10:41	00.17	484.445	6.032	15.63	0.028	
DH42	05/06/86	10:10	00.19	490.424	5.979	15.82	0.032	
DH42	05/13/86	10:00	00.20	497.417	6.993	16.02	0.029	
DH42	05/20/86	11:00	00.20	504.458	7.041	16.22	0.028	
DH42	05/27/86	15:35	00.20	511.649	7.191	16.42	0.028	
DH42	06/03/86	09:50	00.20	518.410	6.761	16.62	0.030	
DH42	06/10/86	11:13	00.17	525.467	7.057	16.79	0.024	
DH42	06/17/86	10:40	00.20	532.444	6.977	16.99	0.029	

DH42	06/24/86	10:40	00.18	539.444	7.000	17.17	0.026	
DH42	07/01/86	13:45	00.20	546.573	7.129	17.37	0.028	
DH42	07/08/86	10:22	00.20	553.432	6.859	17.57	0.029	
DH42	07/16/86	10:15	00.30	561.427	7.995	17.87	0.038	
DH42	07/22/86	09:50	00.16	567.410	5.983	18.03	0.027	
DH42	07/29/86	10:25	00.20	574.434	7.024	18.23	0.028	
DH42	08/05/86	11:00	00.22	581.458	7.024	18.45	0.031	
DH42	08/12/86	10:20	00.20	588.431	6.973	18.65	0.029	
DH42	08/19/86	11:20	00.18	595.472	7.041	18.83	0.026	
DH42	08/26/86	10:25	00.20	602.434	6.962	19.03	0.029	
DH42	09/04/86	10:20	00.25	611.431	8.997	19.28	0.028	
DH42	09/09/86	09:46	00.14	616.407	4.976	19.42	0.028	
DH42	09/16/86	09:52	00.20	623.411	7.004	19.62	0.029	
DH42	09/23/86	09:58	00.15	630.415	7.004	19.77	0.021	
DH42	10/01/86	12:03	00.36	638.502	8.087	20.13	0.045	
DH42	10/08/86	10:55	00.15	645.455	6.953	20.28	0.022	
DH42	10/14/86	11:19	00.15	651.472	6.017	20.43	0.025	
DH42	11/05/86	11:07	0.52	673.463	21.991	20.95	0.024	
DH42	11/20/86	12:10	00.33	688.507	15.044	21.28	0.022	
DH42	12/30/86	11:45	00.78	728.490	39.983	22.06	0.020	
DH42	02/03/87	12:50	00.85	763.535	35.045	22.91	0.024	
DH42	03/06/87	10:45	0.68	794.448	30.913	23.59	0.022	
DH42	03/30/87	11:00	0.53	818.458	24.010	24.12	0.021	
DH42	05/07/87	11:15	0.90	856.469	38.011	25.02	0.024	Brine effervesces.
DH42	06/17/87	10:35	0.91	897.441	0.000	25.93	0.000	Wood fragments in hole. Some brine left in hole, no calculation.
DH42	06/18/87	11:56	0.10	898.497	42.028	26.03	0.024	Calculated using 1.01 liters (0.91 l. 6/17/87 plus 0.10 l. 6/18/87).
DH42	07/28/87	11:10	0.94	938.465	39.968	26.97	0.024	
DH42	09/01/87	10:15	0.79	973.427	34.962	27.76	0.023	
DH42	10/20/87	11:31	1.29	1022.48	49.053	29.05	0.026	
DH42	11/19/87	10:55	0.75	1052.45	29.970	29.80	0.025	
DH42	01/04/88	11:30	1.13	1098.48	46.030	30.93	0.025	
DH42	02/08/88	11:20	0.75	1133.47	34.990	31.68	0.021	
DH42	03/29/88	11:20	1.10	1183.47	50.000	32.78	0.022	
DH42	05/05/88	09:30	0.75.	1220.40	36.930	33.53	0.020	
DH42	05/12/88	09:45	0.13	1227.41	7.010	33.66	0.019	
DH42	07/12/88	08:35	1.15	1288.36	60.950	34.81	0.019	
DH42	07/28/88	10:10	0.34	1304.42	16.060	35.15	0.021	
DH42	09/27/88	10:20	0.66	1365.43	61.010	35.81	0.011	
DH42	12/13/88	09:38	1.71	1442.40	76.970	37.52	0.022	

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
DH42A	12/30/84	00:00	NA	0.000	0.000	0.00	0.000	Approximate date this part of Room G excavated.
DH42A	01/25/85	00:00	NA	0.000	0.000	0.00	0.000	Downhole drilled (re-drill of DH42) to recover core from 20 to 40 ft.
DH42A	01/28/85	09:00	NA	27.375	1.000	0.00	0.000	Brine in hole.
DH42A	02/05/85	11:15	00.85	35.469	9.094	0.85	0.093	First time collected.
DH42A	02/11/85	11:00	00.99	41.458	5.989	1.84	0.165	
DH42A	02/19/85	12:10	01.45	49.507	8.049	3.29	0.180	
DH42A	02/26/85	10:45	01.18	56.448	6.941	4.47	0.170	
DH42A	03/05/85	10:00	01.24	63.417	6.969	5.71	0.178	
DH42A	03/12/85	10:20	01.29	70.431	7.014	7.00	0.184	
DH42A	03/20/85	11:00	01.45	78.458	8.027	8.45	0.181	
DH42A	03/26/85	10:10	01.07	84.424	5.966	9.52	0.179	
DH42A	04/02/85	10:45	01.15	91.448	7.024	10.67	0.164	
DH42A	04/10/85	10:45	01.45	99.448	8.000	12.12	0.181	
DH42A	04/17/85	13:30	01.32	106.562	7.114	13.44	0.186	
DH42A	04/23/85	13:23	01.07	112.558	5.996	14.51	0.178	
DH42A	04/30/85	10:23	01.35	119.433	6.875	15.86	0.196	
DH42A	05/07/85	09:23	01.39	126.391	6.958	17.25	0.200	
DH42A	05/14/85	10:25	01.34	133.434	7.043	18.59	0.190	
DH42A	05/21/85	10:14	01.29	140.426	6.992	19.88	0.184	
DH42A	05/29/85	10:30	01.28	148.438	8.012	21.16	0.160	
DH42A	06/04/85	10:50	01.03	154.451	6.013	22.19	0.171	
DH42A	06/11/85	10:15	01.19	161.427	6.976	23.38	0.171	
DH42A	06/18/85	09:51	01.18	168.410	6.983	24.56	0.169	
DH42A	06/25/85	11:05	01.16	175.462	7.052	25.72	0.164	
DH42A	07/02/85	11:00	01.12	182.458	6.996	26.84	0.160	
DH42A	07/09/85	10:25	01.12	189.434	6.976	27.96	0.161	Gas effervescing from sample.
DH42A	07/16/85	11:10	01.11	196.465	7.031	29.07	0.158	Brine effervesces.
DH42A	07/24/85	10:25	01.23	204.434	7.969	30.30	0.154	
DH42A	07/30/85	09:54	00.94	210.412	5.978	31.24	0.157	
DH42A	08/06/85	10:10	01.05	217.424	7.012	32.29	0.150	
DH42A	08/14/85	10:33	01.11	225.440	8.016	33.40	0.138	
DH42A	08/20/85	10:14	00.92	231.426	5.986	34.32	0.154	
DH42A	08/28/85	09:40	01.17	239.403	7.977	35.49	0.147	
DH42A	09/04/85	10:10	00.99	246.424	7.021	36.48	0.141	
DH42A	09/10/85	09:55	00.83	252.413	5.989	37.31	0.139	
DH42A	09/17/85	09:25	00.92	259.392	6.979	38.23	0.132	
DH42A	09/24/85	09:25	00.94	266.392	7.000	39.17	0.134	
DH42A	10/01/85	09:40	00.93	273.403	7.011	40.10	0.133	
DH42A	10/08/85	10:24	00.96	280.433	7.030	41.06	0.137	
DH42A	10/15/85	10:15	00.81	287.427	6.994	41.87	0.116	
DH42A	10/23/85	10:10	01.02	295.424	7.997	42.89	0.128	
DH42A	10/29/85	09:20	00.75	301.389	5.965	43.64	0.126	
DH42A	11/05/85	09:00	00.86	308.375	6.986	44.50	0.123	
DH42A	11/13/85	09:44	01.03	316.406	8.031	45.53	0.128	
DH42A	11/21/85	10:50	00.94	324.451	8.045	46.47	0.117	
DH42A	11/26/85	10:55	00.61	329.455	5.004	47.08	0.122	
DH42A	12/03/85	13:05	00.78	336.545	7.090	47.86	0.110	
DH42A	12/10/85	12:50	00.86	343.535	6.990	48.72	0.123	
DH42A	01/23/86	11:40	05.13	387.486	43.951	53.85	0.117	Entry restricted since 12/10/85 due to mining activities.
DH42A	01/31/86	12:00	00.92	395.500	8.014	54.77	0.115	
DH42A	02/12/86	10:40	01.36	407.444	11.944	56.13	0.114	
DH42A	02/19/86	11:15	00.80	414.469	7.025	56.93	0.114	
DH42A	02/28/86	12:55	00.90	423.538	9.069	57.83	0.099	
DH42A	03/06/86	10:25	00.70	429.434	5.896	58.53	0.119	
DH42A	03/13/86	09:48	00.73	436.408	6.974	59.26	0.105	
DH42A	03/26/86	09:40	01.39	449.403	12.995	60.65	0.107	
DH42A	04/02/86	09:20	00.80	456.389	6.986	61.45	0.115	
DH42A	04/08/86	09:28	00.63	462.394	6.005	62.08	0.105	
DH42A	04/16/86	11:50	00.89	470.493	8.099	62.97	0.110	
DH42A	04/24/86	09:50	00.67	478.410	7.917	63.64	0.085	
DH42A	04/30/86	10:36	00.76	484.442	6.032	64.40	0.126	
DH42A	05/06/86	10:00	00.55	490.417	5.975	64.95	0.092	
DH42A	05/13/86	10:00	00.73	497.417	7.000	65.68	0.104	
DH42A	05/20/86	11:00	00.70	504.458	7.041	66.38	0.099	
DH42A	05/27/86	15:35	00.65	511.649	7.191	67.03	0.090	
DH42A	06/03/86	09:50	00.66	518.410	6.761	67.69	0.098	
DH42A	06/10/86	11:15	00.54	525.469	7.059	68.23	0.076	
DH42A	06/17/86	10:31	00.65	532.438	6.969	68.88	0.093	
DH42A	06/24/86	10:45	00.63	539.448	7.010	69.51	0.090	

DH42A	07/01/86	13:50	00.71	546.576	7.128	70.22	0.100	
DH42A	07/08/86	10:25	00.63	553.434	6.858	70.85	0.092	
DH42A	07/16/86	10:00	00.66	561.417	7.983	71.51	0.083	
DH42A	07/22/86	09:48	00.61	567.408	5.991	72.12	0.102	
DH42A	07/29/86	10:25	00.71	574.434	7.026	72.83	0.101	
DH42A	08/05/86	10:55	00.66	581.455	7.021	73.49	0.094	
DH42A	08/12/86	10:23	00.63	588.433	6.978	74.12	0.090	
DH42A	08/19/86	11:22	00.68	595.474	7.041	74.80	0.097	
DH42A	08/26/86	10:28	00.68	602.436	6.962	75.48	0.098	Static level not measured.
DH42A	09/04/86	10:25	00.71	611.434	8.998	76.19	0.079	Valve broke off and left in hole after collecting most of brine. Some brine left in hole.
DH42A	09/09/86	09:40	00.07	616.403	4.969	76.26	0.014	Bottom obstructed by object in hole.
DH42A	09/16/86	09:59	00.95	623.416	7.013	77.21	0.135	
DH42A	09/23/86	10:02	00.60	630.418	7.002	77.81	0.086	
DH42A	10/01/86	11:57	00.43	638.498	8.080	78.24	0.053	
DH42A	10/08/86	10:55	00.81	645.455	6.957	79.05	0.116	
DH42A	10/14/86	11:24	00.56	651.475	6.020	79.61	0.093	
DH42A	11/05/86	11:04	1.94	673.461	21.986	81.55	0.088	
DH42A	11/20/86	12:08	01.40	688.506	15.045	82.95	0.093	
DH42A	12/31/86	11:30	02.91	729.479	40.973	85.86	0.071	
DH42A	02/03/87	12:35	03.15	763.524	34.045	89.01	0.093	
DH42A	03/06/87	10:45	2.61	794.448	30.924	91.62	0.084	
DH42A	03/30/87	10:56	2.52	818.456	24.008	94.14	0.101	
DH42A	05/07/87	11:10	3.17	856.465	38.009	97.31	0.083	
DH42A	06/17/87	10:30	2.94	897.438	0.000	100.25	0.000	Approx. 0.01 liter spilled. Some brine left in hole, no calc.
DH42A	06/18/87	11:54	0.11	898.496	42.031	100.36	0.072	Calculated using 3.05 liters (2.94 l. 6/17/87 plus 0.11 l. 6/18/87).
DH42A	07/28/87	11:03	3.07	938.460	39.964	103.43	0.077	
DH42A	09/01/87	10:08	2.69	973.422	34.962	106.12	0.077	Samples effervesce.
DH42A	10/20/87	11:28	3.73	1022.48	49.058	109.85	0.076	
DH42A	11/19/87	10:55	2.17	1052.45	29.970	112.02	0.072	
DH42A	01/04/88	11:25	3.28	1098.48	46.030	115.30	0.071	
DH42A	02/08/88	11:10	2.47	1133.47	34.990	117.77	0.071	
DH42A	03/29/88	11:15	3.57	1183.47	50.000	121.34	0.071	
DH42A	05/05/88	09:00	2.38	1220.38	36.910	123.72	0.064	
DH42A	05/12/88	09:40	0.50	1227.40	7.020	124.22	0.071	
DH42A	07/12/88	08:30	4.06	1288.35	60.950	128.28	0.067	
DH42A	07/28/88	10:15	1.25	1304.43	16.080	129.53	0.078	
DH42A	09/14/88	08:45	3.00	1352.36	47.930	132.53	0.063	
DH42A	09/27/88	10:10	1.07	1365.42	13.060	133.60	0.082	
DH42A	12/13/88	09:35	7.95	1442.40	76.980	141.55	0.103	

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Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
DH215	01/02/83	00:00	NA	0.000	0.000	0.00	0.000	Approximate date E140 drift was excavated at S1950.
DH215	01/06/83	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilled 1/05/83 to 1/06/83.
DH215	04/20/84	00:00	NA	0.000	0.000	0.00	0.000	Experimental brine collection device installed.
DH215	01/15/85	11:00	00.05	14.458	1.000	0.05	0.000	First data entry in BSEP Phase I collecting program.
DH215	01/22/85	12:00	00.08	21.500	7.042	0.13	0.011	
DH215	01/29/85	12:00	00.08	28.500	7.000	0.21	0.011	
DH215	02/05/85	12:00	00.04	35.500	7.000	0.25	0.006	
DH215	02/11/85	13:00	00.06	41.542	6.042	0.31	0.010	
DH215	02/14/85	11:00	00.03	44.458	2.916	0.34	0.010	Replaced collecting device.
DH215	02/19/85	10:35	00.07	49.441	4.983	0.41	0.014	
DH215	02/26/85	12:10	00.09	56.507	7.066	0.50	0.013	
DH215	03/07/85	10:30	00.12	65.438	8.931	0.62	0.013	
DH215	03/12/85	12:30	00.10	70.521	5.083	0.72	0.020	
DH215	03/20/85	14:00	00.11	78.583	8.062	0.83	0.014	
DH215	03/26/85	11:30	00.05	84.479	5.896	0.88	0.008	
DH215	04/02/85	13:00	00.05	91.542	7.063	0.93	0.007	
DH215	04/10/85	13:00	00.09	99.542	8.000	1.02	0.011	
DH215	04/17/85	14:00	00.03	106.583	7.041	1.05	0.004	Drip missing funnel.
DH215	04/23/85	14:30	00.10	112.604	6.021	1.15	0.017	
DH215	04/30/85	09:09	00.08	119.381	6.777	1.23	0.012	
DH215	05/07/85	10:50	00.09	126.451	7.070	1.32	0.013	Salt crystals in container.
DH215	05/14/85	13:06	00.11	133.546	7.095	1.43	0.016	
DH215	05/21/85	12:15	00.08	140.510	6.964	1.51	0.011	
DH215	05/29/85	11:00	00.09	148.458	7.948	1.60	0.011	
DH215	06/04/85	13:15	00.09	154.552	6.094	1.69	0.015	Salt crystals in container.
DH215	06/11/85	13:10	00.13	161.549	6.997	1.82	0.019	
DH215	06/18/85	11:22	00.13	168.474	6.925	1.95	0.019	
DH215	06/25/85	12:55	00.12	175.538	7.064	2.07	0.017	
DH215	07/02/85	11:00	00.10	182.458	6.920	2.17	0.014	
DH215	07/09/85	12:39	00.09	189.527	7.069	2.26	0.013	
DH215	07/16/85	12:37	00.11	196.526	6.999	2.37	0.016	Salt crystals in container.
DH215	07/24/85	12:39	00.14	204.527	8.001	2.51	0.017	
DH215	07/30/85	11:09	00.10	210.465	5.938	2.61	0.017	
DH215	08/06/85	11:20	00.11	217.472	7.007	2.72	0.016	
DH215	08/14/85	13:17	00.17	225.553	8.081	2.89	0.021	
DH215	08/20/85	12:57	00.10	231.540	5.987	2.99	0.017	
DH215	08/26/85	14:36	00.12	237.608	6.068	3.11	0.020	
DH215	09/04/85	11:35	00.14	246.483	8.875	3.25	0.016	
DH215	09/10/85	12:05	00.09	252.503	6.020	3.34	0.015	
DH215	09/17/85	10:00	00.12	259.417	6.914	3.46	0.017	
DH215	09/24/85	11:11	00.13	266.466	7.049	3.59	0.018	
DH215	10/01/85	10:55	00.12	273.455	6.989	3.71	0.017	Salt crystals in container.
DH215	10/08/85	12:00	00.10	280.500	7.045	3.81	0.014	
DH215	10/15/85	11:31	00.20	287.480	6.980	4.01	0.029	
DH215	10/23/85	11:54	00.33	295.496	8.016	4.34	0.041	
DH215	10/29/85	11:54	00.12	301.496	6.000	4.46	0.020	
DH215	11/13/85	11:18	00.18	316.471	14.975	4.64	0.012	Floor lowered in E140 north of this location.
DH215	11/19/85	00:00	NA	0.000	0.000	0.00	0.000	Floor of E140 drift excavated, collar of downhole DH216 destroyed.
DH215	11/20/85	00:00	NA	0.000	0.000	0.00	0.000	Crossdrift excavation at S1950 initiated toward east.
DH215	12/04/85	15:00	00.35	337.625	21.154	4.99	0.017	
DH215	12/10/85	13:05	00.11	343.545	5.920	5.10	0.019	
DH215	12/17/85	14:20	00.40	350.597	7.052	5.50	0.057	
DH215	01/03/86	11:00	01.00	367.458	16.861	6.50	0.059	Brine overflowing container, unknown amount not collected.
DH215	01/08/86	11:25	00.36	372.476	5.018	6.86	0.072	
DH215	01/16/86	11:00	00.70	380.458	7.982	7.56	0.088	
DH215	01/23/86	12:00	00.63	387.500	7.042	8.19	0.089	
DH215	01/29/86	00:00	NA	0.000	0.000	0.00	0.000	Crossdrift excavation at S1950 initiated toward west.
DH215	01/31/86	13:50	00.45	395.576	8.076	8.64	0.056	
DH215	02/12/86	12:25	00.27	407.517	11.941	8.91	0.023	Stalactites removed from container.
DH215	02/19/86	13:15	00.26	414.552	7.035	9.17	0.037	
DH215	02/28/86	00:00	NA	0.000	0.000	0.00	0.000	Floor lowered in E140 south of this location.
DH215	03/06/86	12:20	00.96	429.514	14.962	10.13	0.064	
DH215	03/13/86	11:30	00.40	436.479	6.965	10.53	0.057	
DH215	03/26/86	11:15	00.72	449.469	12.990	11.25	0.055	
DH215	04/02/86	10:30	00.30	456.438	6.969	11.55	0.043	

DH215	04/08/86	11:00	00.15	462.458	6.020	11.70	0.025	
DH215	04/16/86	13:00	00.40	470.542	8.084	12.10	0.049	
DH215	04/24/86	11:00	00.26	478.458	7.916	12.36	0.033	
DH215	04/30/86	11:35	00.16	484.483	6.025	12.52	0.027	
DH215	05/06/86	11:05	00.21	490.462	5.979	12.73	0.035	
DH215	05/13/86	10:10	00.29	497.424	6.962	13.02	0.042	
DH215	05/20/86	11:45	00.20	504.490	7.066	13.22	0.028	
DH215	05/27/86	16:00	00.20	511.667	7.177	13.42	0.028	
DH215	06/03/86	11:05	00.27	518.462	6.795	13.69	0.040	
DH215	06/10/86	12:10	00.33	525.507	7.045	14.02	0.047	
DH215	06/17/86	11:47	00.23	532.491	6.984	14.25	0.033	
DH215	06/24/86	11:50	00.10	539.493	7.002	14.35	0.014	
DH215	07/01/86	14:32	00.15	546.606	7.113	14.50	0.021	
DH215	07/08/86	11:30	00.14	553.479	6.873	14.64	0.020	About 1 lb. of salt encrustation removed from funnel on 1/07/86.
DH215	07/16/86	11:45	00.10	561.490	8.011	14.74	0.012	
DH215	07/22/86	10:31	00.06	567.438	5.948	14.80	0.010	
DH215	07/29/86	11:27	00.13	574.477	7.039	14.93	0.018	
DH215	08/05/86	11:59	00.14	581.499	7.022	15.07	0.020	
DH215	08/12/86	11:40	00.13	588.486	6.987	15.20	0.019	
DH215	08/19/86	12:00	00.04	595.500	7.014	15.24	0.006	
DH215	08/26/86	11:55	00.02	602.497	6.997	15.26	0.003	
DH215	09/04/86	11:55	NA	611.497	9.000	15.26	0.000	Trace of brine.
DH215	09/23/86	11:35	00.00	630.483	18.986	15.26	0.000	Dry.
DH215	10/01/86	08:23	00.02	638.349	7.866	15.28	0.003	
DH215	10/08/86	13:41	NA	645.570	7.221	15.28	0.000	Trace, none collected.
DH215	10/14/86	13:47	00.00	651.574	13.225	15.28	0.000	Dry.
DH215	11/05/86	12:50	0.16	673.535	35.186	15.44	0.005	
DH215	11/20/86	NA:	NA	688.000	14.465	15.44	0.000	
DH215	12/30/86	09:51	00.14	728.410	54.875	15.58	0.003	About 1/2 of this volume was a mixture of salt crystals and sun-flower seeds.
DH215	02/04/87	10:06	00.50	764.421	36.011	16.08	0.014	
DH215	03/06/87	09:42	0.29	794.404	29.983	16.37	0.010	
DH215	03/30/87	09:45	0.33	818.406	24.002	16.70	0.013	
DH215	05/07/87	13:10	0.09	856.549	38.143	16.79	0.002	
DH215	06/17/87	09:15	0.18	897.385	40.836	16.97	0.004	
DH215	07/28/87	10:11	0.28	938.424	41.039	17.25	0.007	
DH215	09/01/87	09:05	0.20	973.378	34.954	17.45	0.006	
DH215	10/20/87	08:46	0.00	1022.37	48.992	17.45	0.000	Dry. 1/2-inch salt crust in container.
DH215	11/19/87	08:31	0.00	1052.35	29.980	17.45	0.000	Dry.
DH215	12/11/87	11:00		1074.46	0.000	17.45	0.000	Container is dry. Funnel was removed and the back was trimmed.
DH215	01/04/88	10:05		1098.42	0.000	17.45	0.000	Collar mined out. Dry, no evidence of moisture coming from the hole.
DH215	02/09/88	09:25		1134.39	0.000	17.45	0.000	Sampler removed.
DH215	03/29/88	09:15		1183.39	0.000	17.45	0.000	Collecting device removed by mine operations.
DH215	07/12/88	13:50		1288.58	0.000	17.45	0.000	No funnel.
DH215	09/27/88	13:00	0.00	1365.54	0.000	17.45	0.000	None collected.
DH215	10/13/88	11:00		1381.46	0.000	17.45	0.000	Installed funnel and collection bottle.
DH215	12/13/88	10:45	0	1442.45	390.100	17.45	0.000	Dry.

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DHP401	10/29/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated at S1950/E1320.
DHP401	01/06/87	00:00	NA	0.000	0.000	0.00	0.000	Uphole drilling initiated 12/08/86, stopped on 12/09/86 at 27.9 ft. Drilling resumed 1/02/87 and completed 1/06/87.
DHP401	03/06/87	09:15	0.12	794.385	1.000	0.12	0.000	First time collected.
DHP401	03/30/87	09:15	0.06	818.385	24.000	0.18	0.002	
DHP401	04/22/87	11:10	0.17	841.465	23.080	0.35	0.007	Stalactite growth beside funnel.
DHP401	06/11/87	10:00	0.38	891.417	49.952	0.73	0.008	
DHP401	07/28/87	10:15	0.27	938.427	47.010	1.00	0.006	Clay accumulation in container.
DHP401	09/01/87	08:55	0.32	973.372	34.945	1.32	0.009	
DHP401	09/16/87	09:15		988.385	0.000	1.32	0.000	0.01 liter in jar, not removed. No calculation.
DHP401	11/16/87	08:50	0.59	1049.37	75.998	1.91	0.008	
DHP401	02/09/88	09:00	0.43	1134.38	85.010	2.34	0.005	
DHP401	03/07/88	10:00	0.02	1161.42	27.040	2.36	0.001	Removed collecting device.
DHP401	03/29/88	09:00		1183.38	0.000	2.36	0.000	No collecting device.
DHP401	07/12/88	13:50		1288.58	0.000	2.36	0.000	No funnel.
DHP401	09/27/88	13:00	0.00	1365.54	0.000	2.36	0.000	None collected.
DHP401	10/13/88	10:00		1381.42	0.000	2.36	0.000	Installed funnel and collection bottle.
DHP401	12/13/88	10:50	0	1442.45	281.030	2.36	0.000	Dry.

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DHP402A	10/29/86	00:00	NA	0.000	0.000	0.00	0.000	Drift excavated at S1950/E1320.
DHP402A	12/05/86	00:00	NA	0.000	0.000	0.00	0.000	Downhole completed.
DHP402A	03/06/87	09:40	0.14	794.403	1.000	0.14	0.000	First time sampled.
DHP402A	03/30/87	09:15	0.00	818.385	23.982	0.14	0.000	
DHP402A	04/22/87	11:24	0.03	841.475	47.072	0.17	0.001	Bailer stuck in hole. Hole appers offset or blocked at the 45 foot level. There may be a rock bolt or piece of rod in hole.
DHP402A	07/08/87	00:00	NA	0.000	0.000	0.00	0.000	Horizontal pilot hole for Room 7 of the first Waste Storage Panal started just north of this location, drilled with brine.
DHP402A	07/16/87	09:20	0.00	926.389	0.000	0.17	0.000	Hole entirely filled with brine from drilling the pilot /gas release hole for the last room of the first panel.
DHP402A	07/28/87	10:20	17.50	938.431	0.000	17.67	0.000	Removed 17.5 liters of brine from hole, mostly drilling fluid. No calculation.
DHP402A	07/29/87	09:10	15.00	939.382	0.000	32.67	0.000	Drilling brine removed from hole. Partial evacuation, brine left in hole, no calculation.
DHP402A	08/16/87		NA	0.000	0.000	0.00	0.000	Brine from the AIS sump spread in Panel 1 to assist in the reconstitution of loose muck on floor.
DHP402A	08/20/87		NA	0.000	0.000	0.00	0.000	Brine from the AIS sump spread in Panel 1 to assist in the reconstitution of loose muck on floor.
DHP402A	10/01/87	00:00	NA	0.000	0.000	0.00	0.000	Approximate date the salt muck stockpile was placed at the east end of S1950, covering the collar of this hole.
DHP402A	07/12/88	13:50		1288.58	0.000	32.67	0.000	Muck piled over hole, could not collect.
DHP402A	08/19/88	10:00	57.25	1326.42	484.945	89.92	0.185	Used 72.25 liters for calculation (15.0 on 7/29 + 57.25 on 8/19).
DHP402A	08/30/88	11:00	42.75	1337.46	11.040	132.67	3.872	Depth of water 28.8 feet below floor. Bottom of hole at 44.3 feet. 5.7 feet of salt on bottom of hole.
DHP402A	09/15/88	10:00	0.24	1353.42	0.000	132.91	0.000	Not fully evacuated. Don't use for calculation. Sampled for bacteriology.
DHP402A	09/22/88	09:00	63.75	1360.38	22.920	196.66	2.781	Hole evacuated to 44.2' level.
DHP402A	09/27/88	13:00		1365.54	0.000	196.66	0.000	None collected.
DHP402A	10/18/88	13:45	45	1386.57	26.190	241.66	1.718	Some moisture could have entered hole due to water spread for dust control.
DHP402A	11/15/88	10:30	40.65	1414.44	27.870	282.31	1.459	Evacuated to 43.75 foot level. Lip or obstruction near bottom of hole prevents additional evacuation.
DHP402A	12/13/88	10:50	6.0	1442.45	0.000	288.31	0.000	Not fully evacuated, some brine left in hole. Don't use for calculation.
DHP402A	12/29/88	12:00	43.60	1458.50	44.060	331.91	1.126	Used 49.6 liters for calculation (6.0 on 12/13 + 43.6 on 12/29).

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EES12B	02/17/83	00:00	NA	-684.00	0.000	0.00	0.000	Approximate date drift at N1420/E140 excavated.
EES12B	06/05/86	00:00	NA	520.000	0.000	0.00	0.000	Excavation effects downhole drilled to 9.3 ft..
EES12B	06/12/86	09:44	10.0	527.406	527.406	10.00	0.019	
EES12B	06/12/86	10:20	1.5	527.431	0.025	11.50	60.000	High liters per day results from high initial inflow rate through fractures after bailing.
EES12B	07/10/86	11:16	10.5	555.469	28.038	22.00	0.374	
EES12B	07/10/86	11:29	1.6	555.478	0.009	23.60	177.80	See above, high liters per day.
EES12B	07/10/86	11:40	1.0	555.486	0.008	24.60	125.00	See above, high liters per day.
EES12B	07/10/86	11:48	0.5	555.492	0.006	25.10	83.330	See above, high liters per day.
EES12B	07/10/86	12:33	0.4	555.523	0.031	25.50	12.900	See above, high liters per day.
EES12B	07/29/86	09:40	9.75	574.403	18.880	35.25	0.516	
EES12B	08/05/86	10:30	07.17	581.438	7.035	42.42	1.019	
EES12B	08/12/86	09:30	06.00	588.396	6.958	48.42	0.862	
EES12B	08/19/86	10:15	05.40	595.427	7.031	53.82	0.768	Pumped to 8.0' level (total length of suction hose).
EES12B	08/26/86	09:40	04.84	602.403	6.976	58.66	0.694	
EES12B	09/04/86	09:25	05.39	611.392	8.989	64.05	0.600	
EES12B	09/09/86	12:30	04.50	616.521	5.129	68.55	0.877	
EES12B	09/16/86	09:08	04.33	623.381	6.860	72.88	0.631	
EES12B	09/23/86	09:12	04.58	630.383	7.002	77.46	0.654	
EES12B	10/01/86	10:47	07.90	638.449	8.066	85.36	0.979	Brine left in hole although more evacuated than usual. Brine level at 7.95, top of muck at 8.80.
EES12B	10/08/86	09:49	05.14	645.409	6.960	90.50	0.739	After total evacuation - rapid brine inflow with gas. Connects with holes 3.8' W and 4.3' E. Hole 8.9' deep. 0.64 L taken 5 min. later.
EES12B	10/08/86	09:54	00.64	645.413	0.004	91.14	160.00	High liters per day results from high initial inflow rate after bailing.
EES12B	10/08/86	14:46	01.31	645.615	0.202	92.45	6.485	See above.
EES12B	10/14/86	10:26	02.29	651.435	5.820	94.74	0.393	Complete evacuation.
EES12B	11/05/86	09:40	8.18	673.403	21.968	102.92	0.372	
EES12B	11/20/86	NA:	NA	688.000	14.597	102.92	0.000	
EES12B	12/31/86	10:22	NA	729.432	56.029	102.92	0.000	Last time checked for BSEP.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
EES21B	07/26/85			0.000	0.000	0.00	0.000	Approximate date drift at S700/E66 excavated.
EES21B	07/09/86			554.000	554.000	0.00	0.000	Excavation effects downhole drilled 7/08/86 to 7/09/86.
EES21B	07/09/86	09:17	4.5	554.387	0.387	4.50	11.630	High liters per day results from high initial inflow through fractures after bailing.
EES21B	07/09/86	12:10	1.6	554.507	0.120	6.10	13.330	See above, high liters per day.
EES21B	07/16/86	11:17	4.6	561.470	6.963	10.70	0.661	
EES21B	07/16/86	12:24	0.55	561.517	0.047	11.25	11.700	See above, high liters per day.
EES21B	07/18/86	11:15	4.6	563.469	1.952	15.85	2.357	
EES21B	07/22/86	19:55	4.6	567.830	4.361	20.45	1.055	
EES21B	07/28/86	08:45	4.5	573.365	5.535	24.95	0.813	
EES21B	07/29/86	11:20	3.65	574.472	1.107	28.60	3.297	
EES21B	08/05/86	11:47	04.70	581.491	7.019	33.30	0.670	
EES21B	08/12/86	11:30	04.75	588.479	6.988	38.05	0.680	Pumped to 8'level (total length of suction hose).
EES21B	08/19/86	11:50	04.80	595.493	7.014	42.85	0.684	Bottom of muck.
EES21B	08/26/86	11:20	04.78	602.472	6.979	47.63	0.685	
EES21B	09/04/86	11:25	04.85	611.476	9.004	52.48	0.539	
EES21B	09/09/86	12:30	04.86	616.521	5.045	57.34	0.963	
EES21B	09/16/86	10:51	04.84	623.452	6.931	62.18	0.698	
EES21B	09/23/86	10:50	04.92	630.451	6.999	67.10	0.703	Full to bottom of muck.
EES21B	10/01/86	09:14	04.39	638.385	7.934	71.49	0.553	Full, moisture overflowing, bubbling violently at bottom. Approximately 1 ft. brine still in hole.
EES21B	10/08/86	12:52	05.49	645.536	7.151	76.98	0.768	Brine level right at salt-muck interface 0.20 feet below floor.
EES21B	10/08/86	14:34	00.36	645.607	0.071	77.34	5.070	
EES21B	10/14/86	12:55	04.94	651.538	5.931	82.28	0.833	
EES21B	11/05/86	12:28	4.98	673.519	21.981	87.26	0.227	
EES21B	11/20/86	NA:	NA	688.000	14.481	87.26	0.000	
EES21B	12/30/86	NA:	NA	728.000	54.481	87.26	0.000	Last time checked for BSEP.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
GSEEP	11/21/84			0.000	0.000	0.00	0.000	Approximate date this part of Room G excavated.
GSEEP	08/28/85			0.000	0.000	0.00	0.000	Noticed damp area on floor at this location.
GSEEP	11/12/85	1		0.000	0.000	0.00	0.000	Damp area on floor near S. rib approx. E1140 (45 ft. E. of DH35) and at E1149. Crusted moist area is about 4 ft. by 4 ft., has increased
GSEEP	11/12/85	2		0.000	0.000	0.00	0.000	noticeably in size over last two months. Damp area covers 16 ft. E-W, 13 ft. N-S across width of Room G.
GSEEP	11/12/85	3		0.000	0.000	0.00	0.000	Many weeps on lower 3 ft. of S. rib. Brine is seeping out of air pipe support hole.
GSEEP	11/26/85	12:00	03.00	329.500	1.000	3.00	0.000	First time collection. Dug out salt.
GSEEP	12/03/85	12:00	01.50	336.500	7.000	4.50	0.214	Partial removal.
GSEEP	12/04/85	12:00	01.13	337.500	1.000	5.63	1.130	
GSEEP	12/10/85	12:00	01.80	343.500	6.000	7.43	0.300	
GSEEP	01/23/86	12:00	00.50	387.500	44.000	7.93	0.011	Lots of salt in pool.
GSEEP	01/31/86	12:00	00.94	395.500	8.000	8.87	0.117	
GSEEP	02/12/86	12:00	02.23	407.500	12.000	11.10	0.186	Pumped twice.
GSEEP	02/19/86	12:00	02.14	414.500	7.000	13.24	0.306	
GSEEP	02/28/86	12:00	01.95	423.500	9.000	15.19	0.217	Partial removal. No pump, scooped with beaker.
GSEEP	03/04/86	11:20	02.62	427.472	3.972	17.81	0.660	
GSEEP	03/06/86	10:50	02.07	429.451	1.979	19.88	1.046	
GSEEP	03/13/86	11:46	03.23	436.490	7.039	23.11	0.459	Collected three times.
GSEEP	03/26/86	10:20	03.00	449.431	12.941	26.11	0.232	
GSEEP	04/02/86	10:00	02.68	456.417	6.986	28.79	0.384	
GSEEP	04/08/86	10:00	02.50	462.417	6.000	31.29	0.417	
GSEEP	04/16/86	12:00	02.24	470.500	8.083	33.53	0.277	
GSEEP	04/24/86	10:30	02.35	478.438	7.938	35.88	0.296	
GSEEP	04/30/86	11:00	02.40	484.458	6.020	38.28	0.399	
GSEEP	05/06/86	10:30	02.49	490.438	5.980	40.77	0.416	
GSEEP	05/13/86	11:20	02.66	497.472	7.034	43.43	0.378	
GSEEP	05/20/86	11:20	02.44	504.472	7.000	45.87	0.349	
GSEEP	05/27/86	15:30	03.11	511.646	7.174	48.98	0.434	
GSEEP	06/03/86	10:40	03.31	518.444	6.798	52.29	0.487	
GSEEP	06/10/86	11:38	03.21	525.485	7.041	55.50	0.456	
GSEEP	06/17/86	11:15	03.11	532.469	6.984	58.61	0.445	
GSEEP	06/24/86	11:00	04.60	539.458	6.989	63.21	0.658	Very humid air in workings.
GSEEP	07/01/86	14:00	05.43	546.583	7.125	68.64	0.762	Very humid last week, rain on surface.
GSEEP	07/08/86	10:50	04.14	553.451	6.868	72.78	0.603	
GSEEP	07/16/86	10:50	03.32	561.451	8.000	76.10	0.415	
GSEEP	07/22/86	10:15	02.29	567.427	5.976	78.39	0.383	
GSEEP	07/29/86	10:45	02.68	574.448	7.021	81.07	0.382	
GSEEP	08/05/86	11:20	02.60	581.472	7.024	83.67	0.370	
GSEEP	08/12/86	10:45	03.67	588.448	6.976	87.34	0.526	
GSEEP	08/19/86	11:40	03.90	595.486	7.038	91.24	0.554	
GSEEP	08/26/86	11:00	03.73	602.458	6.972	94.97	0.535	
GSEEP	09/04/86	10:55	05.15	611.455	8.997	100.12	0.572	Last week has been humid and rainy.
GSEEP	09/09/86	10:00	03.70	616.417	4.962	103.82	0.746	
GSEEP	09/16/86	10:25	03.82	623.434	7.017	107.64	0.544	
GSEEP	09/23/86	10:20	04.29	630.431	6.997	111.93	0.613	
GSEEP	10/01/86	12:24	03.70	638.517	8.086	115.63	0.458	
GSEEP	10/08/86	10:45	03.80	645.448	6.931	119.43	0.548	
GSEEP	10/08/86	14:57	01.87	645.623	0.175	121.30	10.690	Second collection for this day.
GSEEP	10/10/86	09:16	01.24	647.386	1.763	122.54	0.703	
GSEEP	10/14/86	11:10	02.19	651.465	4.079	124.73	0.537	
GSEEP	11/05/86	10:45	4.44	673.448	21.983	129.17	0.202	First time 3.74 liters, second time 0.70 liters.
GSEEP	11/20/86	12:02	03.84	688.501	15.053	133.01	0.255	
GSEEP	12/30/86	12:50	04.44	728.535	40.034	137.45	0.111	
GSEEP	02/03/87	13:45	03.45	763.573	35.038	140.90	0.098	
GSEEP	03/06/87	11:30	3.0	794.479	30.906	143.90	0.097	
GSEEP	03/30/87	11:34	2.51	818.482	24.003	146.41	0.100	
GSEEP	05/07/87	11:48	3.31	856.492	38.010	149.72	0.087	
GSEEP	06/30/87	10:00	12.24	910.417	53.925	161.96	0.227	
GSEEP	07/16/87	10:30	11.66	926.438	16.021	173.62	0.728	
GSEEP	07/23/87	09:20	3.87	933.389	6.951	177.49	0.557	
GSEEP	07/28/87	11:35	2.36	938.483	5.094	179.85	0.463	
GSEEP	08/07/87	09:15	5.33	948.385	9.902	185.18	0.538	
GSEEP	08/12/87	10:12	2.80	953.425	5.040	187.98	0.556	
GSEEP	08/24/87	08:46	6.53	965.365	11.940	194.51	0.547	

GSEEP	09/01/87	11:00	5.26	973.458	8.093	199.77	0.650	
GSEEP	09/11/87	09:00	5.03	983.375	9.917	204.80	0.507	
GSEEP	09/16/87	09:33	2.42	988.398	5.023	207.22	0.482	
GSEEP	09/25/87	08:55	4.12	997.372	8.974	211.34	0.459	Sump drilled to facilitate accumulation of brine.
GSEEP	10/01/87	12:15	2.81	1003.51	6.138	214.15	0.458	
GSEEP	10/08/87	10:25	2.97	1010.43	6.920	217.12	0.429	
GSEEP	10/16/87	10:41	3.37	1018.45	8.020	220.49	0.420	
GSEEP	10/20/87	11:59	2.06	1022.50	4.050	222.55	0.509	
GSEEP	11/12/87	10:41	10.21	1045.45	22.950	232.76	0.445	
GSEEP	11/19/87	11:35	2.90	1052.48	7.030	235.66	0.413	
GSEEP	12/07/87	12:50	7.02	1070.53	18.050	242.68	0.389	
GSEEP	01/04/88	12:10	16.11	1098.51	27.980	258.79	0.576	
GSEEP	01/20/88	11:25	8.68	1114.48	15.970	267.47	0.544	
GSEEP	02/08/88	12:15	9.58	1133.51	19.030	277.05	0.503	
GSEEP	02/25/88	10:40	11.87	1150.44	16.930	288.92	0.701	
GSEEP	03/09/88	10:18	7.35	1163.43	12.990	296.27	0.566	
GSEEP	03/17/88	11:20	4.45	1171.47	8.040	300.72	0.553	
GSEEP	03/29/88	11:45	5.42	1183.49	12.020	306.14	0.451	
GSEEP	04/15/88	11:01	7.43	1200.46	16.970	313.57	0.438	
GSEEP	05/05/88	10:10	9.34	1220.42	19.960	322.91	0.468	
GSEEP	05/12/88	09:30	3.55	1227.40	6.980	326.46	0.509	
GSEEP	06/09/88	08:45	12.00	1255.36	27.960	338.46	0.429	
GSEEP	06/16/88	09:43	4.13	1262.40	7.040	342.59	0.587	
GSEEP	06/30/88	08:30	6.00	1276.35	13.950	348.59	0.430	
GSEEP	07/12/88	09:00	6.40	1288.38	12.030	354.99	0.532	
GSEEP	07/28/88	10:30	11.35	1304.44	16.060	366.34	0.707	
GSEEP	08/11/88	10:00	12.02	1318.42	13.980	378.36	0.860	
GSEEP	08/25/88	09:07	6.72	1332.38	13.960	385.08	0.481	Hole covered with tight fitting brattice cloth.
GSEEP	09/08/88	14:48	7.31	1346.62	14.240	392.39	0.513	
GSEEP	09/14/88	08:30	3.00	1352.35	5.730	395.39	0.524	
GSEEP	09/27/88	10:50	6.45	1365.45	13.100	401.84	0.492	
GSEEP	10/18/88	10:22	10.20	1386.43	20.980	412.04	0.486	
GSEEP	11/10/88	09:08	12.62	1409.38	22.950	424.66	0.550	Smell of urine in sample and coming from hole.
GSEEP	12/13/88	10:20	17.81	1442.43	33.050	442.47	0.539	Sample effervesces and brine feels warmer than usual.

WIPP BRINE SAMPLING AND EVALUATION PROGRAM
Appendix A for the 1988 BSEP Report
Data through December 31, 1988

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
IG201	03/16/83			0.000	0.000	0.00	0.000	Approximate date the west side of SPDV Test Room 2 excavated.
IG201	03/20/83			0.000	0.000	0.00	0.000	Approximate date hole drilled, inclinometer guide tube partially grouted into hole 3/28/83.
IG201	11/30/84	12:00	63.10	-31.500	1.000	63.10	0.000	First time collected, 63.10 liters removed.
IG201	01/08/85	12:00	01.52	7.500	39.000	64.62	0.000	Partialy evacuated, some brine left in hole.
IG201	01/09/85	10:00	02.48	8.417	0.917	67.10	2.704	Some fluid was lost. Should add 1.52 liters from partial evacuation day before to this volume for liters/day calculation. Volume high
IG201	01/15/85	09:10	00.33	14.382	5.965	67.43	0.055	for 1/09/85 because some brine was stored behind the liner and drained into hole after initial draining.
IG201	01/22/85	10:10	00.38	21.424	7.042	67.81	0.054	
IG201	01/29/85	10:44	00.25	28.447	7.023	68.06	0.036	
IG201	02/05/85	09:20	00.30	35.389	6.942	68.36	0.043	
IG201	02/11/85	09:45	00.24	41.406	6.017	68.60	0.040	
IG201	02/19/85	11:15	00.32	49.469	8.063	68.92	0.040	
IG201	02/26/85	09:45	00.26	56.406	6.937	69.18	0.037	
IG201	03/05/85	09:22	00.25	63.390	6.984	69.43	0.036	
IG201	03/12/85	09:00	00.25	70.375	6.985	69.68	0.036	
IG201	03/20/85	09:38	00.17	78.401	8.026	69.85	0.021	
IG201	03/26/85	09:10	00.27	84.382	5.981	70.12	0.045	
IG201	04/02/85	09:30	00.24	91.396	7.014	70.36	0.034	
IG201	04/10/85	09:30	00.26	99.396	8.000	70.62	0.033	
IG201	04/17/85	13:40	00.26	106.569	7.173	70.88	0.036	
IG201	04/23/85	12:00	00.23	112.500	5.931	71.11	0.039	
IG201	04/30/85	11:41	00.21	119.487	6.987	71.32	0.030	
IG201	05/07/85	10:30	00.23	126.438	6.951	71.55	0.033	
IG201	05/14/85	11:00	00.24	133.458	7.020	71.79	0.034	
IG201	05/21/85	11:09	00.23	140.465	7.007	72.02	0.033	
IG201	05/29/85	10:00	00.30	148.417	7.952	72.32	0.038	
IG201	06/04/85	11:45	00.16	154.490	6.073	72.48	0.026	
IG201	06/11/85	11:20	00.22	161.472	6.982	72.70	0.032	
IG201	06/18/85	10:42	00.21	168.446	6.974	72.91	0.030	
IG201	06/25/85	09:55	00.22	175.413	6.967	73.13	0.032	
IG201	07/02/85	11:00	00.23	182.458	7.045	73.36	0.033	
IG201	07/09/85	11:33	00.24	189.481	7.023	73.60	0.034	Brine effervesces.
IG201	07/16/85	12:00	00.27	196.500	7.019	73.87	0.038	Brine effervesces.
IG201	07/24/85	11:02	00.31	204.460	7.960	74.18	0.039	
IG201	07/30/85	10:40	00.24	210.444	5.984	74.42	0.040	
IG201	08/06/85	10:49	00.24	217.451	7.007	74.66	0.034	
IG201	08/14/85	12:04	00.28	225.503	8.052	74.94	0.035	
IG201	08/20/85	11:24	00.26	231.475	5.972	75.20	0.044	
IG201	08/28/85	10:00	00.21	239.417	7.942	75.41	0.026	
IG201	09/04/85	10:52	00.16	246.453	7.036	75.57	0.023	
IG201	09/10/85	11:16	00.12	252.469	6.016	75.69	0.020	
IG201	09/17/85	10:11	00.15	259.424	6.955	75.84	0.022	
IG201	09/24/85	10:08	00.16	266.422	6.998	76.00	0.023	
IG201	10/01/85	10:20	00.13	273.431	7.009	76.13	0.019	
IG201	10/08/85	11:09	00.18	280.465	7.034	76.31	0.026	
IG201	10/15/85	10:45	00.17	287.448	6.983	76.48	0.024	
IG201	10/23/85	10:52	00.19	295.453	8.005	76.67	0.024	
IG201	10/29/85	10:37	00.14	301.442	5.989	76.81	0.023	
IG201	11/05/85	09:38	00.19	308.401	6.959	77.00	0.027	
IG201	11/13/85	10:40	00.24	316.444	8.043	77.24	0.030	
IG201	11/21/85	11:48	00.25	324.492	8.048	77.49	0.031	
IG201	11/26/85	10:35	00.15	329.441	4.949	77.64	0.030	
IG201	12/10/85	11:10	00.35	343.465	14.024	77.99	0.025	Two weeks.
IG201	12/17/85	14:10	00.23	350.590	7.125	78.22	0.032	
IG201	01/03/86	10:20	00.42	367.431	16.841	78.64	0.025	
IG201	01/08/86	10:30	00.20	372.438	5.007	78.84	0.040	
IG201	01/16/86	10:10	00.16	380.424	7.986	79.00	0.020	
IG201	01/23/86	10:20	00.15	387.431	7.007	79.15	0.021	
IG201	01/31/86	12:38	00.17	395.526	8.095	79.32	0.021	
IG201	02/12/86	11:30	00.25	407.479	11.953	79.57	0.021	
IG201	02/19/86	12:00	00.17	414.500	7.021	79.74	0.024	
IG201	02/28/86	13:45	00.30	423.573	9.073	80.04	0.033	
IG201	03/06/86	11:00	00.19	429.458	5.885	80.23	0.032	
IG201	03/13/86	10:27	00.20	436.435	6.977	80.43	0.029	
IG201	03/26/86	10:25	00.31	449.434	12.999	80.74	0.024	

IG201	04/02/86	10:05	00.16	456.420	6.986	80.90	0.023	
IG201	04/08/86	10:15	00.13	462.427	6.007	81.03	0.022	
IG201	04/16/86	12:30	00.15	470.521	8.094	81.18	0.019	
IG201	04/24/86	10:35	00.13	478.441	7.920	81.31	0.016	
IG201	04/30/86	11:14	00.10	484.468	6.027	81.41	0.017	
IG201	05/06/86	10:40	NA	490.444	5.976	81.41	0.000	Not collected, sampler left in hole.
IG201	05/20/86	11:30	NA	504.479	20.011	81.41	0.000	
IG201	05/27/86	16:10	NA	511.674	27.206	81.41	0.000	
IG201	06/03/86	10:45	NA	518.448	33.980	81.41	0.000	
IG201	06/10/86	11:45	NA	525.490	41.022	81.41	0.000	
IG201	06/17/86	11:22	NA	532.474	48.006	81.41	0.000	
IG201	06/24/86	11:20	NA	539.472	55.004	81.41	0.000	
IG201	07/01/86	14:20	NA	546.597	62.129	81.41	0.000	
IG201	07/08/86	10:55	NA	553.455	68.987	81.41	0.000	
IG201	07/16/86	11:00	NA	561.458	76.990	81.41	0.000	
IG201	07/22/86	10:20	NA	567.431	82.963	81.41	0.000	
IG201	07/29/86	10:55	NA	574.455	89.987	81.41	0.000	
IG201	09/04/86	11:00	NA	611.458	126.990	81.41	0.000	
IG201	09/09/86	09:15	NA	616.385	131.917	81.41	0.000	
IG201	09/16/86	10:28	NA	623.436	138.968	81.41	0.000	
IG201	10/01/86	12:31	NA	638.522	154.054	81.41	0.000	
IG201	10/08/86	11:25	02.57	645.476	161.008	83.98	0.016	Solvent odor, fluid "frothy" in container. First evacuation in 161 days.
IG201	10/14/86	12:14	00.19	651.510	6.034	84.17	0.031	
IG201	11/05/86	11:55	NA	673.497	21.987	84.17	0.000	Wrong bailer, not collected.
IG201	11/20/86	NA:	NA	688.000	36.490	84.17	0.000	
IG201	12/30/86	01:13	00.53	728.051	76.541	84.70	0.007	
IG201	02/04/87	09:30	00.44	764.396	36.345	85.14	0.012	
IG201	03/06/87	13:00	0.37	794.542	30.146	85.51	0.012	
IG201	09/01/87	14:00	3.07	973.583	179.041	88.58	0.017	Hole pinched shut by shear closure. Barely able to get sampler down hole. Last time sampled for BSEP.

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IG202	04/08/83			0.000	0.000	0.00	0.000	Approximate date west side of SPDV Test Room 1 excavated.
IG202	04/10/83			0.000	0.000	0.00	0.000	Approximate date hole drilled, inclinometer guide tube partially grouted into hole 4/21/83.
IG202	11/30/84	12:00	52.00	-31.500	1.000	52.00	0.000	First time collected.
IG202	01/08/85	12:00	12.58	7.500	39.000	64.58	0.323	Volume high because some brine was stored behind the liner and drained into hole after initial draining.
IG202	01/15/85	09:25	00.59	14.392	6.892	65.17	0.086	
IG202	01/22/85	12:00	00.34	21.500	7.108	65.51	0.048	
IG202	01/29/85	12:00	00.33	28.500	7.000	65.84	0.047	
IG202	02/05/85	10:17	00.41	35.428	6.928	66.25	0.059	
IG202	02/11/85	09:30	00.27	41.396	5.968	66.52	0.045	
IG202	02/19/85	12:00	00.32	49.500	8.104	66.84	0.039	
IG202	02/26/85	12:00	00.25	56.500	7.000	67.09	0.036	
IG202	03/05/85	09:03	00.20	63.377	6.877	67.29	0.029	
IG202	03/12/85	08:58	00.23	70.374	6.997	67.52	0.033	
IG202	03/20/85	09:16	00.25	78.386	8.012	67.77	0.031	
IG202	03/26/85	09:00	00.18	84.375	5.989	67.95	0.030	
IG202	04/02/85	09:10	00.19	91.382	7.007	68.14	0.027	
IG202	04/10/85	09:19	00.21	99.388	8.006	68.35	0.026	
IG202	04/17/85	13:56	00.18	106.581	7.193	68.53	0.025	
IG202	04/23/85	12:12	00.14	112.508	5.927	68.67	0.024	
IG202	04/30/85	13:00	00.15	119.542	7.034	68.82	0.021	
IG202	05/07/85	10:40	00.14	126.444	6.902	68.96	0.020	
IG202	05/14/85	11:16	00.14	133.469	7.025	69.10	0.020	
IG202	05/21/85	11:30	00.14	140.479	7.010	69.24	0.020	
IG202	05/29/85	10:00	00.15	148.417	7.938	69.39	0.019	
IG202	06/04/85	12:10	00.11	154.507	6.090	69.50	0.018	
IG202	06/11/85	11:40	00.12	161.486	6.979	69.62	0.017	Hole entry becoming tight due to shear closure of guide tube.
IG202	06/18/85	10:55	00.12	168.455	6.969	69.74	0.017	
IG202	06/25/85	09:50	00.11	175.410	6.955	69.85	0.016	
IG202	07/02/85	11:30	00.11	182.479	7.069	69.96	0.016	
IG202	07/09/85	11:15	00.09	189.469	6.990	70.05	0.013	Brine effervesces.
IG202	07/16/85	12:19	00.07	196.513	7.044	70.12	0.010	Brine effervesces.
IG202	07/24/85	11:15	00.11	204.469	7.956	70.23	0.014	
IG202	08/06/85	11:08	00.18	217.464	12.995	70.41	0.014	Not sampled last week.
IG202	08/14/85	12:17	00.09	225.512	8.048	70.50	0.011	
IG202	08/20/85	11:00	00.06	231.458	5.946	70.56	0.010	
IG202	08/28/85	10:00	00.13	239.417	7.959	70.69	0.016	
IG202	09/04/85	10:00	00.09	246.417	7.000	70.78	0.013	
IG202	09/10/85	11:35	00.09	252.483	6.066	70.87	0.015	
IG202	09/17/85	10:00	00.13	259.417	6.934	71.00	0.019	
IG202	09/24/85	10:00	00.10	266.417	7.000	71.10	0.014	
IG202	10/01/85	10:35	00.08	273.441	7.024	71.18	0.011	
IG202	10/08/85	11:15	00.10	280.469	7.028	71.28	0.014	
IG202	04/08/86	11:00	NA	462.458	181.989	71.28	0.000	Guide tube badly distorted, not collected.
IG202	04/24/86	10:50	NA	478.451	197.982	71.28	0.000	
IG202	05/06/86	11:00	NA	490.458	209.989	71.28	0.000	
IG202	05/20/86	11:30	NA	504.479	224.010	71.28	0.000	
IG202	06/03/86	10:55	NA	518.455	237.986	71.28	0.000	
IG202	06/17/86	11:38	NA	532.485	252.016	71.28	0.000	
IG202	07/29/86	11:06	NA	574.463	293.994	71.28	0.000	
IG202	09/04/86	11:50	NA	611.493	331.024	71.28	0.000	
IG202	10/01/86	12:45	NA	638.531	358.062	71.28	0.000	Not collected.
IG202	10/08/86	11:50	05.06	645.493	365.024	76.34	0.014	First time collected in a year.
IG202	10/14/86	12:23	00.17	651.516	6.023	76.51	0.028	
IG202	11/05/86	12:10	0.24	673.507	21.991	76.75	0.011	
IG202	11/20/86	NA:	NA	688.000	14.493	76.75	0.000	
IG202	12/30/86	NA:	NA	728.000	54.493	76.75	0.000	
IG202	02/04/87	09:45	00.99	764.406	90.899	77.74	0.011	Paint chips in brine, smelled like paint thinner.
IG202	03/06/87	13:10	0.36	794.549	30.143	78.10	0.012	Last time sampled for BSEP.
IG202	07/28/87	10:00	0.00	938.417	143.868	78.10	0.000	Hole pinched shut by shear closure. Unable to get sampler down hole.
IG202	09/01/87			973.000	0.000	78.10	0.000	Did not evacuate, no calculation.

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L1S25	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S25	06/28/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S25	08/20/85			0.000	0.000	0.00	0.000	Wet.
L1S25	09/17/85			0.000	0.000	0.00	0.000	Wet.
L1S25	12/10/85	09:00	02.84	343.375	1.000	2.84	0.000	First time collected.
L1S25	12/17/85	09:00	00.18	350.375	7.000	3.02	0.026	
L1S25	01/03/86	09:00	00.25	367.375	17.000	3.27	0.015	
L1S25	01/08/86	09:00	00.10	372.375	5.000	3.37	0.020	
L1S25	01/16/86	09:00	00.13	380.375	8.000	3.50	0.016	
L1S25	01/23/86	09:00	00.11	387.375	7.000	3.61	0.016	
L1S25	01/31/86	09:00	00.13	395.375	8.000	3.74	0.016	
L1S25	02/12/86	09:00	00.19	407.375	12.000	3.93	0.016	
L1S25	02/19/86	09:00	00.12	414.375	7.000	4.05	0.017	
L1S25	02/28/86	09:00	00.15	423.375	9.000	4.20	0.017	
L1S25	03/06/86	09:15	00.10	429.385	6.010	4.30	0.017	
L1S25	03/13/86	08:35	00.10	436.358	6.973	4.40	0.014	
L1S25	03/26/86	08:40	00.20	449.361	13.003	4.60	0.015	
L1S25	04/02/86	08:20	00.11	456.347	6.986	4.71	0.016	
L1S25	04/08/86	08:30	00.09	462.354	6.007	4.80	0.015	
L1S25	04/16/86	10:25	00.10	470.434	8.080	4.90	0.012	
L1S25	04/24/86	08:55	00.13	478.372	7.938	5.03	0.016	
L1S25	04/30/86	09:25	00.10	484.392	6.020	5.13	0.017	Suction probe installed.
L1S25	05/06/86	09:05	00.09	490.378	5.986	5.22	0.015	
L1S25	05/13/86	09:00	00.10	497.375	6.997	5.32	0.014	
L1S25	05/20/86	09:20	00.10	504.389	7.014	5.42	0.014	
L1S25	05/27/86	14:20	00.10	511.597	7.208	5.52	0.014	
L1S25	06/03/86	08:55	00.10	518.372	6.775	5.62	0.015	
L1S25	06/10/86	09:33	00.10	525.398	7.026	5.72	0.014	
L1S25	06/17/86	09:24	00.10	532.392	6.994	5.82	0.014	
L1S25	06/24/86	09:33	00.10	539.398	7.006	5.92	0.014	
L1S25	07/01/86	12:08	00.10	546.506	7.108	6.02	0.014	
L1S25	07/08/86	09:15	00.10	553.385	6.879	6.12	0.015	
L1S25	07/16/86	09:24	00.12	561.392	8.007	6.24	0.015	
L1S25	07/22/86	08:59	00.09	567.374	5.982	6.33	0.015	
L1S25	07/29/86	09:27	00.10	574.394	7.020	6.43	0.014	
L1S25	08/05/86	09:51	00.09	581.410	7.016	6.52	0.013	
L1S25	08/12/86	09:20	00.10	588.389	6.979	6.62	0.014	
L1S25	08/19/86	10:03	00.10	595.419	7.030	6.72	0.014	
L1S25	08/26/86	09:36	00.10	602.400	6.981	6.82	0.014	
L1S25	09/04/86	09:15	00.12	611.385	8.985	6.94	0.013	
L1S25	09/09/86	11:38	00.08	616.485	5.100	7.02	0.016	
L1S25	09/16/86	09:02	00.09	623.376	6.891	7.11	0.013	
L1S25	09/23/86	09:08	00.10	630.381	7.005	7.21	0.014	
L1S25	10/01/86	09:58	00.10	638.415	8.034	7.31	0.012	
L1S25	10/08/86	09:24	00.10	645.392	6.977	7.41	0.014	
L1S25	10/14/86	10:09	00.07	651.423	6.031	7.48	0.012	
L1S25	11/05/86	09:32	0.27	673.397	21.974	7.75	0.012	
L1S25	11/20/86	10:13	00.18	688.426	15.029	7.93	0.012	
L1S25	12/31/86	10:42	00.41	729.446	41.020	8.34	0.010	Suction lysimeter removed.
L1S25	03/06/87	12:20	0.61	794.514	65.068	8.95	0.009	
L1S25	03/31/87	10:25	0.00	819.434	24.920	8.95	0.000	Dry.
L1S25	05/07/87	08:35	0.33	856.358	61.844	9.28	0.005	
L1S25	06/18/87	12:25	0.42	898.517	42.159	9.70	0.010	
L1S25	07/28/87	13:09	0.44	938.548	40.031	10.14	0.011	
L1S25	09/01/87	12:52	0.34	973.536	34.988	10.48	0.010	
L1S25	10/20/87	12:20	0.38	1022.51	48.974	10.86	0.008	
L1S25	11/19/87	12:20	0.19	1052.51	30.000	11.05	0.006	
L1S25	01/04/88	12:33	0.14	1098.52	46.010	11.19	0.003	
L1S25	02/08/88	13:46	0.13	1133.57	35.050	11.32	0.004	
L1S25	03/30/88	12:20	0.28	1184.51	50.940	11.60	0.005	
L1S25	07/12/88	11:50	0.31	1288.49	103.980	11.91	0.003	
L1S25	09/27/88	08:50	0.40	1365.37	76.880	12.31	0.005	
L1S25	12/13/88	11:30	0.55	1442.48	77.110	12.86	0.007	

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L1S26	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S26	06/28/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S26	08/20/85			0.000	0.000	0.00	0.000	Dry.
L1S26	09/17/85			0.000	0.000	0.00	0.000	Dry.
L1S26	12/10/85			0.000	0.000	0.00	0.000	Dry.
L1S26	12/17/85			0.000	0.000	0.00	0.000	Dry.
L1S26	04/02/86	08:20	00.09	456.347	1.000	0.09	0.000	First time collected.
L1S26	04/24/86	08:55	00.05	478.372	22.025	0.14	0.002	
L1S26	05/20/86	09:20	00.05	504.389	26.017	0.19	0.002	
L1S26	06/10/86	09:24	00.05	525.392	21.003	0.24	0.002	
L1S26	06/24/86	09:20	00.05	539.389	13.997	0.29	0.004	
L1S26	07/08/86	09:17	00.04	553.387	13.998	0.33	0.003	
L1S26	07/16/86	09:05	00.02	561.378	7.991	0.35	0.003	
L1S26	07/29/86	09:15	00.04	574.385	13.007	0.39	0.003	
L1S26	08/12/86	09:06	00.04	588.379	13.994	0.43	0.003	
L1S26	08/26/86	09:25	00.04	602.392	14.013	0.47	0.003	
L1S26	09/09/86	11:27	00.05	616.477	14.085	0.52	0.004	
L1S26	09/23/86	08:55	00.03	630.372	13.895	0.55	0.002	
L1S26	10/01/86	09:48	00.03	638.408	8.036	0.58	0.004	
L1S26	11/05/86	09:04	0.03	673.378	34.970	0.61	0.001	
L1S26	11/20/86	09:59	00.03	688.416	15.038	0.64	0.002	
L1S26	12/31/86	10:42	NA	729.446	41.030	0.64	0.000	Dry.
L1S26	03/06/87	12:25	0.05	794.517	106.101	0.69	0.000	
L1S26	03/31/87	10:28	0.00	819.436	24.919	0.69	0.000	Dry.
L1S26	05/07/87	08:37	0.02	856.359	61.842	0.71	0.000	
L1S26	06/18/87	12:27	0.07	898.519	42.160	0.78	0.002	
L1S26	07/28/87	13:13	0.10	938.551	40.032	0.88	0.002	
L1S26	09/01/87	12:55	0.07	973.538	34.987	0.95	0.002	
L1S26	10/20/87	12:24	0.03	1022.52	48.982	0.98	0.001	
L1S26	11/19/87	12:21	0.07	1052.51	29.990	1.05	0.002	
L1S26	01/04/88	12:38	0.03	1098.53	46.020	1.08	0.001	
L1S26	02/08/88	13:47	0.04	1133.57	35.040	1.12	0.001	
L1S26	03/30/88	12:20	Trace	1184.51	50.940	1.12	0.000	
L1S26	07/12/88	11:50	0.11	1288.49	103.980	1.23	0.001	
L1S26	09/27/88	08:52	0.15	1365.37	76.880	1.38	0.002	
L1S26	12/13/88	11:30	0.13	1442.48	77.110	1.51	0.002	

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L1S27	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S27	07/01/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S27	08/20/85			0.000	0.000	0.00	0.000	Wet.
L1S27	09/17/85			0.000	0.000	0.00	0.000	Wet.
L1S27	12/10/85	09:00	00.83	343.375	1.000	0.83	0.000	First time collected.
L1S27	12/17/85			0.000	0.000	0.00	0.000	Wet, partial pool in bottom, none collected.
L1S27	01/03/86	09:00	00.10	367.375	24.000	0.93	0.004	
L1S27	01/16/86	09:00	00.05	380.375	13.000	0.98	0.004	
L1S27	02/12/86	09:00	00.08	407.375	27.000	1.06	0.003	
L1S27	02/19/86	09:00	00.04	414.375	7.000	1.10	0.006	
L1S27	02/28/86	09:00	00.06	423.375	9.000	1.16	0.007	
L1S27	03/13/86	08:35	00.08	436.358	12.983	1.24	0.006	Two weeks collection.
L1S27	03/26/86	08:45	00.06	449.365	13.007	1.30	0.005	
L1S27	04/08/86	08:30	00.07	462.354	12.989	1.37	0.005	
L1S27	04/24/86	09:05	00.08	478.378	16.024	1.45	0.005	
L1S27	05/06/86	08:55	00.05	490.372	11.994	1.50	0.004	
L1S27	05/13/86	08:50	00.04	497.368	6.996	1.54	0.006	
L1S27	05/27/86	14:20	00.07	511.597	14.229	1.61	0.005	
L1S27	06/10/86	09:25	00.06	525.392	13.795	1.67	0.004	
L1S27	06/17/86	09:15	00.04	532.385	6.993	1.71	0.006	
L1S27	06/24/86	09:22	00.04	539.390	7.005	1.75	0.006	
L1S27	07/01/86	11:56	00.04	546.497	7.107	1.79	0.006	
L1S27	07/08/86	09:18	00.04	553.388	6.891	1.83	0.006	
L1S27	07/16/86	09:09	00.04	561.381	7.993	1.87	0.005	
L1S27	07/29/86	09:17	00.07	574.387	13.006	1.94	0.005	
L1S27	08/12/86	09:08	00.06	588.381	13.994	2.00	0.004	
L1S27	08/19/86	09:52	00.05	595.411	7.030	2.05	0.007	
L1S27	08/26/86	09:26	00.04	602.393	6.982	2.09	0.006	
L1S27	09/04/86	08:57	00.05	611.373	8.980	2.14	0.006	
L1S27	09/09/86	11:28	00.04	616.478	5.105	2.18	0.008	
L1S27	09/16/86	08:53	00.04	623.370	6.892	2.22	0.006	
L1S27	09/23/86	08:56	00.03	630.372	7.002	2.25	0.004	
L1S27	10/01/86	09:49	00.03	638.409	8.037	2.28	0.004	
L1S27	11/05/86	09:06	0.06	673.379	34.970	2.34	0.002	
L1S27	11/20/86	10:02	00.04	688.418	15.039	2.38	0.003	
L1S27	12/31/86	10:42	00.00	729.446	41.028	2.38	0.000	Wet, but not enough to remove.
L1S27	03/06/87	12:30	0.13	794.521	65.075	2.51	0.002	
L1S27	03/31/87	10:28	0.00	819.436	24.915	2.51	0.000	Dry.
L1S27	05/07/87	08:39	0.07	856.360	61.839	2.58	0.001	
L1S27	06/18/87	12:30	0.11	898.521	42.161	2.69	0.003	
L1S27	07/28/87	13:14	0.18	938.551	40.030	2.87	0.004	
L1S27	09/01/87	12:55	0.14	973.538	34.987	3.01	0.004	
L1S27	10/20/87	12:25	0.09	1022.52	48.982	3.10	0.002	
L1S27	11/19/87	12:25	0.11	1052.52	30.000	3.21	0.004	
L1S27	01/04/88	12:40	0.00	1098.53	46.010	3.21	0.000	Dry.
L1S27	02/08/88	13:48	0.00	1133.58	35.050	3.21	0.000	Dry.
L1S27	03/30/88	12:20	0.07	1184.51	50.930	3.28	0.001	
L1S27	07/12/88	11:50	0.24	1288.49	103.980	3.52	0.002	
L1S27	09/27/88	08:54	0.53	1365.37	76.880	4.05	0.007	
L1S27	12/13/88	11:30	0.18	1442.48	77.110	4.23	0.002	

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L1S28	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S28	07/12/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S28	08/20/85			0.000	0.000	0.00	0.000	Dry.
L1S28	09/17/85			0.000	0.000	0.00	0.000	Dry.
L1S28	12/10/85			0.000	0.000	0.00	0.000	Dry.
L1S28	12/17/85			0.000	0.000	0.00	0.000	Dry.
L1S28	11/05/86	09:08	0.11	673.381	1.000	0.11	0.000	
L1S28	11/20/86	NA:	NA	688.000	14.619	0.11	0.000	Dry.
L1S28	12/31/86	10:42	NA	729.446	41.011	0.11	0.000	Dry.
L1S28	03/06/87	12:30	NA	794.521	121.140	0.11	0.000	Dry.
L1S28	03/31/87	10:31	0.00	819.438	24.917	0.11	0.000	Dry.
L1S28	05/07/87	08:39	0.00	856.360	61.839	0.11	0.000	Dry.
L1S28	06/18/87	12:35	0.00	898.524	104.003	0.11	0.000	Dry.
L1S28	07/28/87	13:24	0.09	938.558	144.037	0.20	0.001	
L1S28	09/01/87	12:55	0.01	973.538	34.980	0.21	0.000	
L1S28	10/20/87	12:26	0.02	1022.52	48.982	0.23	0.000	
L1S28	11/19/87	12:30	0.00	1052.52	30.000	0.23	0.000	Dry.
L1S28	01/04/88	12:42	0.01	1098.53	46.010	0.24	0.000	
L1S28	02/08/88	13:49	Trace	1133.58	35.050	0.24	0.000	
L1S28	03/30/88	12:20	0.00	1184.51	50.930	0.24	0.000	Dry.
L1S28	07/12/88	11:55	0.50	1288.50	103.990	0.74	0.005	
L1S28	09/27/88	08:56	0.40	1365.37	76.870	1.14	0.005	
L1S28	12/13/88	11:30	0.37	1442.48	77.110	1.51	0.005	

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L1S29	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S29	07/15/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S29	08/20/85			0.000	0.000	0.00	0.000	Wet.
L1S29	09/17/85			0.000	0.000	0.00	0.000	Wet.
L1S29	12/10/85	09:00	02.20	343.375	1.000	2.20	0.000	First time collected.
L1S29	12/17/85	09:00	00.30	350.375	7.000	2.50	0.043	
L1S29	01/03/86	09:00	00.71	367.375	17.000	3.21	0.042	
L1S29	01/08/86	09:00	00.24	372.375	5.000	3.45	0.048	
L1S29	01/16/86	09:00	00.40	380.375	8.000	3.85	0.050	
L1S29	01/23/86	09:00	00.32	387.375	7.000	4.17	0.046	
L1S29	01/31/86	09:00	00.34	395.375	8.000	4.51	0.043	
L1S29	02/12/86	09:00	00.41	407.375	12.000	4.92	0.034	
L1S29	02/19/86	09:00	00.25	414.375	7.000	5.17	0.036	
L1S29	02/28/86	09:00	00.23	423.375	9.000	5.40	0.026	
L1S29	03/06/86	09:20	00.13	429.389	6.014	5.53	0.022	
L1S29	03/13/86	08:35	00.16	436.358	6.969	5.69	0.023	
L1S29	03/26/86	08:50	00.27	449.368	13.010	5.96	0.021	
L1S29	04/02/86	08:30	00.15	456.354	6.986	6.11	0.021	
L1S29	04/08/86	08:40	00.11	462.361	6.007	6.22	0.018	
L1S29	04/16/86	10:35	00.13	470.441	8.080	6.35	0.016	
L1S29	04/24/86	09:10	00.12	478.382	7.941	6.47	0.015	
L1S29	04/30/86	09:35	00.12	484.399	6.017	6.59	0.020	
L1S29	05/06/86	09:00	00.12	490.375	5.976	6.71	0.020	Suction probe installed.
L1S29	05/13/86	08:55	00.12	497.372	6.997	6.83	0.017	
L1S29	05/20/86	09:20	00.11	504.389	7.017	6.94	0.016	
L1S29	05/27/86	14:20	00.13	511.597	7.208	7.07	0.018	
L1S29	06/03/86	08:53	00.13	518.370	6.773	7.20	0.019	
L1S29	06/10/86	09:37	00.14	525.401	7.031	7.34	0.020	
L1S29	06/17/86	09:21	00.13	532.390	6.989	7.47	0.019	
L1S29	06/24/86	09:30	00.14	539.396	7.006	7.61	0.020	
L1S29	07/01/86	12:06	00.15	546.504	7.108	7.76	0.021	
L1S29	07/08/86	09:25	00.13	553.392	6.888	7.89	0.019	
L1S29	07/16/86	09:21	00.16	561.390	7.998	8.05	0.020	
L1S29	07/22/86	09:00	00.11	567.375	5.985	8.16	0.018	
L1S29	07/29/86	09:25	00.12	574.392	7.017	8.28	0.017	
L1S29	08/05/86	09:48	00.13	581.408	7.016	8.41	0.019	
L1S29	08/12/86	09:18	00.14	588.388	6.980	8.55	0.020	
L1S29	08/19/86	10:01	00.18	595.417	7.029	8.73	0.026	
L1S29	08/26/86	09:34	00.26	602.399	6.982	8.99	0.037	
L1S29	09/04/86	09:10	00.60	611.382	8.983	9.59	0.067	
L1S29	09/09/86	11:37	00.48	616.484	5.102	10.07	0.094	
L1S29	09/16/86	09:16	00.76	623.386	6.902	10.83	0.110	
L1S29	09/23/86	09:06	00.77	630.379	6.993	11.60	0.110	
L1S29	10/01/86	10:00	00.74	638.417	8.038	12.34	0.092	
L1S29	10/08/86	09:28	00.69	645.394	6.977	13.03	0.099	
L1S29	10/14/86	10:12	00.67	651.425	6.031	13.70	0.111	
L1S29	11/05/86	09:35	0.80	673.399	21.974	14.50	0.036	
L1S29	11/20/86	10:27	05.60	688.435	15.036	20.10	0.372	0.70 liters in probe. Opened hole and found suction tube floating on brine. Bailed hole dry.
L1S29	12/31/86	10:32	06.48	729.439	41.004	26.58	0.158	Suction lysimeter removed.
L1S29	03/06/87	12:40	10.32	794.528	65.089	36.90	0.159	
L1S29	03/31/87	10:30	4.19	819.438	24.910	41.09	0.162	
L1S29	05/07/87	08:45	18.82	856.365	36.927	59.91	0.510	
L1S29	05/08/87	08:45	13.35	857.365	0.000	73.26	0.000	Not pumped dry, brine left in hole, no calculation.
L1S29	06/17/87	14:10	16.31	897.590	0.000	89.59	0.000	Partial removal, no calculation.
L1S29	06/18/87	12:36	3.66	898.525	42.160	93.23	0.790	Used 33.32 liters in 42.16 days for calculation (5/08/87, 6/17/87, and 6/18/87).
L1S29	07/28/87	13:25	11.32	938.559	40.034	104.55	0.283	
L1S29	09/01/87	12:55	2.43	973.538	34.979	106.98	0.069	
L1S29	10/20/87	12:28	2.61	1022.52	48.982	109.59	0.053	
L1S29	11/19/87	12:35	1.43	1052.52	30.000	111.02	0.048	
L1S29	01/04/88	12:45	2.85	1098.53	46.010	113.87	0.062	
L1S29	02/08/88	13:49	2.43	1133.58	35.050	116.30	0.069	
L1S29	03/30/88	12:20	3.00	1184.51	50.930	119.30	0.059	
L1S29	07/12/88	11:58	7.14	1288.50	103.990	126.44	0.069	
L1S29	09/27/88	08:58	14.23	1365.37	76.870	140.67	0.185	
L1S29	12/13/88	11:45	9.97	1442.49	77.120	150.64	0.129	

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
L1S30	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S30	07/15/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S30	08/20/85			0.000	0.000	0.00	0.000	Dry.
L1S30	09/17/85			0.000	0.000	0.00	0.000	Dry.
L1S30	12/10/85			0.000	0.000	0.00	0.000	Dry.
L1S30	12/17/85			0.000	0.000	0.00	0.000	Dry.
L1S30	01/23/86	09:00	00.07	387.375	1.000	0.07	0.000	First time collected.
L1S30	02/12/86	09:00	00.09	407.375	20.000	0.16	0.004	
L1S30	03/26/86	08:45	00.32	449.365	41.990	0.48	0.008	
L1S30	04/08/86	08:35	00.13	462.358	12.993	0.61	0.010	
L1S30	04/24/86	09:10	00.10	478.382	16.024	0.71	0.006	
L1S30	05/06/86	09:00	00.05	490.375	11.993	0.76	0.004	
L1S30	05/13/86	08:50	00.05	497.368	6.993	0.81	0.007	
L1S30	05/27/86	14:20	00.08	511.597	14.229	0.89	0.006	
L1S30	06/17/86	09:17	00.07	532.387	20.790	0.96	0.003	
L1S30	07/01/86	11:58	00.05	546.499	14.112	1.01	0.004	
L1S30	07/16/86	09:10	00.03	561.382	14.883	1.04	0.002	
L1S30	07/29/86	09:19	00.04	574.388	13.006	1.08	0.003	
L1S30	08/19/86	09:53	00.04	595.412	21.024	1.12	0.002	
L1S30	09/04/86	09:00	00.04	611.375	15.963	1.16	0.003	
L1S30	09/09/86	11:29	00.02	616.478	5.103	1.18	0.004	
L1S30	09/23/86	08:58	00.02	630.374	13.896	1.20	0.001	
L1S30	10/01/86	09:51	00.02	638.410	8.036	1.22	0.002	
L1S30	10/14/86	10:01	00.00	651.417	13.007	1.22	0.000	Dry.
L1S30	11/05/86	09:35	NA	673.399	34.989	1.22	0.000	Dry.
L1S30	11/20/86	NA:	NA	688.000	49.590	1.22	0.000	
L1S30	12/31/86	10:08	00.05	729.422	91.012	1.27	0.001	
L1S30	03/06/87	12:45	0.21	794.531	65.109	1.27	0.000	
L1S30	03/31/87	10:33	0.15	819.440	24.909	1.42	0.006	
L1S30	05/07/87	09:37	22.87	856.401	36.961	24.29	0.619	
L1S30	05/08/87	08:35	16.28	857.358	0.000	40.57	0.000	Brine left in hole, no calculation.
L1S30	06/17/87	14:35	17.42	897.608	0.000	57.99	0.000	Brine left in hole, no calculation.
L1S30	06/18/87	12:40	0.58	898.528	42.127	58.57	0.814	Used 34.38 liters in 42.127 days for calculation (5/08/87, 6/17/87, and 6/18/87).
L1S30	07/28/87	13:29	3.82	938.562	40.034	62.39	0.095	
L1S30	09/01/87	13:00	2.09	973.542	34.980	64.48	0.060	One ear plug found in hole.
L1S30	10/20/87	12:36	1.59	1022.52	48.978	66.07	0.032	
L1S30	11/19/87	12:40	0.43	1052.53	30.010	66.50	0.014	
L1S30	01/04/88	12:47	0.28	1098.53	46.000	66.78	0.006	
L1S30	02/08/88	13:50	0.03	1133.58	35.050	66.81	0.001	
L1S30	03/30/88	12:30	5.07	1184.52	50.940	71.88	0.100	
L1S30	07/12/88	12:05	1.64	1288.50	103.980	73.52	0.016	
L1S30	09/27/88	09:15	7.55	1365.39	76.890	81.07	0.098	
L1S30	12/13/88	11:45	1.50	1442.49	77.100	82.57	0.019	

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L1S31	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84. Hole drilled before 12/85.
L1S31	07/24/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S31	08/20/85			0.000	0.000	0.00	0.000	Dry.
L1S31	09/17/85			0.000	0.000	0.00	0.000	Dry.
L1S31	12/10/85			0.000	0.000	0.00	0.000	Dry.
L1S31	12/17/85			0.000	0.000	0.00	0.000	Dry.
L1S31	11/05/86	09:35	NA	673.399	1.000	0.00	0.000	Dry.
L1S31	11/20/86	NA:	NA	688.000	15.601	0.00	0.000	Installed vacuum probe.
L1S31	12/31/86	10:08	NA	729.422	57.023	0.00	0.000	Dry.
L1S31	03/06/87	12:50	NA	794.535	122.136	0.00	0.000	Dry.
L1S31	03/31/87	10:33	0.00	819.440	24.905	0.00	0.000	Dry.
L1S31	05/07/87	09:41	0.73	856.403	61.868	0.73	0.012	
L1S31	06/18/87	12:42	3.39	898.529	42.126	4.12	0.080	
L1S31	07/28/87	13:32	0.37	938.564	40.035	4.49	0.009	
L1S31	09/01/87	13:05	0.21	973.545	34.981	4.70	0.006	
L1S31	10/20/87	12:39	0.27	1022.53	48.985	4.97	0.006	
L1S31	11/19/87	12:45	0.21	1052.53	30.000	5.18	0.007	
L1S31	01/04/88	12:48	0.20	1098.53	46.000	5.38	0.004	
L1S31	02/08/88	13:55	0.26	1133.58	35.050	5.64	0.007	
L1S31	03/30/88	12:35	0.30	1184.52	50.940	5.94	0.006	
L1S31	07/12/88	12:08	2.83	1288.51	103.990	8.77	0.027	
L1S31	09/27/88	09:20	8.08	1365.39	76.880	16.85	0.105	
L1S31	12/13/88	11:50	11.48	1442.49	77.100	28.33	0.149	

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L1S32	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S32	07/24/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S32	08/20/85			0.000	0.000	0.00	0.000	Dry.
L1S32	09/17/85			0.000	0.000	0.00	0.000	Moist.
L1S32	12/10/85			0.000	0.000	0.00	0.000	Dry.
L1S32	12/17/85			0.000	0.000	0.00	0.000	Dry.
L1S32	04/16/86	10:30	00.07	470.438	1.000	0.07	0.000	First collection.
L1S32	05/20/86	09:20	00.02	504.389	33.951	0.09	0.001	
L1S32	06/03/86	08:45	00.05	518.365	13.976	0.14	0.004	
L1S32	06/24/86	09:25	00.05	539.392	21.027	0.19	0.002	
L1S32	07/16/86	09:12	00.07	561.383	21.991	0.26	0.003	
L1S32	07/29/86	09:20	00.05	574.389	13.006	0.31	0.004	
L1S32	08/12/86	09:10	00.11	588.382	13.993	0.42	0.008	
L1S32	08/19/86	09:55	00.10	595.413	7.031	0.52	0.014	
L1S32	08/26/86	09:28	00.12	602.394	6.981	0.64	0.017	
L1S32	09/04/86	09:03	00.19	611.377	8.983	0.83	0.021	
L1S32	09/09/86	11:30	00.11	616.479	5.102	0.94	0.022	
L1S32	09/16/86	08:54	00.19	623.371	6.892	1.13	0.028	
L1S32	09/23/86	09:01	00.20	630.376	7.005	1.33	0.029	
L1S32	10/01/86	09:52	00.22	638.411	8.035	1.55	0.027	
L1S32	10/08/86	09:29	00.20	645.395	6.984	1.75	0.029	
L1S32	10/14/86	10:04	00.16	651.419	6.024	1.91	0.027	
L1S32	11/05/86	09:10	0.57	673.382	21.963	2.48	0.026	
L1S32	11/20/86	10:05	00.56	688.420	15.038	3.04	0.037	
L1S32	12/31/86	10:15	01.62	729.427	41.007	4.66	0.040	
L1S32	03/06/87	12:50	3.31	794.535	65.108	7.97	0.051	
L1S32	03/31/87	10:37	1.57	819.442	24.907	9.54	0.061	
L1S32	04/22/87	10:40	1.27	841.444	22.002	10.81	0.058	
L1S32	05/07/87	09:44	1.25	856.406	14.962	12.06	0.084	
L1S32	06/18/87	12:45	7.44	898.531	42.125	19.50	0.177	
L1S32	07/28/87	13:38	5.89	938.568	40.037	25.37	0.147	
L1S32	09/01/87	13:12	5.39	973.550	34.982	30.76	0.154	
L1S32	10/20/87	12:50	7.14	1022.53	48.980	37.90	0.146	
L1S32	11/19/87	12:50	4.32	1052.53	30.000	42.22	0.144	
L1S32	01/04/88	12:56	6.98	1098.54	46.010	49.20	0.152	
L1S32	02/08/88	14:00	6.11	1133.58	35.040	55.31	0.174	
L1S32	03/30/88	12:40	7.84	1184.53	50.950	63.15	0.154	
L1S32	07/12/88	12:20	12.64	1288.51	103.980	75.79	0.122	
L1S32	09/27/88	09:25	13.03	1365.39	76.880	88.82	0.169	
L1S32	12/13/88	11:50	12.40	1442.49	77.100	101.22	0.161	

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
L1S33	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S33	07/23/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S33	08/20/85			0.000	0.000	0.00	0.000	Wet.
L1S33	09/17/85			0.000	0.000	0.00	0.000	Wet.
L1S33	12/10/85	09:00	01.01	343.375	1.000	1.01	0.000	First time collected.
L1S33	12/17/85	09:00	00.11	350.375	7.000	1.12	0.016	
L1S33	01/03/86	09:00	00.21	367.375	17.000	1.33	0.012	
L1S33	01/08/86	09:00	00.06	372.375	5.000	1.39	0.012	
L1S33	01/16/86	09:00	00.09	380.375	8.000	1.48	0.011	
L1S33	01/23/86	09:00	00.08	387.375	7.000	1.56	0.011	
L1S33	01/31/86	09:00	00.09	395.375	8.000	1.65	0.011	
L1S33	02/12/86	09:00	00.15	407.375	12.000	1.80	0.012	
L1S33	02/19/86	09:00	00.12	414.375	7.000	1.92	0.017	
L1S33	02/28/86	09:00	00.11	423.375	9.000	2.03	0.012	Estimated,lost some during collection.
L1S33	03/06/86	09:20	00.09	429.389	6.014	2.12	0.015	
L1S33	03/13/86	08:40	00.10	436.361	6.972	2.22	0.014	
L1S33	03/26/86	08:50	00.20	449.368	13.007	2.42	0.015	
L1S33	04/02/86	08:30	00.10	456.354	6.986	2.52	0.014	
L1S33	04/08/86	08:38	00.08	462.360	6.006	2.60	0.013	
L1S33	04/16/86	10:30	00.11	470.438	8.078	2.71	0.014	
L1S33	04/24/86	09:10	00.12	478.382	7.944	2.83	0.015	
L1S33	04/30/86	09:30	00.10	484.396	6.014	2.93	0.017	
L1S33	05/06/86	09:00	00.09	490.375	5.979	3.02	0.015	
L1S33	05/13/86	08:55	00.11	497.372	6.997	3.13	0.016	
L1S33	05/20/86	09:20	00.12	504.389	7.017	3.25	0.017	
L1S33	05/27/86	14:20	00.12	511.597	7.208	3.37	0.017	
L1S33	06/03/86	08:50	00.12	518.368	6.771	3.49	0.018	
L1S33	06/10/86	09:28	00.12	525.394	7.026	3.61	0.017	
L1S33	06/17/86	09:19	00.12	532.388	6.994	3.73	0.017	
L1S33	06/24/86	09:25	00.13	539.392	7.004	3.86	0.019	
L1S33	07/01/86	12:00	00.11	546.500	7.108	3.97	0.015	
L1S33	07/08/86	09:20	00.10	553.389	6.889	4.07	0.015	
L1S33	07/16/86	09:14	00.13	561.385	7.996	4.20	0.016	
L1S33	07/22/86	08:52	00.10	567.369	5.984	4.30	0.017	
L1S33	07/29/86	09:22	00.15	574.390	7.021	4.45	0.021	
L1S33	08/05/86	09:43	00.13	581.405	7.015	4.58	0.019	
L1S33	08/12/86	09:13	00.16	588.384	6.979	4.74	0.023	
L1S33	08/19/86	09:56	00.16	595.414	7.030	4.90	0.023	
L1S33	08/26/86	09:29	00.18	602.395	6.981	5.08	0.026	
L1S33	09/04/86	09:04	00.22	611.378	8.983	5.30	0.024	
L1S33	09/09/86	11:31	00.14	616.480	5.102	5.44	0.027	
L1S33	09/16/86	08:55	00.16	623.372	6.892	5.60	0.023	
L1S33	09/23/86	09:02	00.17	630.376	7.004	5.77	0.024	
L1S33	10/01/86	09:54	00.20	638.413	8.037	5.97	0.025	
L1S33	10/08/86	09:29	00.18	645.395	6.982	6.15	0.026	
L1S33	10/14/86	10:06	00.17	651.421	6.026	6.32	0.028	
L1S33	11/05/86	09:15	0.45	673.385	21.964	6.77	0.020	
L1S33	11/20/86	10:07	00.35	688.422	15.037	7.12	0.023	
L1S33	12/31/86	10:17	00.69	729.428	41.006	7.81	0.017	
L1S33	03/06/87	12:55	0.68	794.538	65.110	8.49	0.010	
L1S33	03/31/87	10:40	0.81	819.444	24.906	9.30	0.031	
L1S33	05/07/87	09:46	1.50	856.407	36.963	10.80	0.041	
L1S33	06/18/87	12:50	4.39	898.535	42.128	15.19	0.104	
L1S33	07/28/87	13:45	2.10	938.573	40.038	17.29	0.052	
L1S33	09/01/87	13:13	0.27	973.551	34.978	17.56	0.008	
L1S33	10/20/87	12:52	2.20	1022.54	48.989	19.76	0.045	
L1S33	11/19/87	12:55	1.43	1052.54	30.000	21.19	0.048	
L1S33	01/04/88	12:58	2.82	1098.54	46.000	24.01	0.061	
L1S33	02/08/88	14:10	1.65	1133.59	35.050	25.66	0.047	
L1S33	03/30/88	12:45	1.96	1184.53	50.940	27.62	0.038	
L1S33	07/12/88	12:25	6.11	1288.52	103.990	33.73	0.059	
L1S33	09/27/88	09:40	7.77	1365.40	76.880	41.50	0.101	
L1S33	12/13/88	12:00	8.42	1442.50	77.100	49.92	0.109	

WIPP BRINE SAMPLING AND EVALUATION PROGRAM
Appendix A for the 1988 BSEP Report
Data through December 31, 1988

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
L1S34	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S34	07/18/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S34	08/20/85			0.000	0.000	0.00	0.000	Dry.
L1S34	09/17/85			0.000	0.000	0.00	0.000	Dry.
L1S34	12/10/85			0.000	0.000	0.00	0.000	Dry.
L1S34	12/17/85			0.000	0.000	0.00	0.000	Dry.
L1S34	11/05/86	09:15	NA	673.385	1.000	0.00	0.000	Dry.
L1S34	11/20/86	NA:	NA	688.000	15.615	0.00	0.000	
L1S34	12/31/86	10:17	NA	729.428	57.043	0.00	0.000	Dry.
L1S34	03/06/87	13:00	NA	794.542	122.157	0.00	0.000	Dry.
L1S34	03/31/87	10:40	0.00	819.444	24.902	0.00	0.000	Dry.
L1S34	05/07/87	09:46	0.00	856.407	61.865	0.00	0.000	Dry.
L1S34	06/18/87	12:51	0.00	898.535	103.993	0.00	0.000	Dry.
L1S34	07/28/87	13:38	0.00	938.568	144.026	0.00	0.000	Dry.
L1S34	09/01/87	13:13	0.00	973.551	34.983	0.00	0.000	Dry.
L1S34	10/20/87	12:53	0.00	1022.54	48.989	0.00	0.000	Dry.
L1S34	11/19/87	13:00	0.00	1052.54	30.000	0.00	0.000	Dry.
L1S34	01/04/88	12:58	0.00	1098.54	46.000	0.00	0.000	Dry.
L1S34	02/08/88	14:15		1133.59	0.000	0.00	0.000	Did not sample.
L1S34	03/30/88	12:45	0.00	1184.53	85.990	0.00	0.000	Dry.
L1S34	07/12/88	12:25	0.00	1288.52	103.990	0.00	0.000	Dry.
L1S34	09/27/88	09:40	0.00	1365.40	76.880	0.00	0.000	Dry.
L1S34	12/13/88	12:00	0	1442.50	77.100	0.00	0.000	Dry.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
L1S35	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S35	07/17/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S35	08/20/85			0.000	0.000	0.00	0.000	Dry.
L1S35	09/17/85			0.000	0.000	0.00	0.000	Dry.
L1S35	12/10/85			0.000	0.000	0.00	0.000	Dry.
L1S35	12/17/85			0.000	0.000	0.00	0.000	Dry.
L1S35	11/05/86	09:20	0.09	673.389	1.000	0.09	0.000	
L1S35	11/20/86	NA:	NA	688.000	14.611	0.09	0.000	
L1S35	12/31/86	10:17	NA	729.428	56.039	0.09	0.000	Dry.
L1S35	03/06/87	13:00	NA	794.542	121.153	0.09	0.000	Dry.
L1S35	03/31/87	10:40	0.00	819.444	24.902	0.09	0.000	Dry.
L1S35	05/07/87	09:46	0.00	856.407	61.865	0.09	0.000	Dry.
L1S35	06/18/87	12:52	0.00	898.536	103.994	0.09	0.000	Dry.
L1S35	07/28/87	13:38	0.00	938.568	144.026	0.09	0.000	Dry.
L1S35	09/01/87	13:13	0.00	973.551	34.983	0.09	0.000	Dry.
L1S35	10/20/87	12:53	0.00	1022.54	48.989	0.09	0.000	Dry.
L1S35	11/19/87	13:05	0.00	1052.55	30.010	0.09	0.000	Dry.
L1S35	01/04/88	12:58	0.00	1098.54	45.990	0.09	0.000	Dry.
L1S35	02/08/88	14:25		1133.60	0.000	0.09	0.000	Did not sample.
L1S35	03/30/88	12:45	0.00	1184.53	85.990	0.09	0.000	Dry.
L1S35	07/12/88	12:25	0.00	1288.52	103.990	0.09	0.000	Dry.
L1S35	09/27/88	09:40	0.00	1365.40	76.880	0.09	0.000	Dry.
L1S35	12/13/88	12:30	0	1442.52	77.120	0.09	0.000	Dry.

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
L1S36	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1S36	07/22/85			0.000	0.000	0.00	0.000	Downhole drilled.
L1S36	08/20/85			0.000	0.000	0.00	0.000	Wet.
L1S36	09/17/85			0.000	0.000	0.00	0.000	Wet.
L1S36	12/10/85	09:00	01.28	343.375	1.000	1.28	0.000	First time collected.
L1S36	12/17/85	09:00	00.09	350.375	7.000	1.37	0.013	
L1S36	01/03/86	09:00	00.12	367.375	17.000	1.49	0.007	
L1S36	01/08/86	09:00	00.05	372.375	5.000	1.54	0.010	
L1S36	01/16/86	09:00	00.04	380.375	8.000	1.58	0.005	
L1S36	02/12/86	09:00	00.15	407.375	27.000	1.73	0.006	
L1S36	02/28/86	09:00	00.11	423.375	16.000	1.84	0.007	
L1S36	03/13/86	08:40	00.06	436.361	12.986	1.90	0.005	
L1S36	04/02/86	08:35	00.11	456.358	19.997	2.01	0.006	Yellow color.
L1S36	04/16/86	10:30	00.08	470.438	14.080	2.09	0.006	
L1S36	04/30/86	09:30	00.09	484.396	13.958	2.18	0.006	
L1S36	05/13/86	08:58	00.08	497.374	12.978	2.26	0.006	
L1S36	05/27/86	14:20	00.09	511.597	14.223	2.35	0.006	
L1S36	06/10/86	09:30	00.10	525.396	13.799	2.45	0.007	
L1S36	06/24/86	09:28	00.10	539.394	13.998	2.55	0.007	
L1S36	07/01/86	12:03	00.05	546.502	7.108	2.60	0.007	
L1S36	07/08/86	09:22	00.05	553.390	6.888	2.65	0.007	
L1S36	07/16/86	09:16	00.06	561.386	7.996	2.71	0.008	
L1S36	07/22/86	08:56	00.05	567.372	5.986	2.76	0.008	
L1S36	07/29/86	09:23	00.05	574.391	7.019	2.81	0.007	
L1S36	08/05/86	09:46	00.05	581.407	7.016	2.86	0.007	
L1S36	08/12/86	09:15	00.05	588.385	6.978	2.91	0.007	
L1S36	08/19/86	09:59	00.06	595.416	7.031	2.97	0.009	
L1S36	08/26/86	09:30	00.06	602.396	6.980	3.03	0.009	
L1S36	09/04/86	09:05	00.07	611.378	8.982	3.10	0.008	
L1S36	09/09/86	11:32	00.04	616.481	5.103	3.14	0.008	
L1S36	09/16/86	08:56	00.05	623.372	6.891	3.19	0.007	
L1S36	09/23/86	09:03	00.05	630.377	7.005	3.24	0.007	
L1S36	10/01/86	09:55	0.05	638.413	8.036	3.29	0.006	
L1S36	10/08/86	09:30	00.03	645.396	6.983	3.32	0.004	
L1S36	11/05/86	09:25	0.10	673.392	27.996	3.42	0.004	
L1S36	11/20/86	10:10	00.05	688.424	15.032	3.47	0.003	
L1S36	12/31/86	10:22	00.05	729.432	41.008	3.52	0.001	
L1S36	03/06/87	13:00	0.14	794.542	65.110	3.66	0.002	
L1S36	03/31/87	10:45	0.03	819.448	24.906	3.69	0.001	
L1S36	05/07/87	09:47	0.03	856.408	36.960	3.72	0.001	
L1S36	06/18/87	12:53	0.19	898.537	42.129	3.91	0.005	
L1S36	07/28/87	13:47	0.19	938.574	40.037	4.10	0.005	
L1S36	09/01/87	13:15	0.14	973.552	34.978	4.24	0.004	
L1S36	10/20/87	12:57	0.15	1022.54	48.988	4.39	0.003	
L1S36	11/19/87	13:10	0.08	1052.55	30.010	4.47	0.003	
L1S36	01/04/88	12:59	0.08	1098.54	45.990	4.55	0.002	
L1S36	02/08/88	14:30	Wet	1133.60	35.060	4.55	0.000	
L1S36	03/30/88	12:45	0.00	1184.53	50.930	4.55	0.000	Dry.
L1S36	07/12/88	12:25	0.00	1288.52	103.990	4.55	0.000	Dry.
L1S36	09/27/88	09:40	0.00	1365.40	76.880	4.55	0.000	Dry.
L1S36	12/13/88	12:30	0.04	1442.52	77.120	4.59	0.001	

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
L1X00	04/21/84			0.000	0.000	0.00	0.000	Room L1 excavated 4/19/84 to 4/21/84.
L1X00	05/13/84			0.000	0.000	0.00	0.000	Downhole drilled 5/10/84 to 5/13/84. Brine entered hole over weekend during drilling.
L1X00	11/27/84	NA	11	-34.417	0.000	11.00	0.000	First time collected. Brine and salt muck.
L1X00	05/14/85	11:24	11.46	133.475	1.000	22.46	0.000	Hole looked dry due to floating salt dust on surface of brine. Salt muck removed with brine. Volume high due to near-hole storage.
L1X00	05/21/85	12:33	00.31	140.523	7.048	22.77	0.044	
L1X00	05/29/85	10:00	00.23	148.417	7.894	23.00	0.029	Removed 1 lb. of salt muck with brine.
L1X00	06/04/85	09:25	00.17	154.392	5.975	23.17	0.028	
L1X00	06/11/85	09:00	00.23	161.375	6.983	23.40	0.033	2 lbs. salt removed with brine during bailing.
L1X00	06/18/85	09:05	00.23	168.378	7.003	23.63	0.033	
L1X00	06/25/85	08:55	00.21	175.372	6.994	23.84	0.030	
L1X00	07/02/85	11:00	00.23	182.458	7.086	24.07	0.032	
L1X00	07/09/85	09:10	00.21	189.382	6.924	24.28	0.030	
L1X00	07/16/85	09:12	00.21	196.383	7.001	24.49	0.030	
L1X00	07/24/85	09:29	00.22	204.395	8.012	24.71	0.027	
L1X00	07/30/85	08:42	00.18	210.363	5.968	24.89	0.030	
L1X00	08/06/85	09:07	00.18	217.380	7.017	25.07	0.026	
L1X00	08/14/85	08:53	00.23	225.370	7.990	25.30	0.029	
L1X00	08/20/85	08:58	00.16	231.374	6.004	25.46	0.027	
L1X00	08/28/85	08:25	00.23	239.351	7.977	25.69	0.029	
L1X00	09/04/85	09:09	00.19	246.381	7.030	25.88	0.027	
L1X00	09/10/85	08:53	00.16	252.370	5.989	26.04	0.027	
L1X00	09/17/85	08:25	00.21	259.351	6.981	26.25	0.030	
L1X00	09/24/85	08:40	00.21	266.361	7.010	26.46	0.030	
L1X00	10/01/85	08:52	00.17	273.369	7.008	26.63	0.024	
L1X00	10/08/85	09:55	00.19	280.413	7.044	26.82	0.027	
L1X00	10/15/85	08:45	00.16	287.365	6.952	26.98	0.023	
L1X00	10/23/85	09:09	00.20	295.381	8.016	27.18	0.025	
L1X00	10/29/85	11:30	00.18	301.479	6.098	27.36	0.030	
L1X00	11/05/85	08:17	00.16	308.345	6.866	27.52	0.023	
L1X00	11/13/85	08:47	00.18	316.366	8.021	27.70	0.022	
L1X00	11/21/85	10:00	00.17	324.417	8.051	27.87	0.021	
L1X00	11/26/85	09:25	00.12	329.392	4.975	27.99	0.024	
L1X00	12/03/85	14:35	00.14	336.608	7.216	28.13	0.019	
L1X00	12/10/85	12:55	00.14	343.538	6.930	28.27	0.020	
L1X00	12/17/85	13:02	00.15	350.543	7.005	28.42	0.021	
L1X00	01/03/86	09:05	00.38	367.378	16.835	28.80	0.023	
L1X00	01/08/86	09:25	00.11	372.392	5.014	28.91	0.022	
L1X00	01/16/86	09:00	00.18	380.375	7.983	29.09	0.023	
L1X00	01/23/86	09:15	00.14	387.385	7.010	29.23	0.020	
L1X00	01/31/86	09:45	00.18	395.406	8.021	29.41	0.022	
L1X00	02/12/86	08:50	00.30	407.368	11.962	29.71	0.025	
L1X00	02/19/86	09:40	00.16	414.403	7.035	29.87	0.023	
L1X00	02/28/86	11:20	00.24	423.472	9.069	30.11	0.026	
L1X00	03/06/86	09:10	00.12	429.382	5.910	30.23	0.020	
L1X00	03/13/86	08:30	00.16	436.354	6.972	30.39	0.023	
L1X00	03/26/86	08:35	00.29	449.358	13.004	30.68	0.022	
L1X00	04/02/86	08:15	00.17	456.344	6.986	30.85	0.024	
L1X00	04/08/86	08:26	00.15	462.351	6.007	31.00	0.025	
L1X00	04/16/86	10:20	00.19	470.431	8.080	31.19	0.024	
L1X00	04/24/86	08:50	00.16	478.368	7.937	31.35	0.020	
L1X00	04/30/86	09:20	00.16	484.389	6.021	31.51	0.027	
L1X00	05/06/86	08:50	00.15	490.368	5.979	31.66	0.025	
L1X00	05/13/86	08:48	00.18	497.367	6.999	31.84	0.026	
L1X00	05/20/86	09:20	00.18	504.389	7.022	32.02	0.026	
L1X00	05/27/86	14:20	00.17	511.597	7.208	32.19	0.024	
L1X00	06/03/86	08:43	00.15	518.363	6.766	32.34	0.022	
L1X00	06/10/86	09:20	00.21	525.389	7.026	32.55	0.030	
L1X00	06/17/86	09:12	00.14	532.383	6.994	32.69	0.020	
L1X00	06/24/86	09:15	00.22	539.385	7.002	32.91	0.031	
L1X00	07/01/86	11:53	00.22	546.495	7.110	33.13	0.031	
L1X00	07/08/86	09:10	00.22	553.382	6.887	33.35	0.032	
L1X00	07/16/86	09:00	00.21	561.375	7.993	33.56	0.026	
L1X00	07/22/86	08:45	00.17	567.365	5.990	33.73	0.028	
L1X00	07/29/86	09:08	00.18	574.381	7.016	33.91	0.026	
L1X00	08/05/86	09:33	00.20	581.398	7.017	34.11	0.029	
L1X00	08/12/86	09:05	00.20	588.378	6.980	34.31	0.029	
L1X00	08/19/86	09:49	00.20	595.409	7.031	34.51	0.028	
L1X00	08/26/86	09:20	00.19	602.389	6.980	34.70	0.027	

L1X00	09/04/86	08:55	00.25	611.372	8.983	34.95	0.028	
L1X00	09/09/86	11:25	00.16	616.476	5.104	35.11	0.031	
L1X00	09/16/86	08:50	00.19	623.368	6.892	35.30	0.028	
L1X00	09/23/86	08:53	00.20	630.370	7.002	35.50	0.029	
L1X00	10/01/86	09:46	00.22	638.407	8.037	35.72	0.027	
L1X00	10/08/86	09:17	00.18	645.387	6.980	35.90	0.026	
L1X00	10/14/86	10:00	00.14	651.417	6.030	36.04	0.023	
L1X00	11/05/86	09:02	0.52	673.376	21.959	36.56	0.024	
L1X00	11/20/86	09:47	00.36	688.408	15.032	36.92	0.024	
L1X00	12/31/86	10:00	00.88	729.417	41.009	37.80	0.021	
L1X00	02/03/87	10:45	00.61	763.448	34.031	38.41	0.018	
L1X00	03/06/87	09:45	0.58	794.406	30.958	38.99	0.019	Hole looked dry due to floating salt dust on surface of brine.
L1X00	04/10/87	09:30	0.68	829.396	34.990	39.67	0.019	
L1X00	06/17/87	14:00	0.83	897.583	0.000	40.50	0.000	Brine left in hole, no calculation.
L1X00	07/28/87	13:07	1.09	938.547	1.000	41.50	0.018	Calculated using 1.92 liters in 109.151 days (6/17/87 and 7/28/87).
L1X00	09/01/87	12:45	0.95	973.531	34.984	42.45	0.027	
L1X00	09/10/87	10:34	0.25	982.440	8.909	42.70	0.028	Installed lysimeter.
L1X00	10/20/87	12:18	0.09	1022.51	40.070	42.79	0.002	
L1X00	11/19/87	12:15	1.35	1052.51	30.000	44.14	0.045	
L1X00	01/04/88	12:30	0.43	1098.52	46.010	44.57	0.009	
L1X00	02/08/88	13:45	0.93	1133.57	35.050	45.50	0.027	
L1X00	03/30/88	12:20	1.00	1184.51	50.940	46.50	0.020	
L1X00	07/12/88	12:25	2.33	1288.52	104.010	48.83	0.022	
L1X00	09/27/88	08:45	2.07	1365.36	76.840	50.90	0.027	
L1X00	12/13/88	11:30	1.85	1442.48	77.120	52.75	0.024	

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
L2C03	04/25/84			0.000	0.000	0.00	0.000	Room L2 excavated 4/22/84 to 4/25/84.
L2C03	03/26/85			0.000	0.000	0.00	0.000	Hole L2C25, a 5" overcore of a previously grouted hole, drilled at this location. Brine blew into hole L2C29, 4 ft. to the north.
L2C03	04/02/85			0.000	0.000	0.00	0.000	Approximate date hole L2C03 drilled, a 16" overcore of L2C25.
L2C03	12/17/85	12:39	05.15	350.527	1.000	5.15	0.000	First time collected. Brine enters through fracture, connects to L2C29, 4 ft. north.
L2C03	01/03/86	08:55	00.24	367.372	16.845	5.39	0.014	
L2C03	01/08/86	09:20	00.01	372.389	5.017	5.40	0.002	
L2C03	01/16/86	08:50	00.04	380.368	7.979	5.44	0.005	
L2C03	01/23/86	09:10	00.03	387.382	7.014	5.47	0.004	
L2C03	02/12/86	08:40	00.10	407.361	19.979	5.57	0.005	
L2C03	04/16/86	10:15	00.60	470.427	63.066	6.17	0.010	
L2C03	04/24/86	08:45	00.10	478.365	7.938	6.27	0.013	
L2C03	05/06/86	08:40	00.16	490.361	11.996	6.43	0.013	
L2C03	05/13/86	08:40	00.06	497.361	7.000	6.49	0.009	
L2C03	05/20/86	09:20	00.12	504.389	7.028	6.61	0.017	
L2C03	06/03/86	08:40	00.25	518.361	13.972	6.86	0.018	
L2C03	06/10/86	09:10	00.14	525.382	7.021	7.00	0.020	
L2C03	06/17/86	09:10	00.15	532.382	7.000	7.15	0.021	
L2C03	06/24/86	09:05	00.17	539.378	6.996	7.32	0.024	
L2C03	07/01/86	11:40	00.21	546.486	7.108	7.53	0.030	
L2C03	07/08/86	09:00	00.23	553.375	6.889	7.76	0.033	
L2C03	07/16/86	08:55	00.31	561.372	7.997	8.07	0.039	
L2C03	07/22/86	08:39	00.24	567.360	5.988	8.31	0.040	
L2C03	07/29/86	09:00	00.31	574.375	7.015	8.62	0.044	
L2C03	08/05/86	09:28	00.30	581.394	7.019	8.92	0.043	
L2C03	08/12/86	08:58	00.30	588.374	6.980	9.22	0.043	
L2C03	08/19/86	09:40	00.25	595.403	7.029	9.47	0.036	
L2C03	08/26/86	09:14	00.28	602.385	6.982	9.75	0.040	
L2C03	09/04/86	08:50	00.68	611.368	8.983	10.43	0.076	
L2C03	09/09/86	11:48	00.42	616.492	5.124	10.85	0.082	
L2C03	09/16/86	08:40	00.49	623.361	6.869	11.34	0.071	
L2C03	09/23/86	08:45	00.50	630.365	7.004	11.84	0.071	
L2C03	10/01/86	09:39	00.48	638.402	8.037	12.32	0.060	
L2C03	10/08/86	09:13	00.28	645.384	6.982	12.60	0.040	
L2C03	10/14/86	09:51	00.20	651.410	6.026	12.80	0.033	
L2C03	11/05/86	09:00	0.79	673.375	21.965	13.59	0.036	
L2C03	11/20/86	09:45	00.38	688.406	15.031	13.97	0.025	
L2C03	12/31/86	09:40	01.36	729.403	40.997	15.33	0.033	Last time sampled for BSEP.

WIPP BRINE SAMPLING AND EVALUATION PROGRAM
Appendix A for the 1988 BSEP Report
Data through December 31, 1988

Location	Date	Time	Liters Removed	Days Since 1/01/85	Days Used For Calc.	Cumulative Liters Collected	Liters per Day	Remarks
NG252	03/16/83			0.000	0.000	0.00	0.000	West side of SPDV Test Room 2 excavated. (Room excavated 3/09/83 to 3/20/83).
NG252	03/20/83			0.000	0.000	0.00	0.000	Approximate date downhole drilled.
NG252	03/04/84			0.000	0.000	0.00	0.000	Overcored non-functional stress meter with 6" hole (to 1.5 ft.).
NG252	11/21/84			0.000	0.000	0.00	0.000	Brine 7" below west edge of collar. Cleaned hole.
NG252	11/30/84			0.000	0.000	0.00	0.000	Installed PVC casing for BSEP observations.
NG252	12/19/84	12:00	04.60	-12.500	1.000	4.60	0.000	Partial removal. First time collected.
NG252	12/20/84	09:00	04.35	-11.625	0.875	8.95	0.000	Pumped dry. Inflow rate about 2 cc/hr.
NG252	01/08/85	09:43	08.19	7.405	19.030	17.14	0.430	Pumped dry.
NG252	02/05/85	09:30	08.48	35.396	27.991	25.62	0.303	Gas bubbles observed rising through brine in hole.
NG252	02/14/85	10:33	04.14	44.440	9.044	29.76	0.458	
NG252	02/19/85	10:18	03.92	49.429	4.989	33.68	0.786	
NG252	03/07/85	10:57	03.83	65.456	16.027	37.51	0.239	
NG252	03/12/85	09:10	03.41	70.382	4.926	40.92	0.692	
NG252	03/20/85	10:00	03.71	78.417	8.035	44.63	0.462	
NG252	03/26/85	09:30	03.24	84.396	5.979	47.87	0.542	
NG252	04/02/85	10:00	03.38	91.417	7.021	51.25	0.481	
NG252	04/10/85	10:02	03.29	99.418	8.001	54.54	0.411	
NG252	04/17/85	13:50	03.57	106.576	7.158	58.11	0.499	
NG252	04/23/85	12:00	02.58	112.500	5.924	60.69	0.436	
NG252	04/30/85	11:39	03.28	119.485	6.985	63.97	0.470	
NG252	05/07/85	10:25	02.96	126.434	6.949	66.93	0.426	
NG252	05/14/85	11:05	02.83	133.462	7.028	69.76	0.403	
NG252	05/21/85	11:12	03.01	140.467	7.005	72.77	0.430	Brine degassing in collecting container.
NG252	05/29/85	10:00	03.45	148.417	7.950	76.22	0.434	
NG252	06/04/85	11:50	02.90	154.493	6.076	79.12	0.477	
NG252	06/11/85	11:35	03.06	161.483	6.990	82.18	0.438	
NG252	06/18/85	10:47	02.82	168.449	6.966	85.00	0.405	
NG252	06/25/85	10:00	03.34	175.417	6.968	88.34	0.479	
NG252	07/02/85	11:00	03.50	182.458	7.041	91.84	0.497	
NG252	07/09/85	11:30	03.46	189.479	7.021	95.30	0.493	Brine effervesces.
NG252	07/16/85	12:09	03.43	196.506	7.027	98.73	0.488	Brine effervesces.
NG252	07/24/85	11:10	03.83	204.465	7.959	102.56	0.481	
NG252	07/30/85	10:45	02.79	210.448	5.983	105.35	0.466	
NG252	08/06/85	10:58	03.05	217.457	7.009	108.40	0.435	
NG252	08/14/85	12:10	03.48	225.507	8.050	111.88	0.432	
NG252	08/20/85	11:31	03.15	231.480	5.973	115.03	0.527	
NG252	08/28/85	10:00	03.11	239.417	7.937	118.14	0.392	
NG252	09/04/85	10:58	03.17	246.457	7.040	121.31	0.450	
NG252	09/10/85	11:23	03.04	252.474	6.017	124.35	0.505	
NG252	09/17/85	10:16	02.68	259.428	6.954	127.03	0.385	
NG252	09/24/85	10:20	02.98	266.431	7.003	130.01	0.426	
NG252	10/01/85	10:25	03.19	273.434	7.003	133.20	0.456	
NG252	10/08/85	11:05	03.36	280.462	7.028	136.56	0.478	
NG252	10/15/85	10:46	02.64	287.449	6.987	139.20	0.378	
NG252	10/23/85	10:58	02.93	295.457	8.008	142.13	0.366	
NG252	10/29/85	10:45	02.64	301.448	5.991	144.77	0.441	
NG252	11/05/85	09:40	02.16	308.403	6.955	146.93	0.311	10 days after brine was removed from 36" hole in SPDV Test Room 3.
NG252	11/13/85	10:45	02.72	316.448	8.045	149.65	0.338	
NG252	11/21/85	11:50	02.88	324.493	8.045	152.53	0.358	
NG252	11/26/85	10:40	02.28	329.444	4.951	154.81	0.461	
NG252	12/03/85	14:15	02.45	336.594	7.150	157.26	0.343	
NG252	12/10/85	13:41	02.34	343.570	6.976	159.60	0.335	
NG252	12/17/85	14:15	02.73	350.594	7.024	162.33	0.389	
NG252	01/03/86	10:30	04.03	367.438	16.844	166.30	0.239	Partial removal only.
NG252	01/08/86	10:40	03.00	372.444	5.006	169.36	0.599	High volume of brine due to only partial removal on 1/03/86.
NG252	01/16/86	10:10	03.90	380.424	7.980	173.26	0.489	
NG252	01/23/86	10:20	02.84	387.431	7.007	176.10	0.405	
NG252	01/31/86	12:45	02.94	395.531	8.100	179.04	0.363	
NG252	02/12/86	11:30	02.87	407.479	11.948	181.91	0.240	
NG252	02/19/86	12:13	02.85	414.509	7.030	184.76	0.405	
NG252	03/06/86	11:00	04.10	429.458	14.949	188.86	0.274	
NG252	03/13/86	10:30	02.78	436.438	6.980	191.64	0.398	
NG252	03/26/86	10:25	03.50	449.434	12.996	195.14	0.269	
NG252	04/02/86	10:10	02.67	456.424	6.990	197.81	0.382	
NG252	04/08/86	10:15	02.00	462.427	6.003	199.81	0.333	
NG252	04/16/86	12:30	02.52	470.521	8.094	202.33	0.311	

NG252	04/24/86	10:40	01.93	478.444	7.923	204.26	0.244	
NG252	04/30/86	11:20	02.10	484.472	6.028	206.36	0.348	
NG252	05/06/86	10:45	01.80	490.448	5.976	208.16	0.301	
NG252	05/13/86	11:35	01.33	497.483	7.035	209.49	0.189	
NG252	05/20/86	11:25	01.22	504.476	6.993	210.71	0.174	
NG252	05/27/86	16:10	01.60	511.674	7.198	212.31	0.222	
NG252	06/03/86	10:45	01.49	518.448	6.774	213.80	0.220	
NG252	06/10/86	11:45	02.18	525.490	7.042	215.98	0.310	
NG252	06/17/86	11:21	02.65	532.473	6.983	218.63	0.379	
NG252	06/24/86	11:15	01.77	539.469	6.996	220.40	0.253	
NG252	07/01/86	14:20	01.80	546.597	7.128	222.20	0.253	
NG252	07/08/86	10:55	01.50	553.455	6.858	223.70	0.219	
NG252	07/16/86	11:00	01.88	561.458	8.003	225.58	0.235	
NG252	07/22/86	10:22	01.94	567.432	5.974	227.52	0.325	
NG252	07/29/86	10:55	02.16	574.455	7.023	229.68	0.308	
NG252	08/05/86	11:33	01.92	581.481	7.026	231.60	0.273	
NG252	08/12/86	10:50	01.90	588.451	6.970	233.50	0.273	
NG252	08/19/86	11:45	01.82	595.490	7.039	235.32	0.259	
NG252	08/26/86	11:05	01.85	602.462	6.972	237.17	0.265	
NG252	09/04/86	11:00	02.15	611.458	8.996	239.32	0.239	
NG252	09/09/86	09:12	01.85	616.383	4.925	241.17	0.376	
NG252	09/16/86	10:27	01.81	623.435	7.052	242.98	0.257	
NG252	09/23/86	10:30	01.65	630.438	7.003	244.63	0.236	
NG252	10/01/86	12:30	02.67	638.521	8.083	247.30	0.330	
NG252	10/08/86	11:30	01.61	645.479	6.958	248.91	0.231	
NG252	10/14/86	12:10	01.72	651.507	6.028	250.63	0.285	
NG252	11/05/86	11:57	3.45	673.498	21.991	254.08	0.157	
NG252	11/20/86	12:40	03.93	688.528	15.030	258.01	0.261	
NG252	12/30/86	13:13	03.54	728.551	40.023	261.55	0.090	
NG252	01/06/87	13:00	02.38	735.542	6.991	263.93	0.318	
NG252	01/12/87	12:15	06.81	741.510	5.968	270.74	1.141	
NG252	02/03/87	09:15	03.93	763.385	21.875	274.67	0.180	
NG252	03/06/87	13:35	4.2	794.566	31.181	278.87	0.135	
NG252	04/22/87	09:17	4.83	841.387	46.821	283.70	0.101	
NG252	05/07/87	11:59	4.24	856.499	15.112	287.94	0.281	Low liters/day values for some periods between 11/05/86 and 6/16/87 may be the result in part of the long time between collections.
NG252	06/17/87	14:10	4.63	897.590	0.000	292.57	0.000	Some brine left in hole, no calc.
NG252	06/30/87	10:20	4.10	910.431	12.841	296.67	0.162	Calculation used 8.73 liters in 53.932 days (6/17/87 and 6/30/87).
NG252	07/16/87	10:50	3.77	926.451	16.020	300.44	0.235	
NG252	07/23/87	09:35	2.32	933.399	6.948	302.76	0.334	
NG252	07/29/87	09:54	2.07	939.413	6.014	304.83	0.344	
NG252	08/07/87	09:00	1.89	948.375	8.962	306.72	0.211	
NG252	08/12/87	10:00	1.28	953.417	5.042	308.00	0.254	
NG252	08/24/87	08:57	1.89	965.373	11.956	309.89	0.158	
NG252	09/01/87	13:41	1.75	973.570	8.197	311.64	0.213	
NG252	09/11/87	08:35	2.04	983.358	9.788	313.68	0.208	
NG252	09/16/87	09:45	1.45	988.406	5.048	315.13	0.287	
NG252	09/25/87	09:05	1.64	997.378	8.972	316.77	0.183	
NG252	10/01/87	12:25	1.22	1003.52	6.142	317.99	0.199	
NG252	10/08/87	10:36	1.12	1010.44	6.920	319.11	0.162	
NG252	10/16/87	10:49	1.38	1018.45	8.010	320.49	0.172	
NG252	10/20/87	12:06	0.87	1022.50	4.050	321.36	0.215	
NG252	11/12/87	10:54	2.47	1045.45	22.950	323.83	0.108	
NG252	11/19/87	11:50	1.84	1052.49	7.040	325.67	0.261	
NG252	12/07/87	13:15	3.00	1070.55	18.060	328.67	0.166	
NG252	01/04/88	12:23	2.80	1098.52	27.970	331.47	0.100	
NG252	01/20/88	11:33	2.96	1114.48	15.960	334.43	0.185	
NG252	02/08/88	13:30	2.87	1133.56	19.080	337.30	0.150	
NG252	02/25/88	10:53	3.09	1150.45	16.890	340.39	0.183	
NG252	03/09/88	10:30	2.92	1163.44	12.990	343.31	0.225	
NG252	03/17/88	11:30	2.28	1171.48	8.040	345.59	0.284	
NG252	03/29/88	12:30	1.91	1183.52	12.040	347.50	0.159	
NG252	04/15/88	11:10	2.37	1200.47	16.950	349.87	0.140	
NG252	05/05/88	10:30	1.95	1220.44	19.970	351.82	0.098	
NG252	05/12/88	11:00	1.38	1227.46	7.020	353.20	0.197	
NG252	06/09/88	09:00	2.88	1255.38	27.920	356.08	0.103	
NG252	06/16/88	10:00	1.95	1262.42	7.040	358.03	0.277	
NG252	07/12/88	09:10	2.32	1288.38	25.960	360.35	0.089	
NG252	08/11/88	11:00	2.53	1318.46	30.080	362.88	0.084	
NG252	08/25/88	10:00	2.37	1332.42	13.960	365.25	0.170	
NG252	09/08/88	14:55	2.64	1346.62	14.200	367.89	0.186	
NG252	09/27/88	11:00	2.40	1365.46	18.840	370.29	0.127	
NG252	10/18/88	10:51	1.33	1386.45	20.990	371.62	0.063	
NG252	11/10/88	09:23	1.98	1409.39	22.940	373.60	0.086	Smell of paint thinner. Sample effervesces.
NG252	12/13/88	10:30	3.34	1442.44	33.050	376.94	0.101	

APPENDIX B

GRAPHS OF BRINE ACCUMULATION DATA

APPENDIX B

GRAPHS OF BRINE ACCUMULATION DATA

This appendix contains graphs of data presented in Appendix A for selected locations. As described in Deal and Case (1987), much of the variability in the quantity of brine collected resulted from limitations of the collecting techniques rather than variations in the actual inflow of brine from bedrock into the collecting locations. As a result, plotting of the inflow data from the data tables (Appendix A) results in an irregular plot that implies variations in inflow that, in fact, do not exist. The graphed data included in this report were processed and plotted by a standard software program (STSC Statgraphics)[1] on an IBM XT microcomputer, using a simple moving average to smooth the curve. Unless otherwise stated, an 11-point moving average was used for the graphs. The smoothed result reflects trends in the body of the curve that are representative of the brine seepage rates while still showing variations that are probably the result of collecting techniques.

At the beginning and end of each curve, where there are not enough data points, the smoothing program projects the calculated trend. As a result, initial and ending real values, usually zero, and maximum inflow values within the first few data points, tend to be distorted by the smoothing program.

In order to present a graph of the data presented in Appendix A that provides the best visual representation of actual data, end-point data and maximum flow rates within a few points of the origin of the curves has been manually reinserted prior to plotting. Additional discussion of the collection and data handling is provided in Deal and Case (1987).

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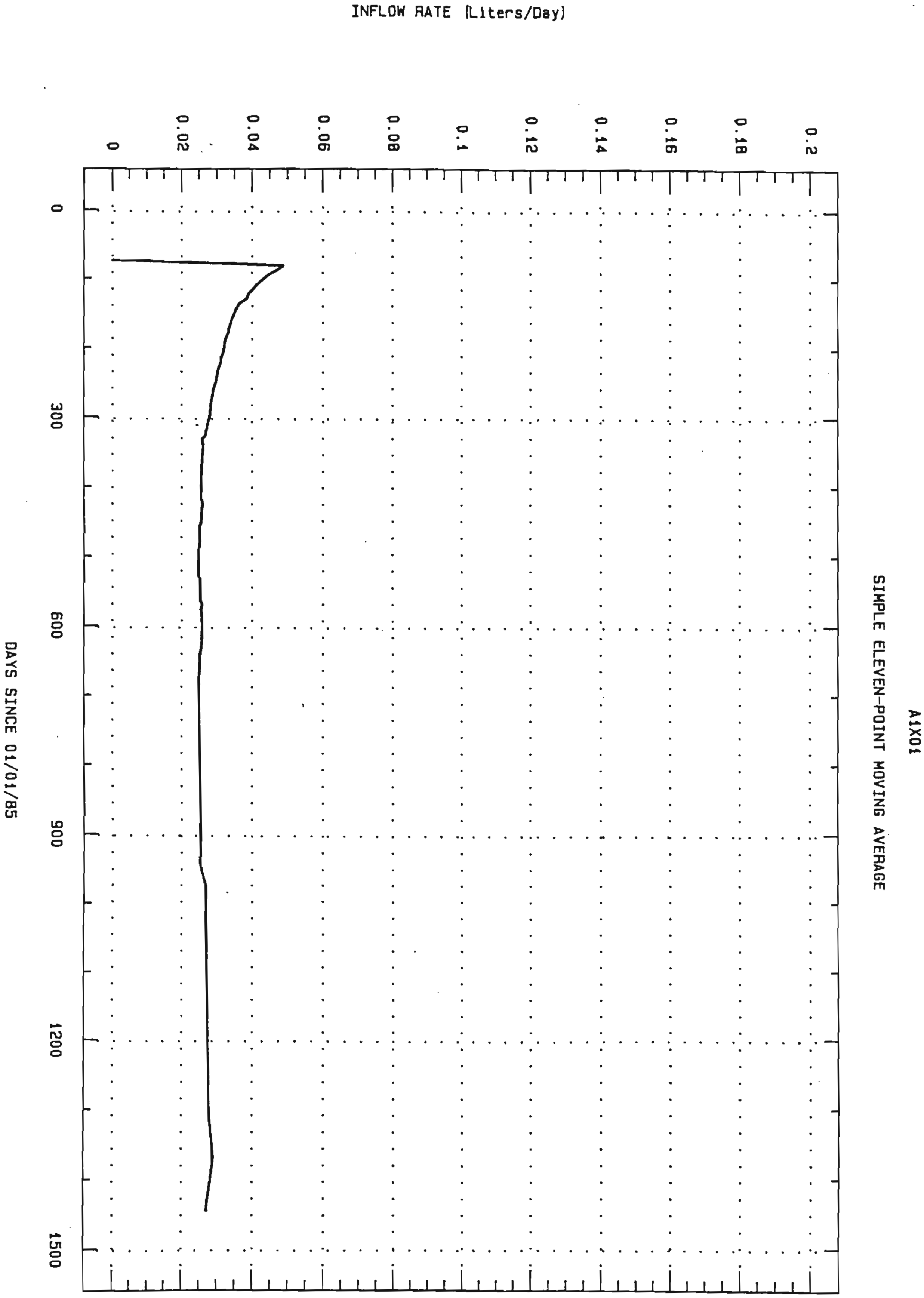
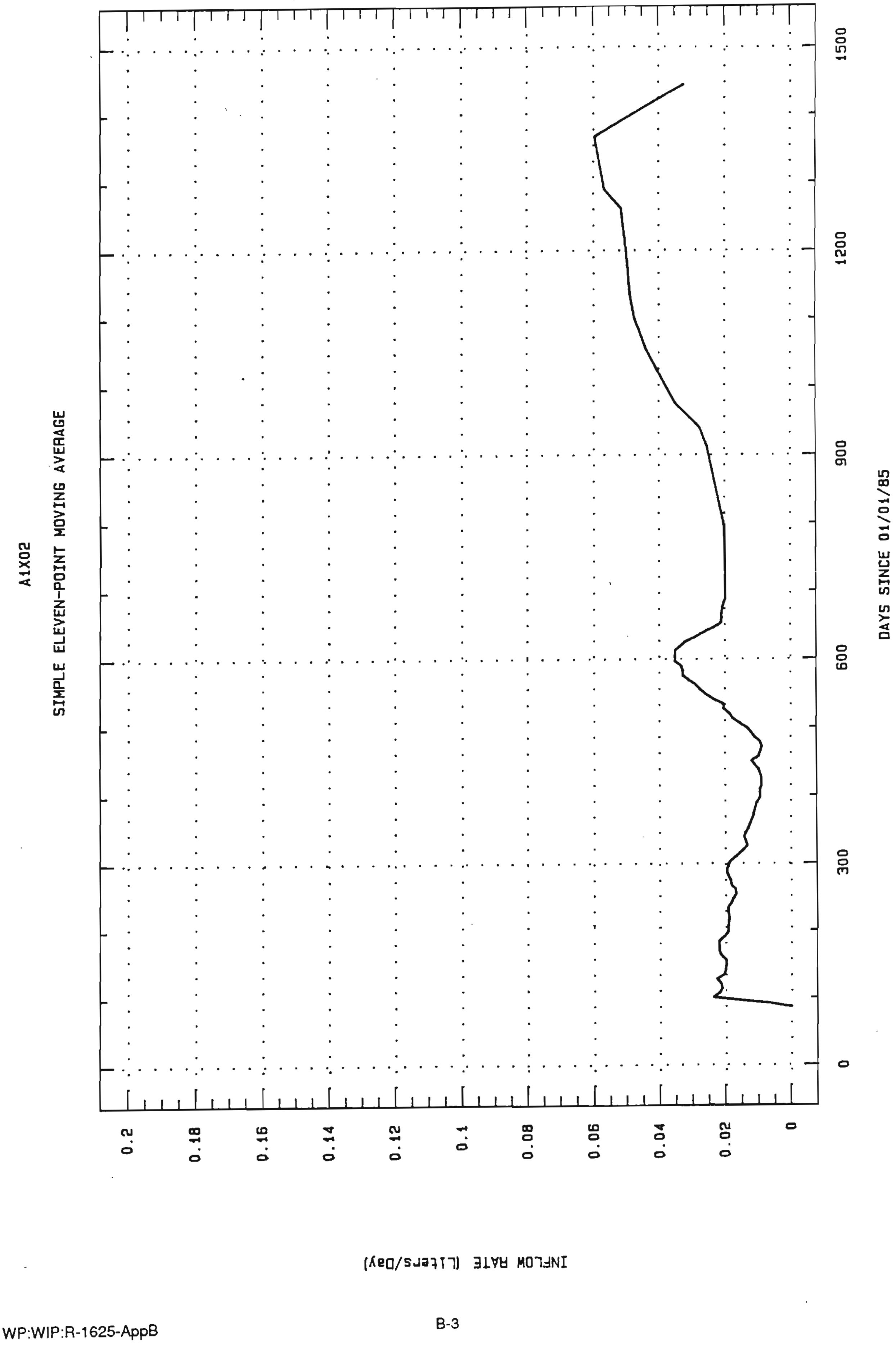
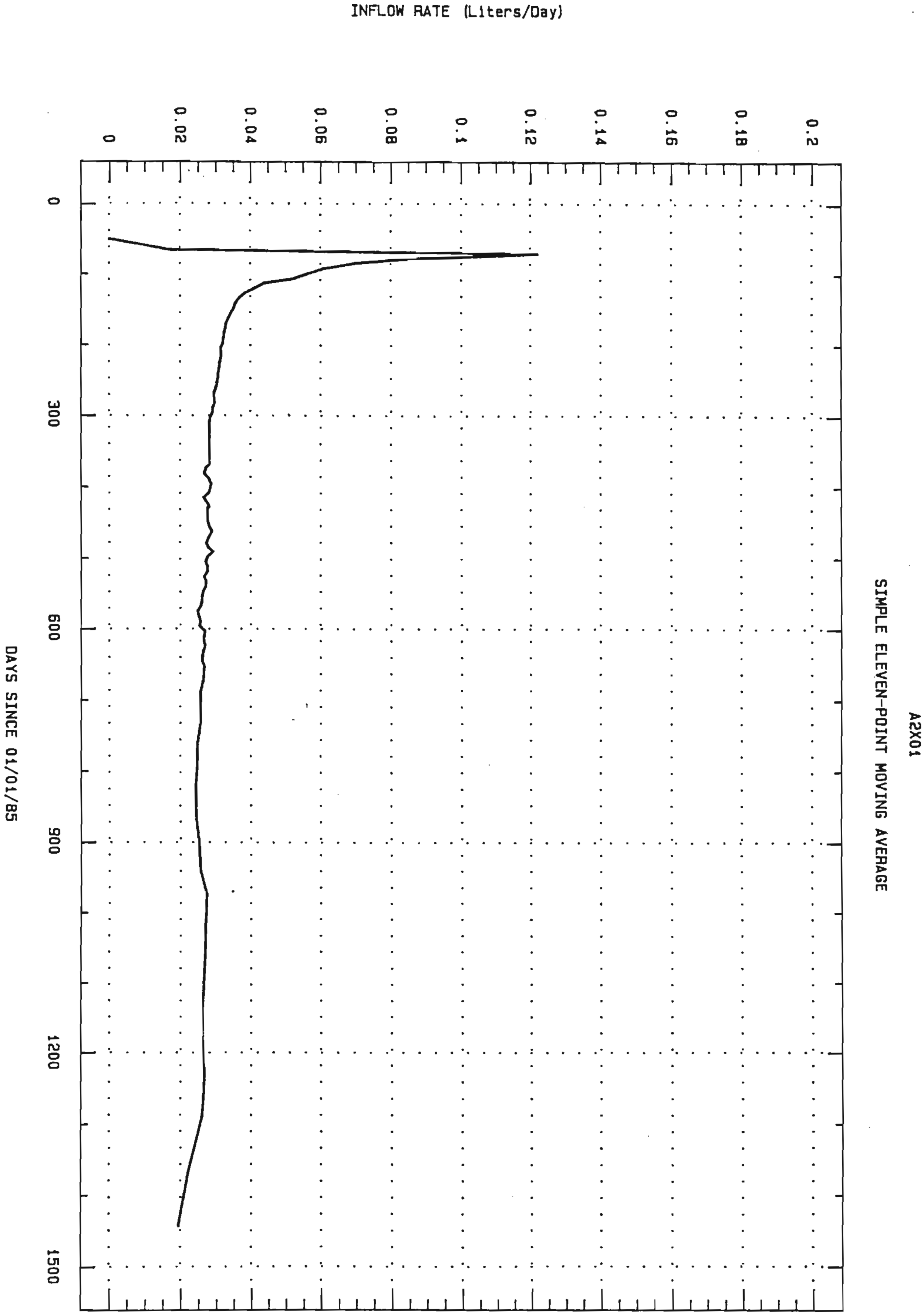
[1] Statgraphics, 1989, Version 4.0, Statistical Graphics Corporation, Rockville, Maryland.

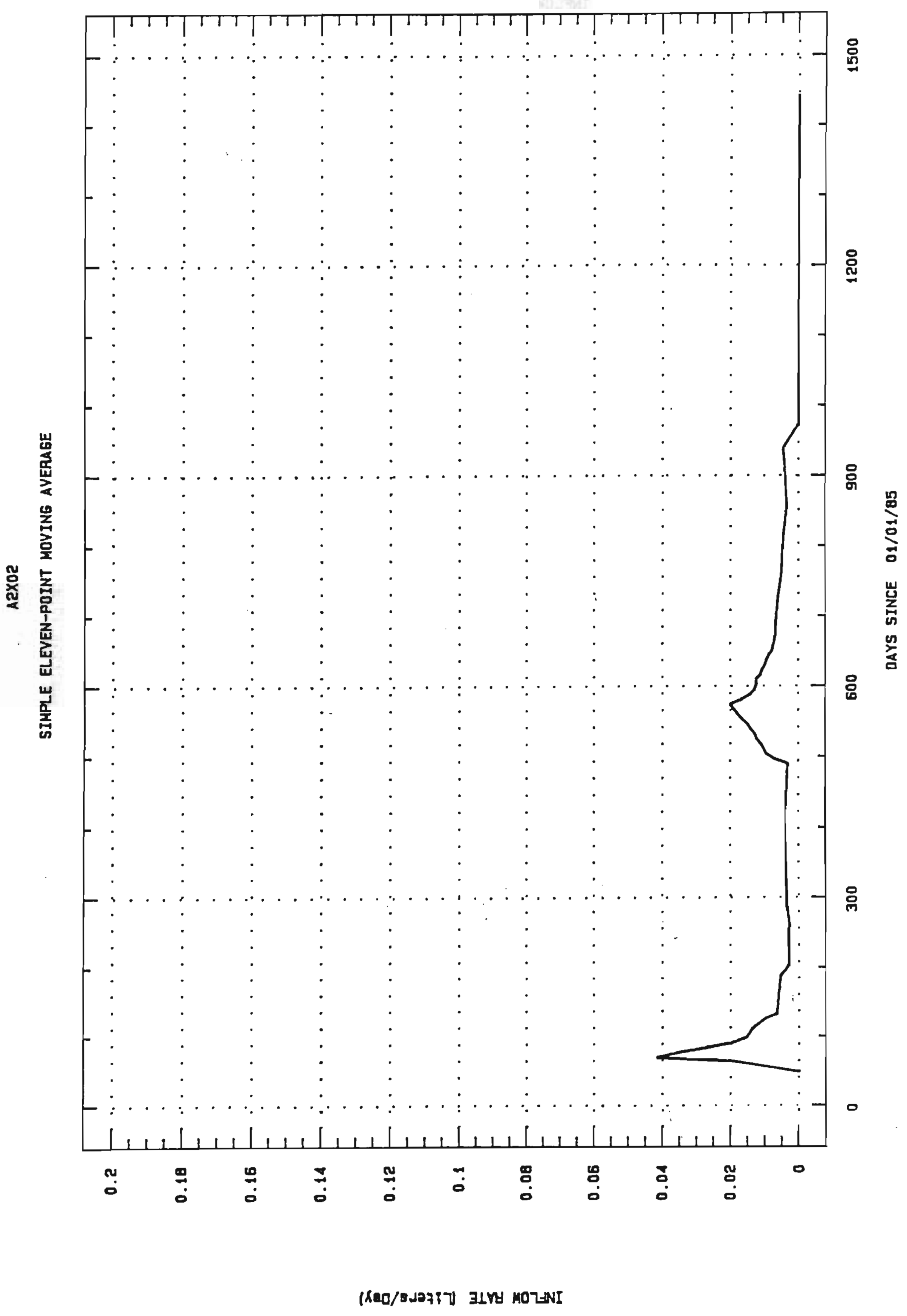

A1X01
SIMPLE ELEVEN-POINT MOVING AVERAGE
INFLOW RATE (Liters/Day)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
DAYS SINCE 01/01/85
0
300
600
900
1200
1500



A1X02

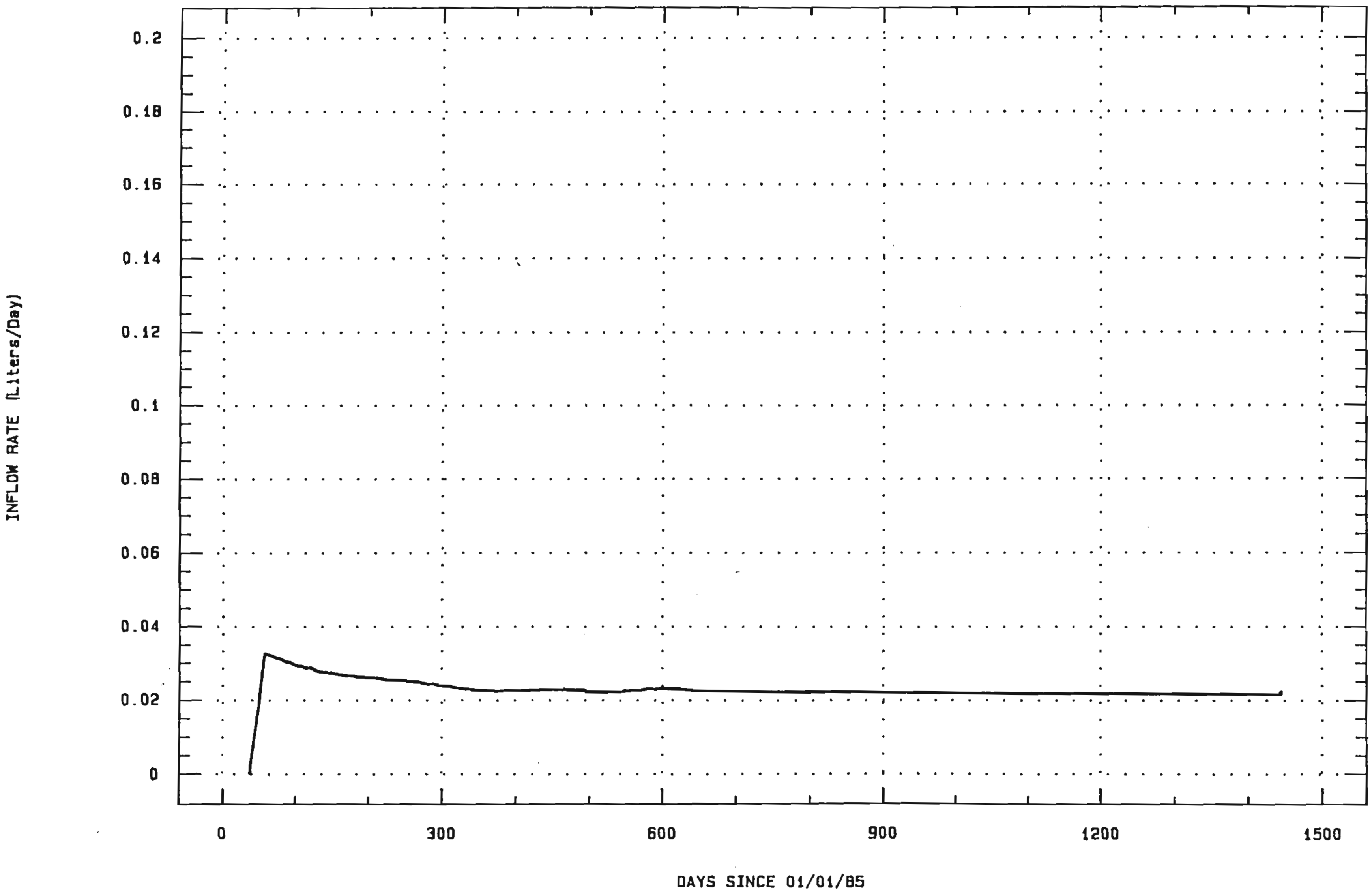
SIMPLE ELEVEN-POINT MOVING AVERAGE

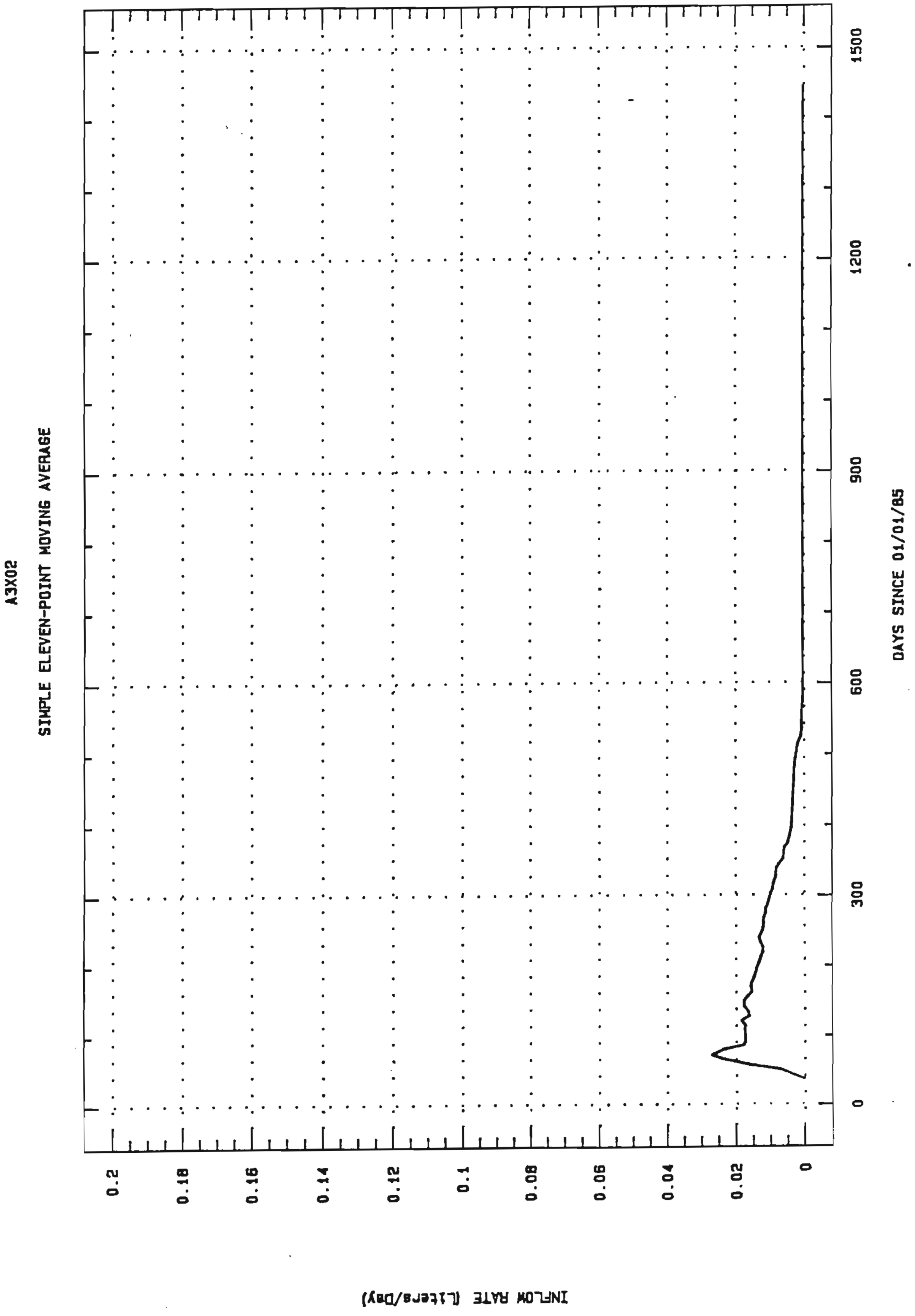

A2X01
SIMPLE ELEVEN-POINT MOVING AVERAGE
INFLOW RATE (Liters/Day)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
DAYS SINCE 01/01/85
0
300
600
900
1200
1500


A2X02
SIMPLE ELEVEN-POINT MOVING AVERAGE
INFLOW RATE (Liters/Day)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
DAYS SINCE 01/01/85
0
300
600
900
1200
1500

A3X01

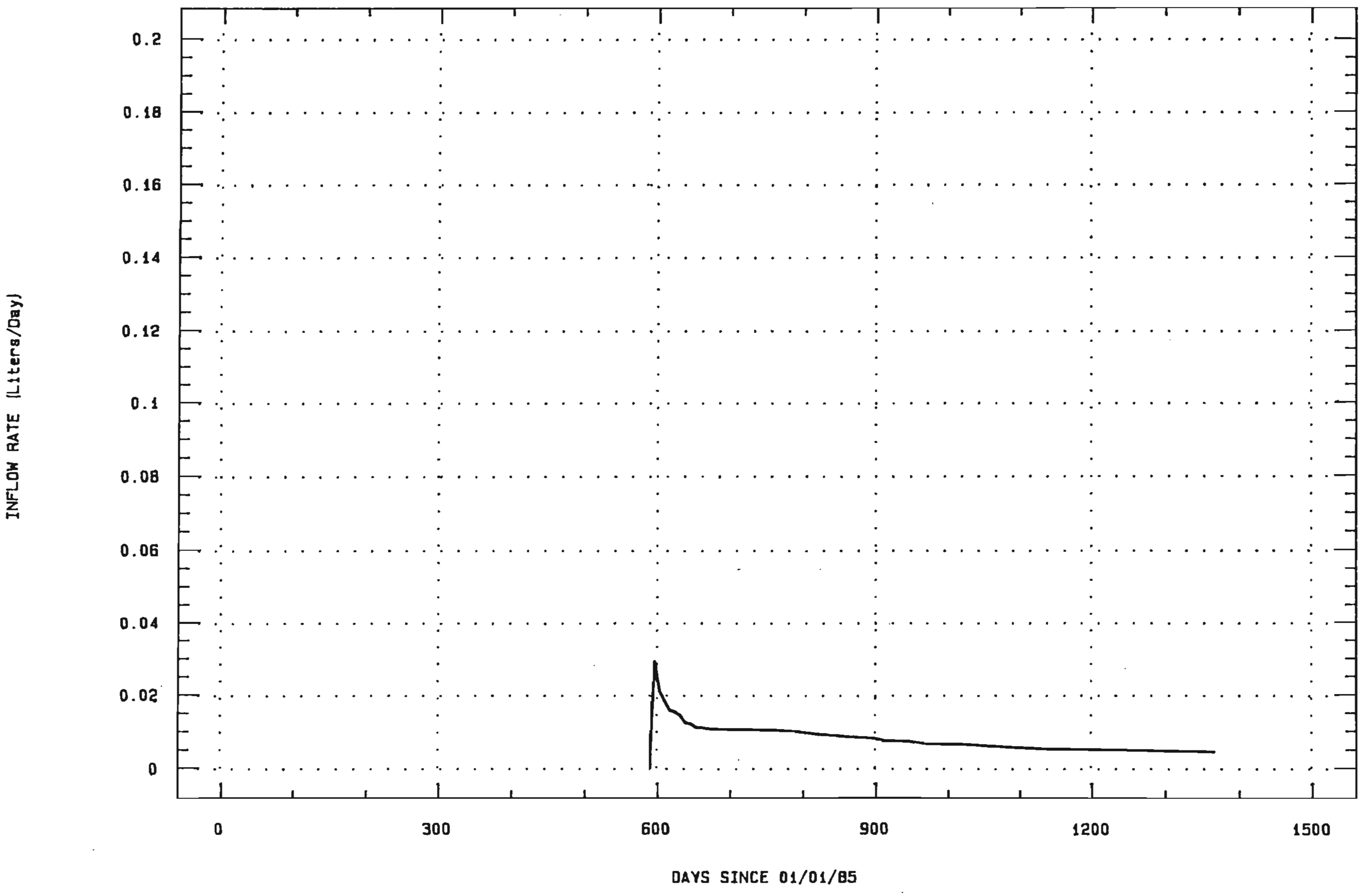
SIMPLE ELEVEN-POINT MOVING AVERAGE

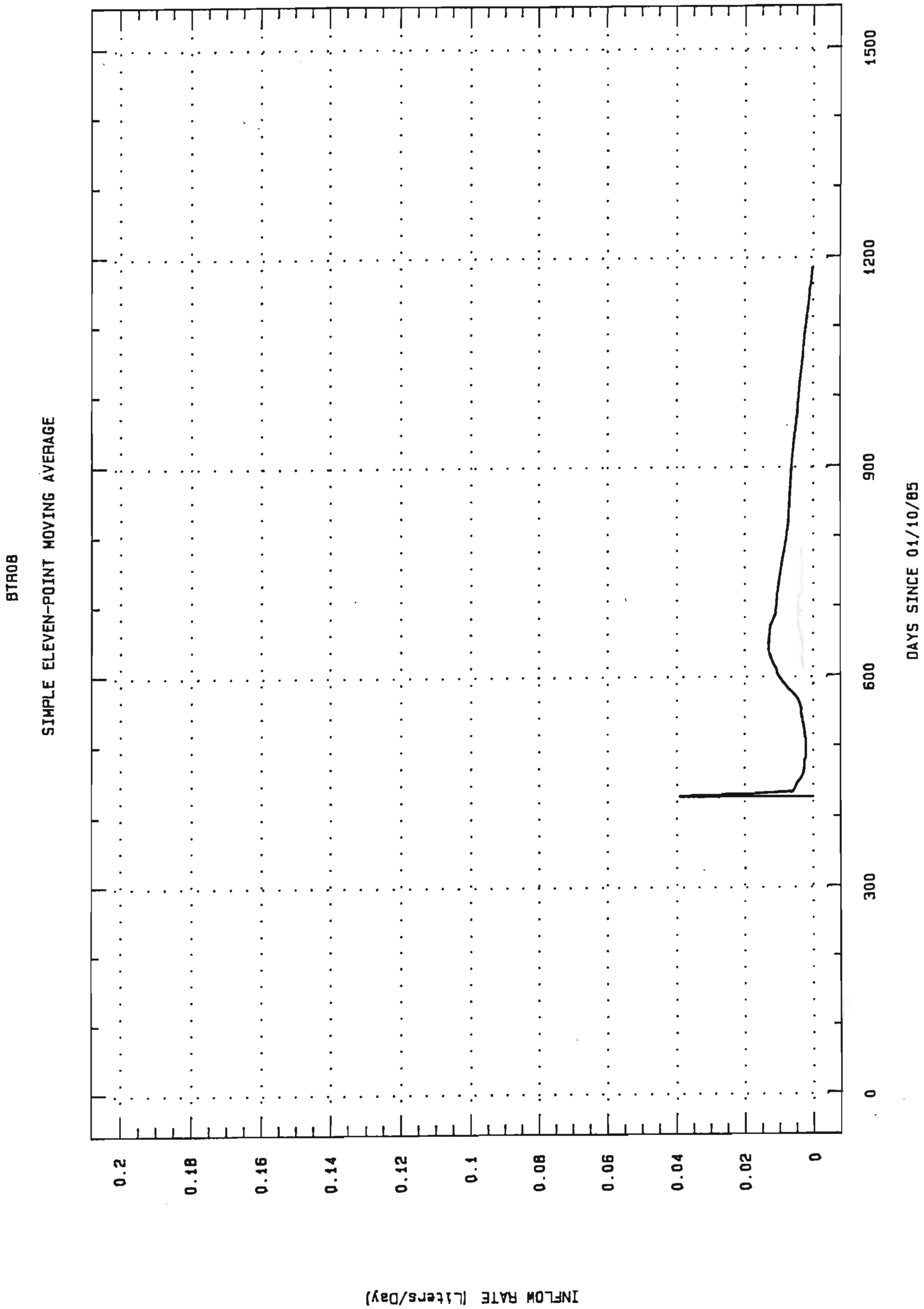



A3X02
SIMPLE ELEVEN-POINT MOVING AVERAGE
INFLOW RATE (Liters/Day)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
DAYS SINCE 01/01/85
0
300
600
900
1200
1500

BTCP4

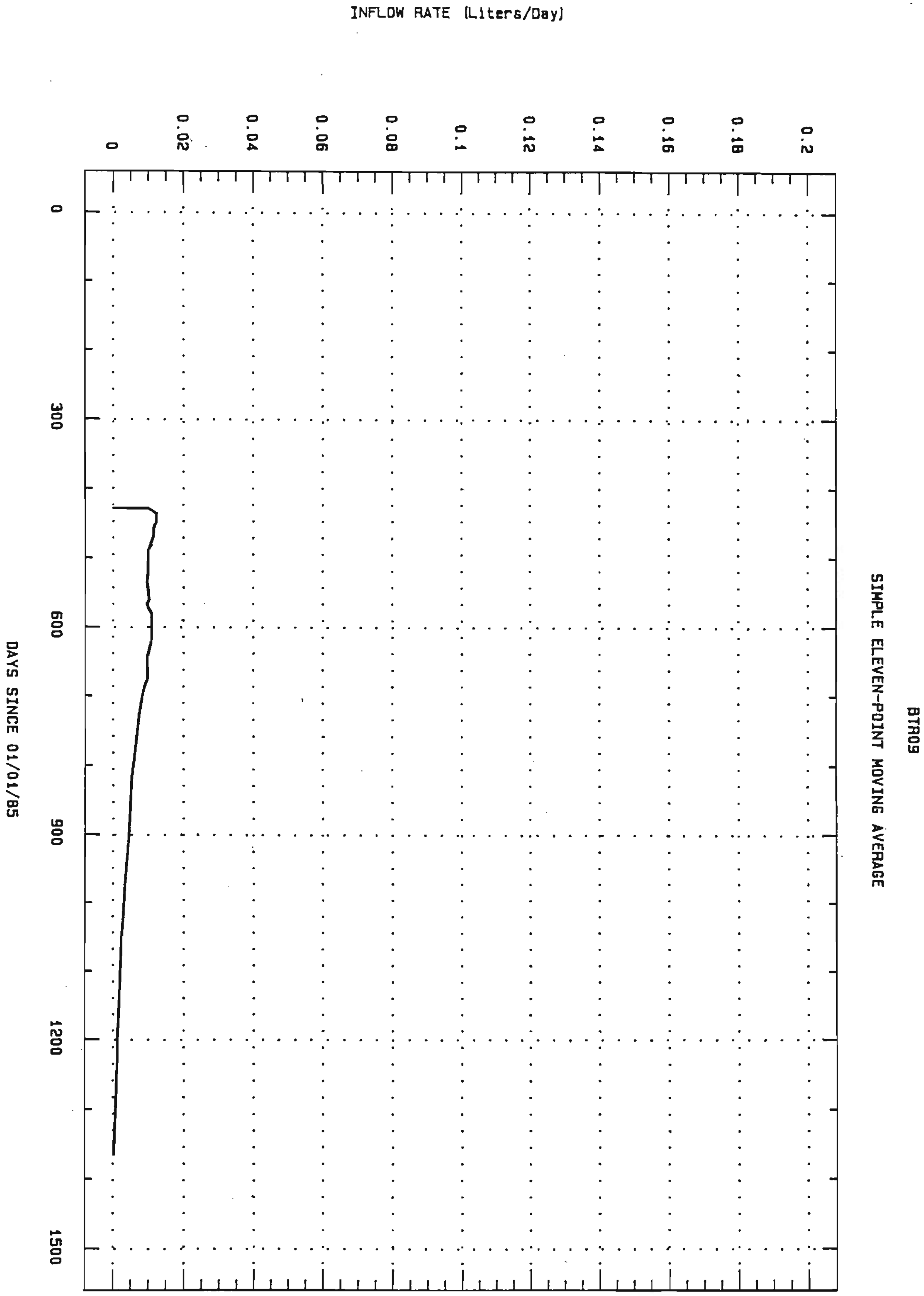
SIMPLE ELEVEN-POINT MOVING AVERAGE




BTR08
SIMPLE ELEVEN-POINT MOVING AVERAGE
INFLOW RATE (Liters/Day)
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
DAYS SINCE 01/10/85
0
300
600
900
1200
1500

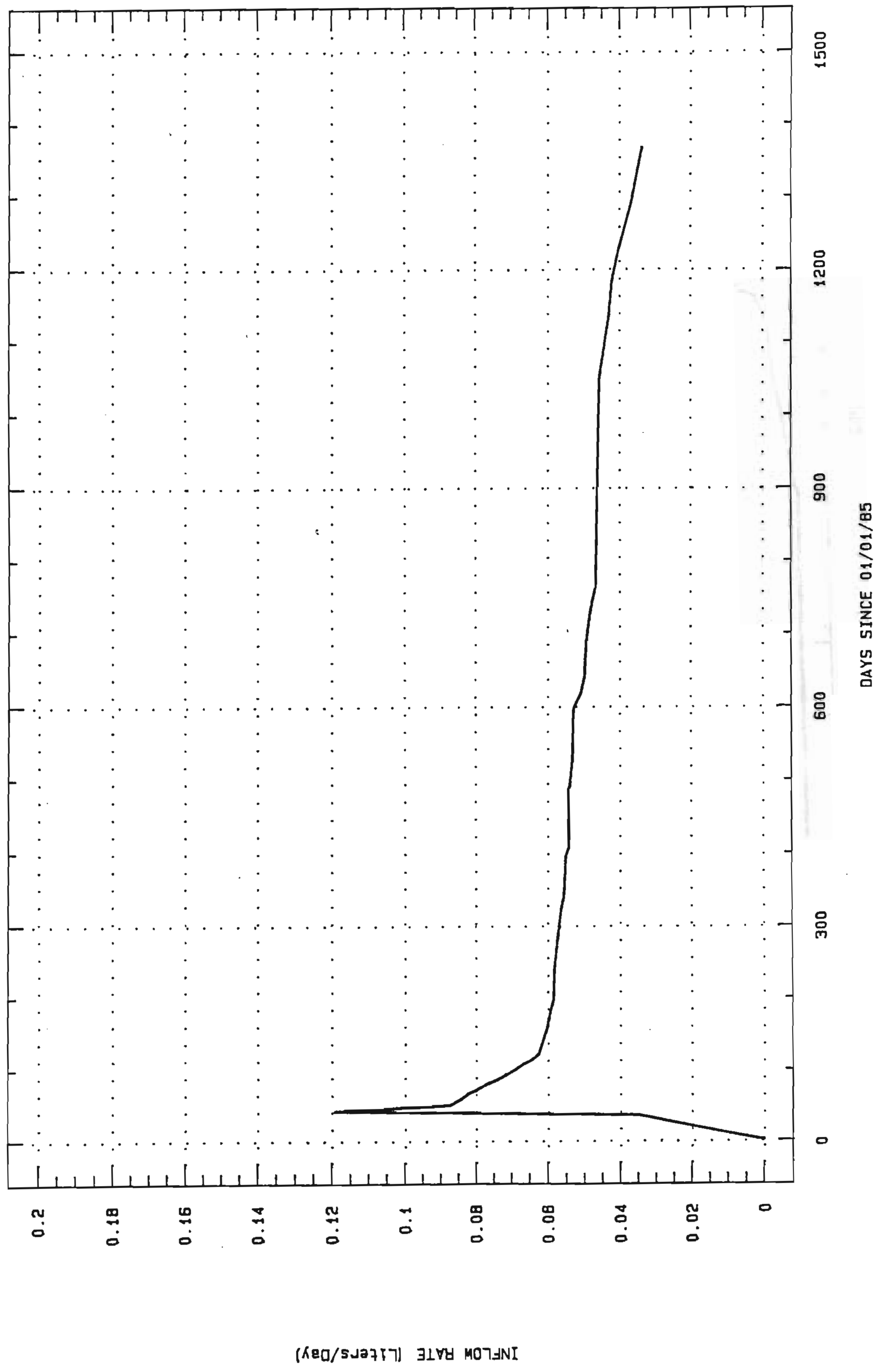
BTR09

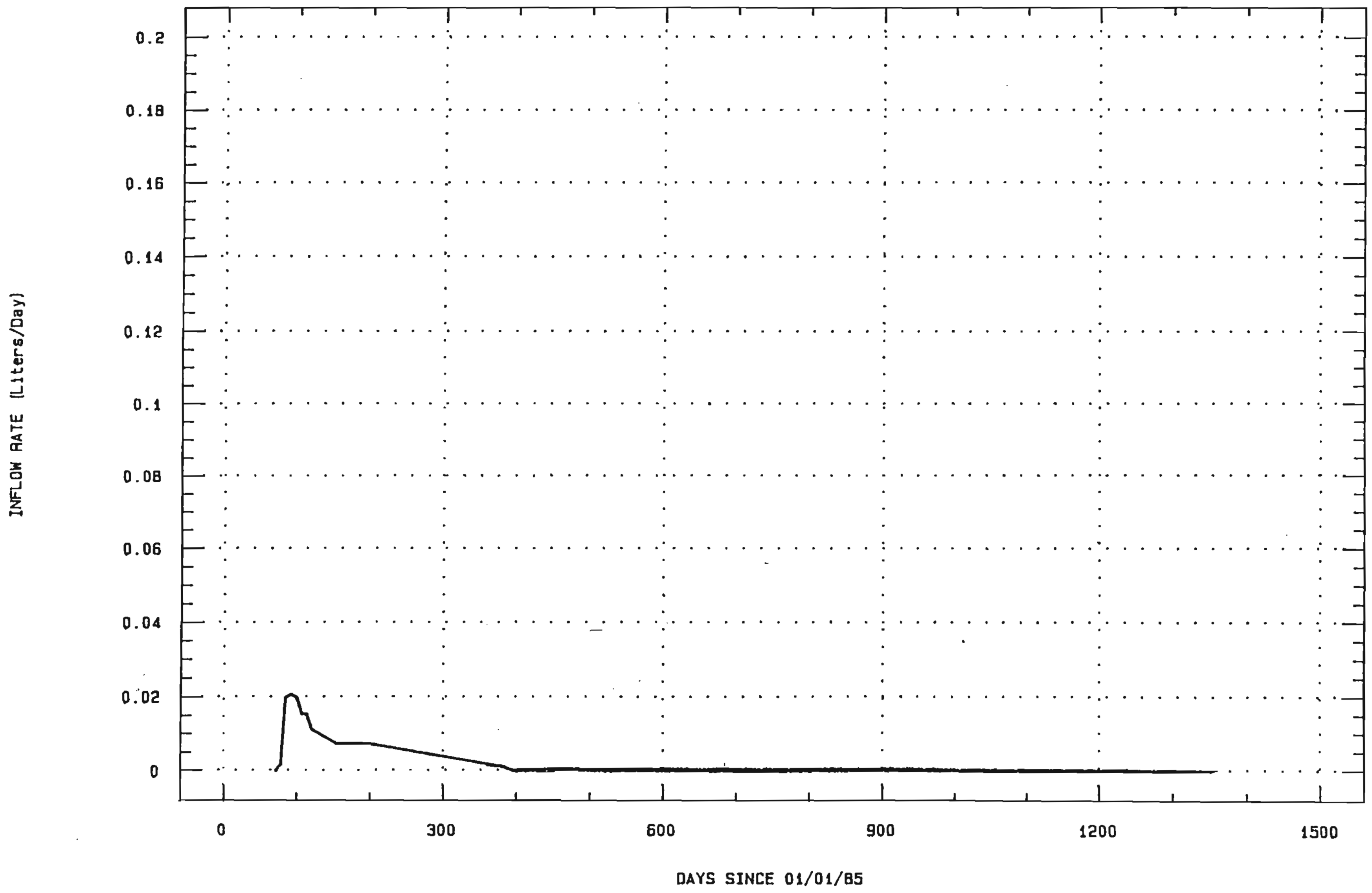
SIMPLE ELEVEN-POINT MOVING AVERAGE



BX01

SIMPLE ELEVEN-POINT MOVING AVERAGE



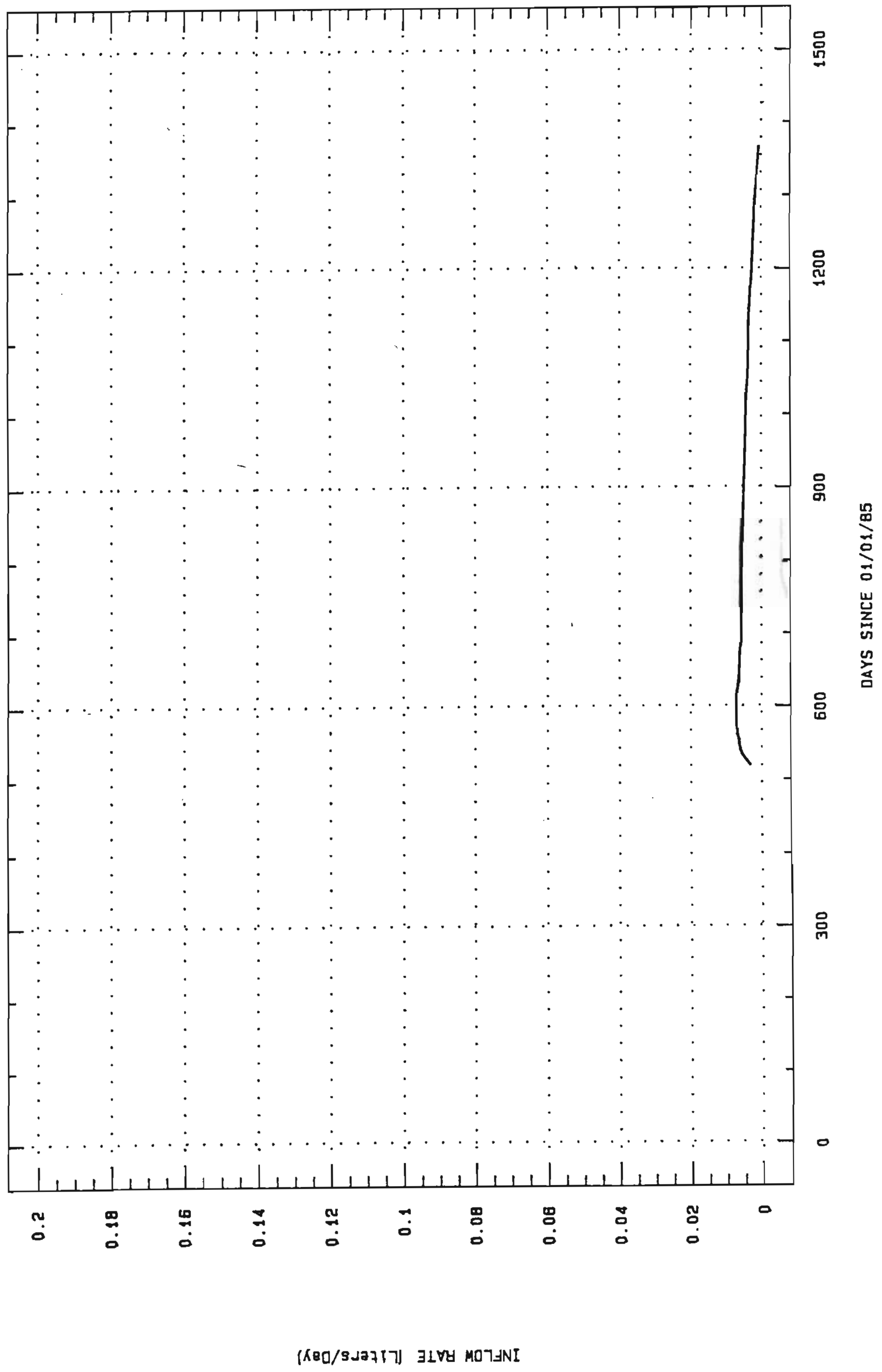


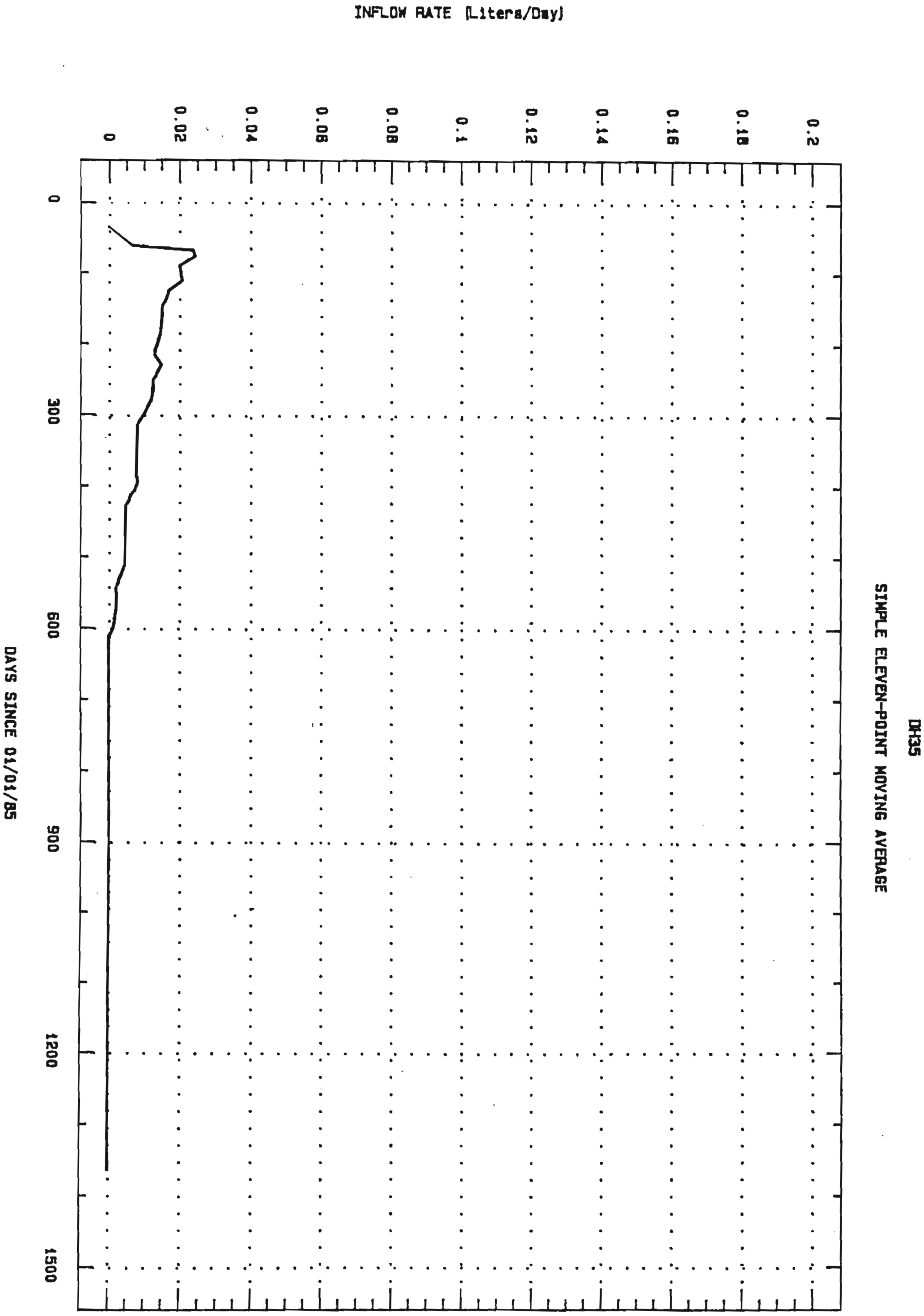
BX02

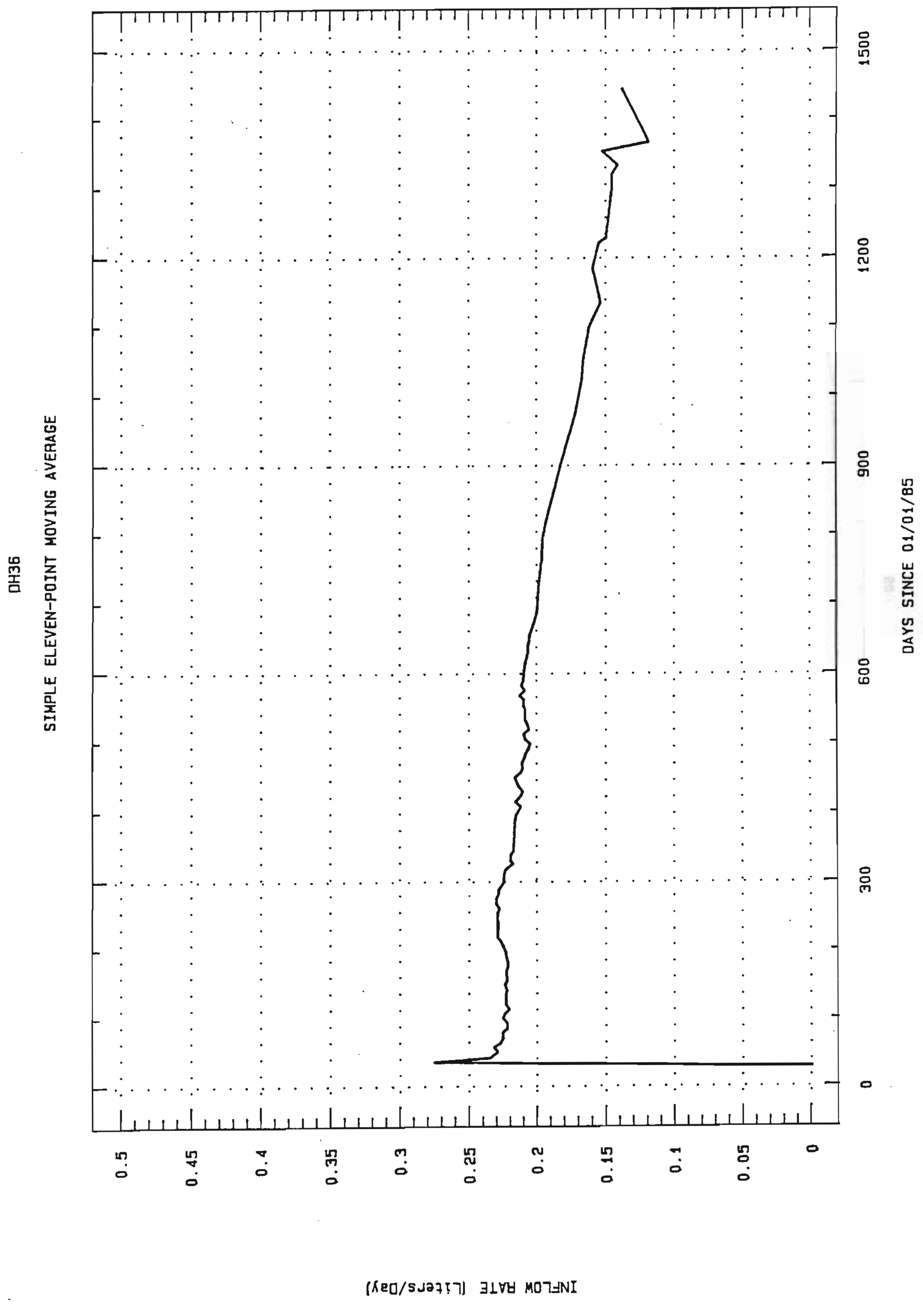
SIMPLE FIVE-POINT MOVING AVERAGE

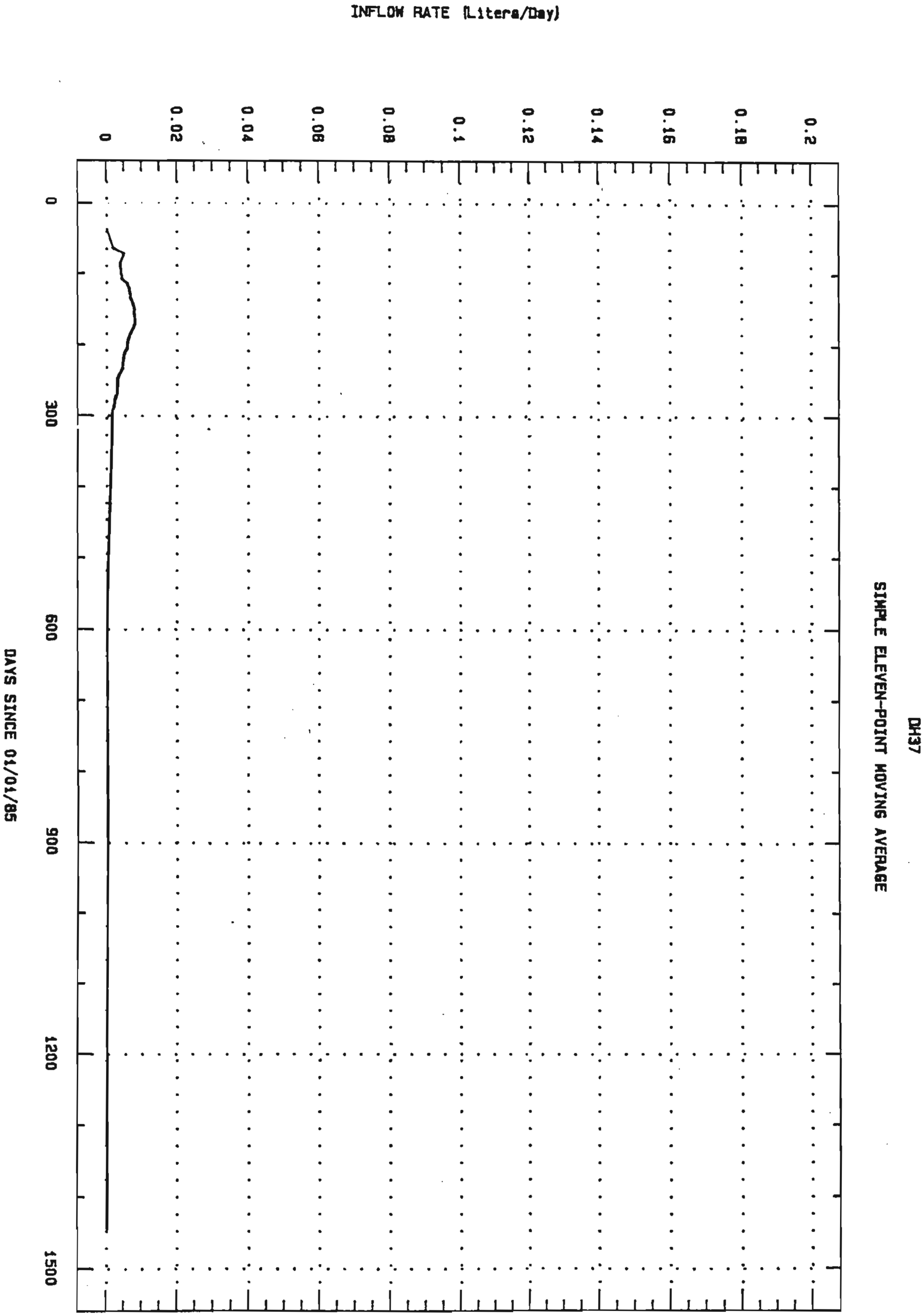
DH15

SIMPLE ELEVEN-POINT MOVING AVERAGE




INFLOW RATE (Liters/Day)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0
300
600
900
1200
1500
DAYS SINCE 01/01/85
DH35
SIMPLE ELEVEN-POINT MOVING AVERAGE

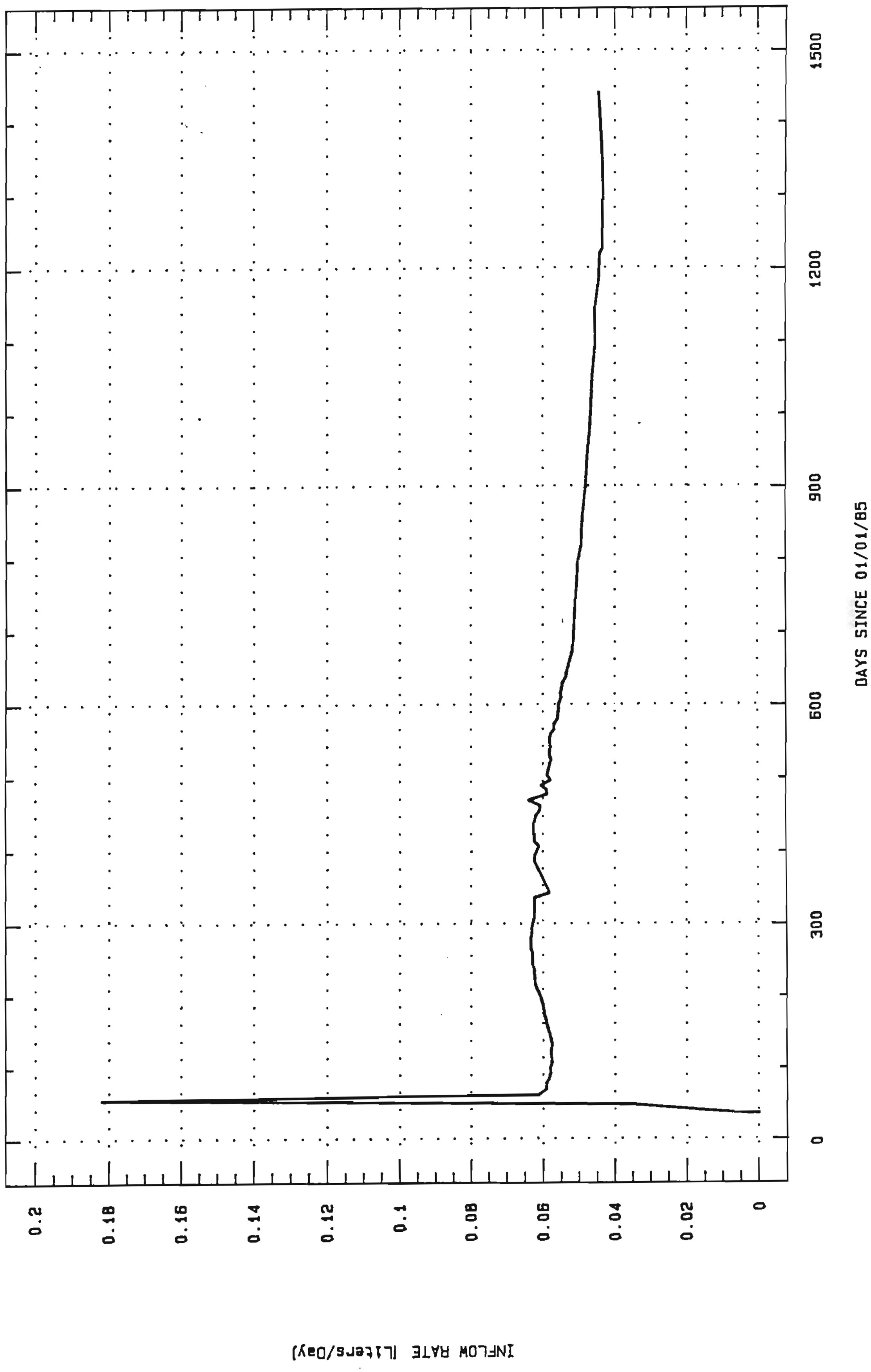

DH36
SIMPLE ELEVEN-POINT MOVING AVERAGE
INFLOW RATE (Liters/Day)
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
DAYS SINCE 01/01/85
0
300
600
900
1200
1500

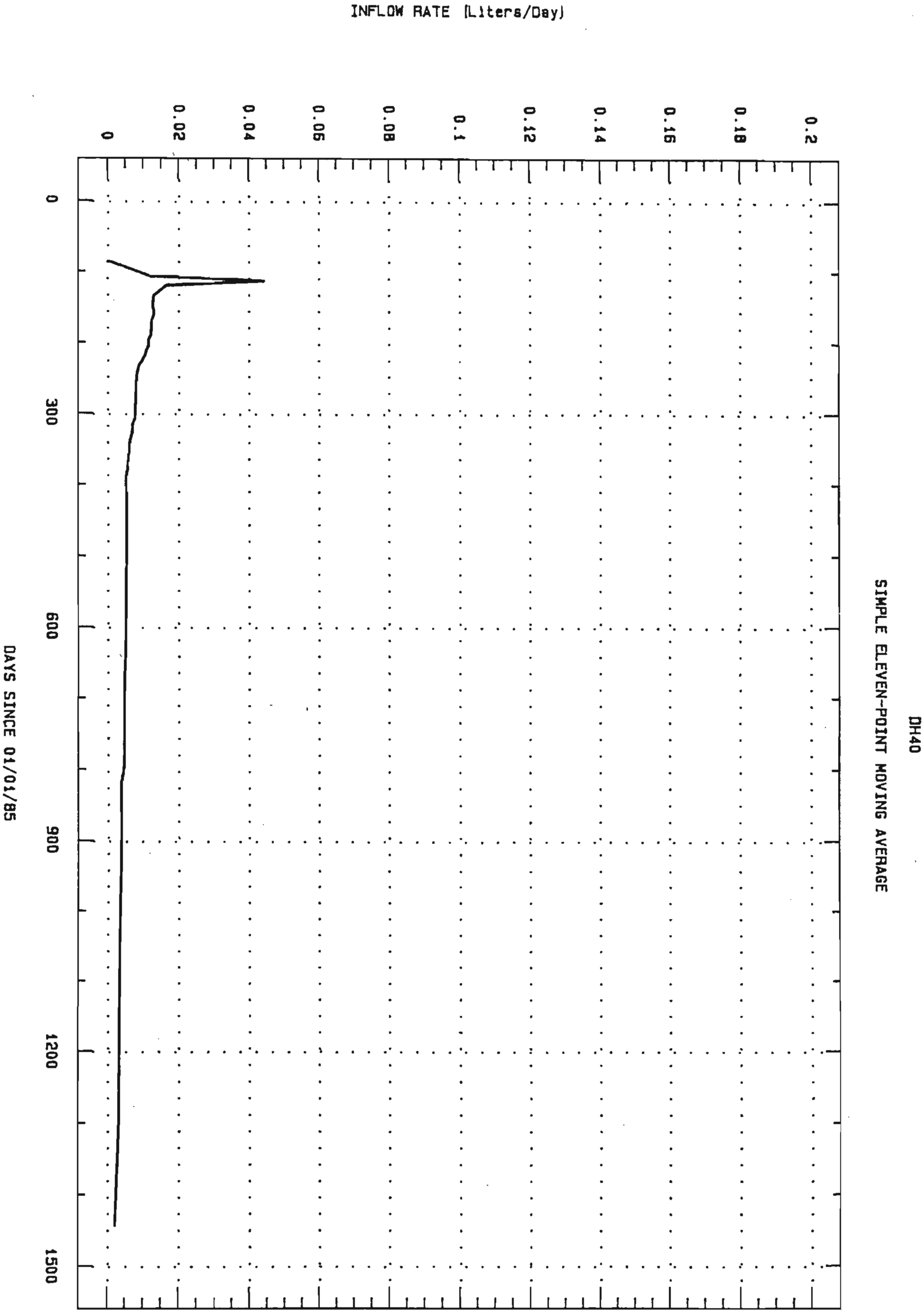

DH37

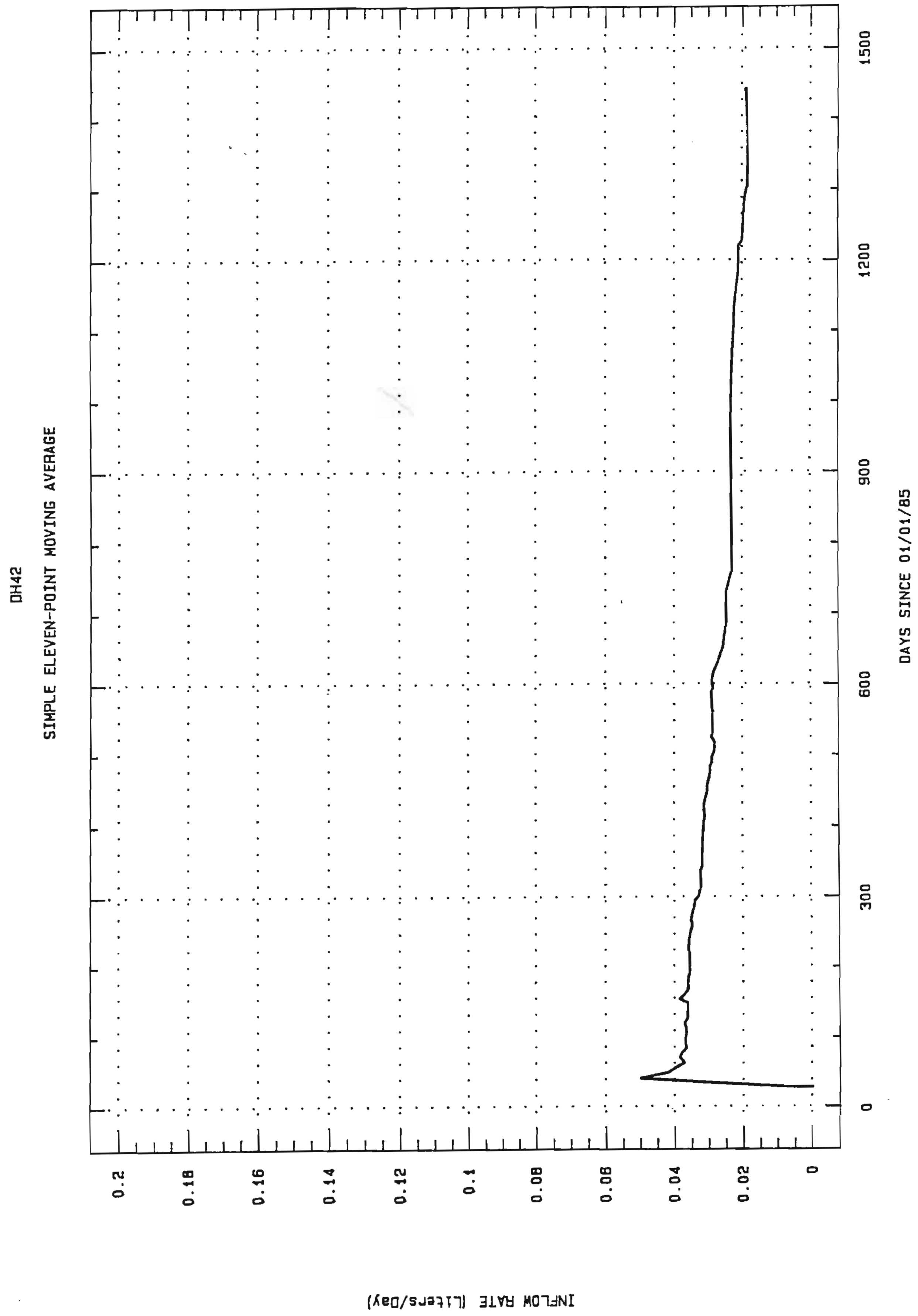
SIMPLE ELEVEN-POINT MOVING AVERAGE

DH38

SIMPLE ELEVEN-POINT MOVING AVERAGE

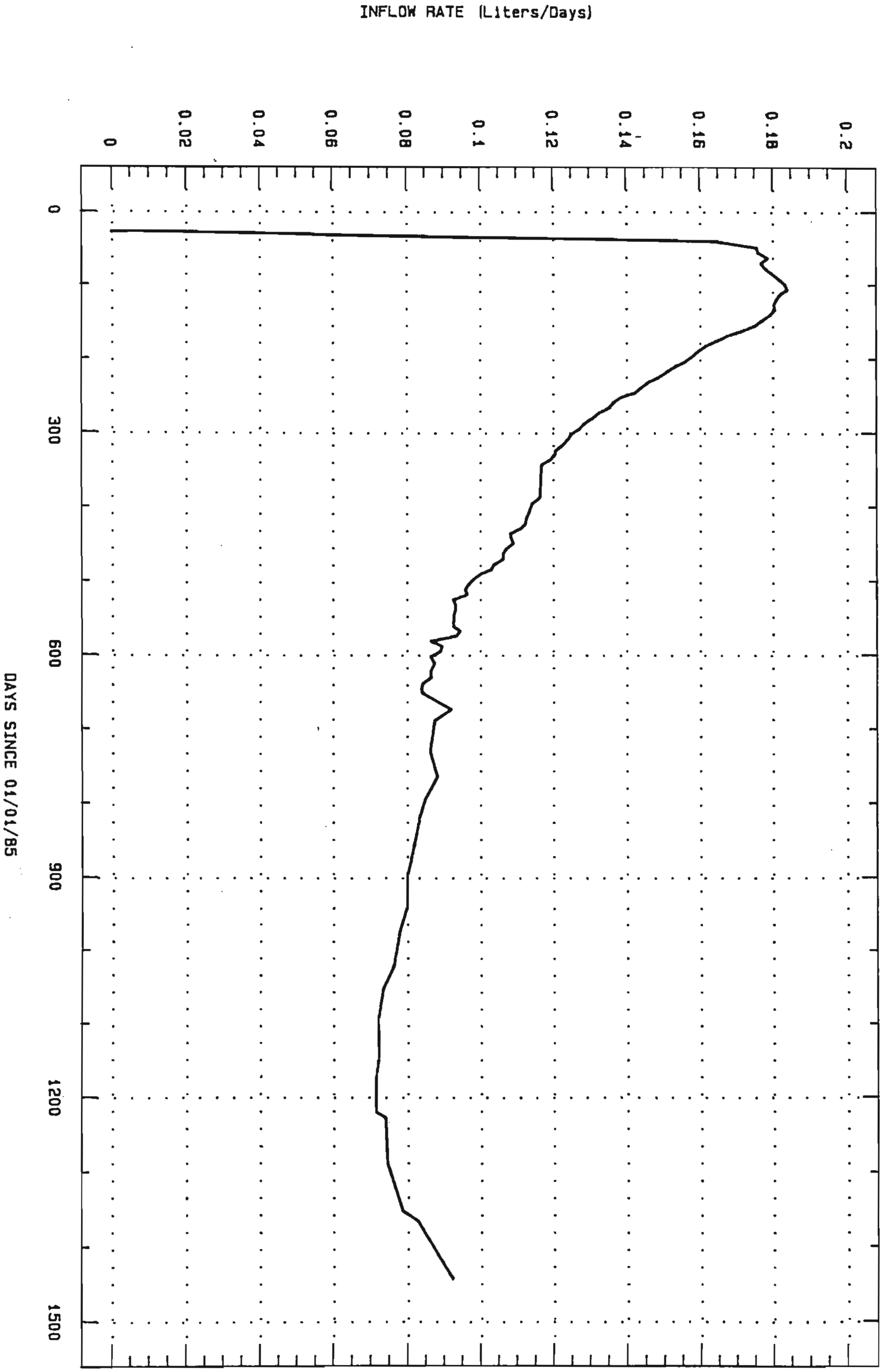



DH40
SIMPLE ELEVEN-POINT MOVING AVERAGE
INFLOW RATE (Liters/Day)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
DAYS SINCE 01/01/85
0
300
600
900
1200
1500



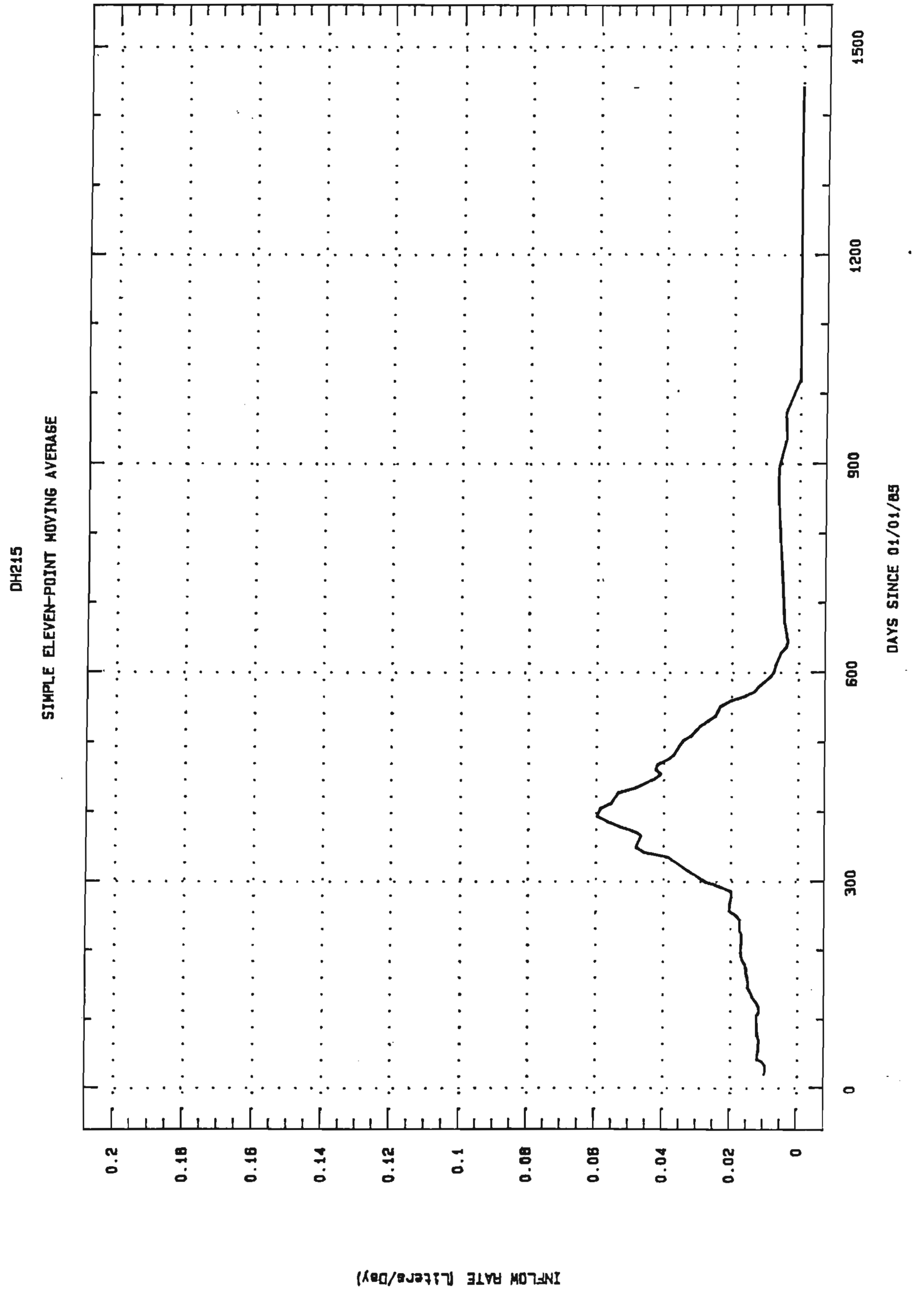
DH42

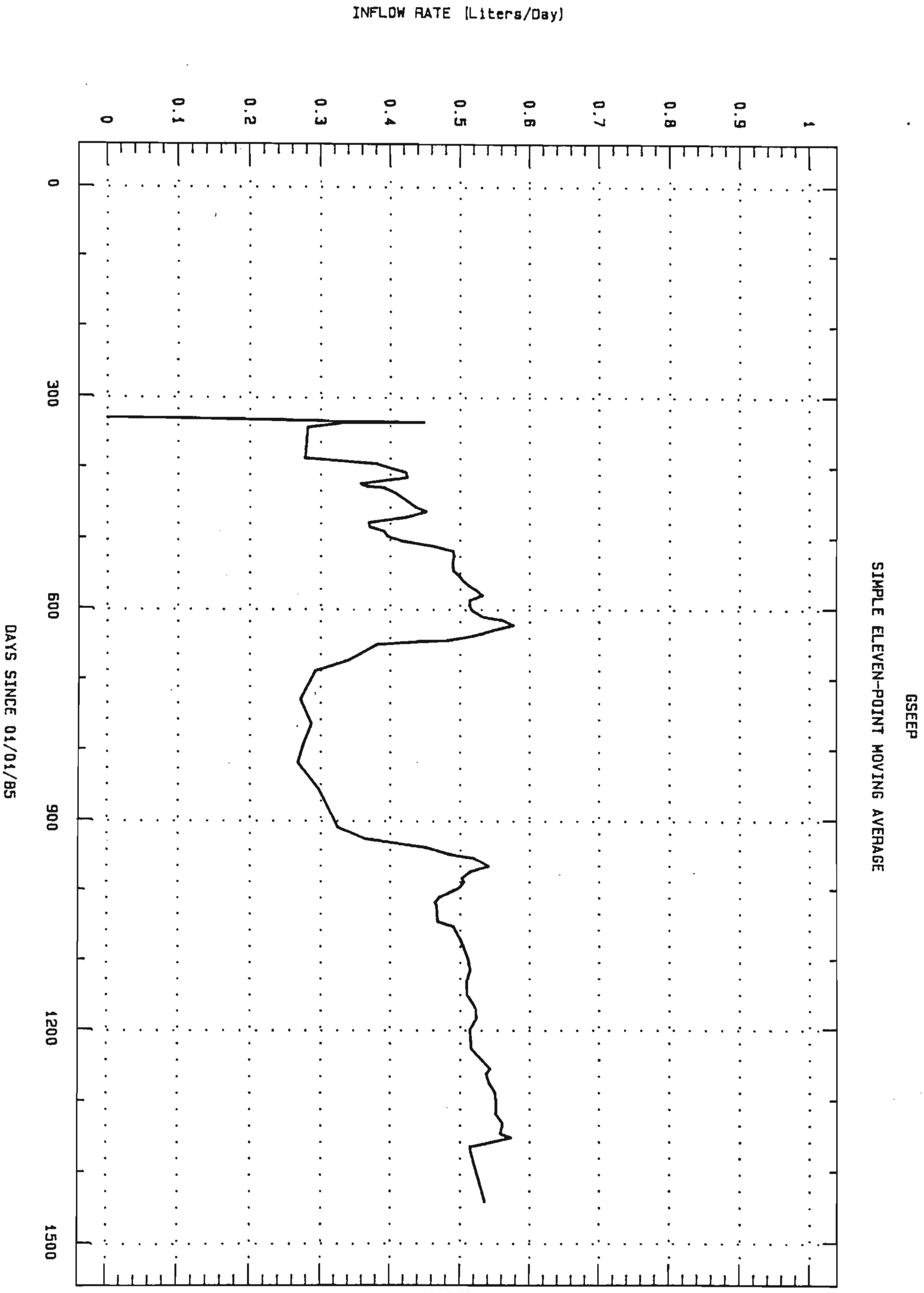
SIMPLE ELEVEN-POINT MOVING AVERAGE



DH42A

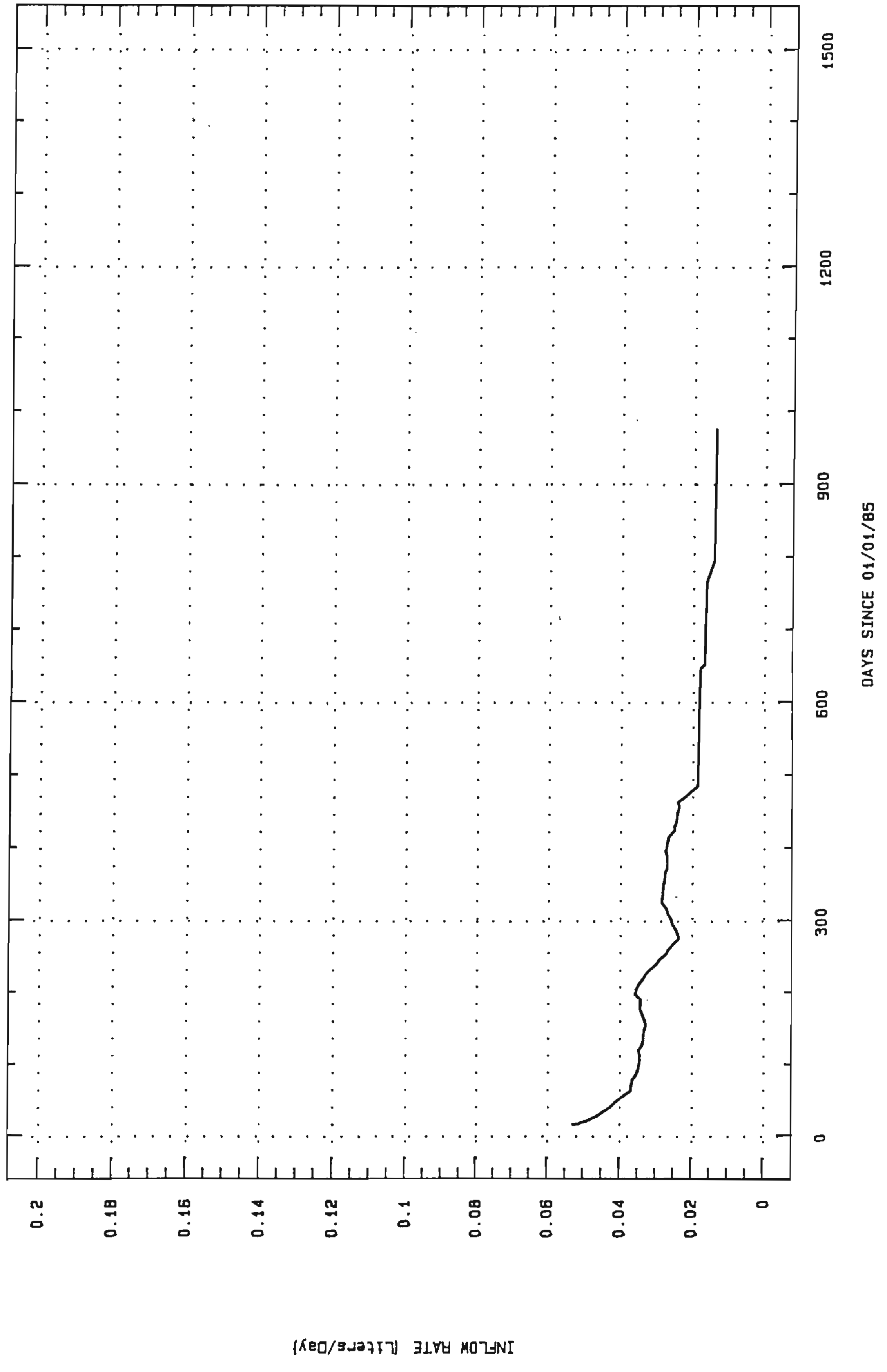
SIMPLE ELEVEN-POINT MOVING AVERAGE

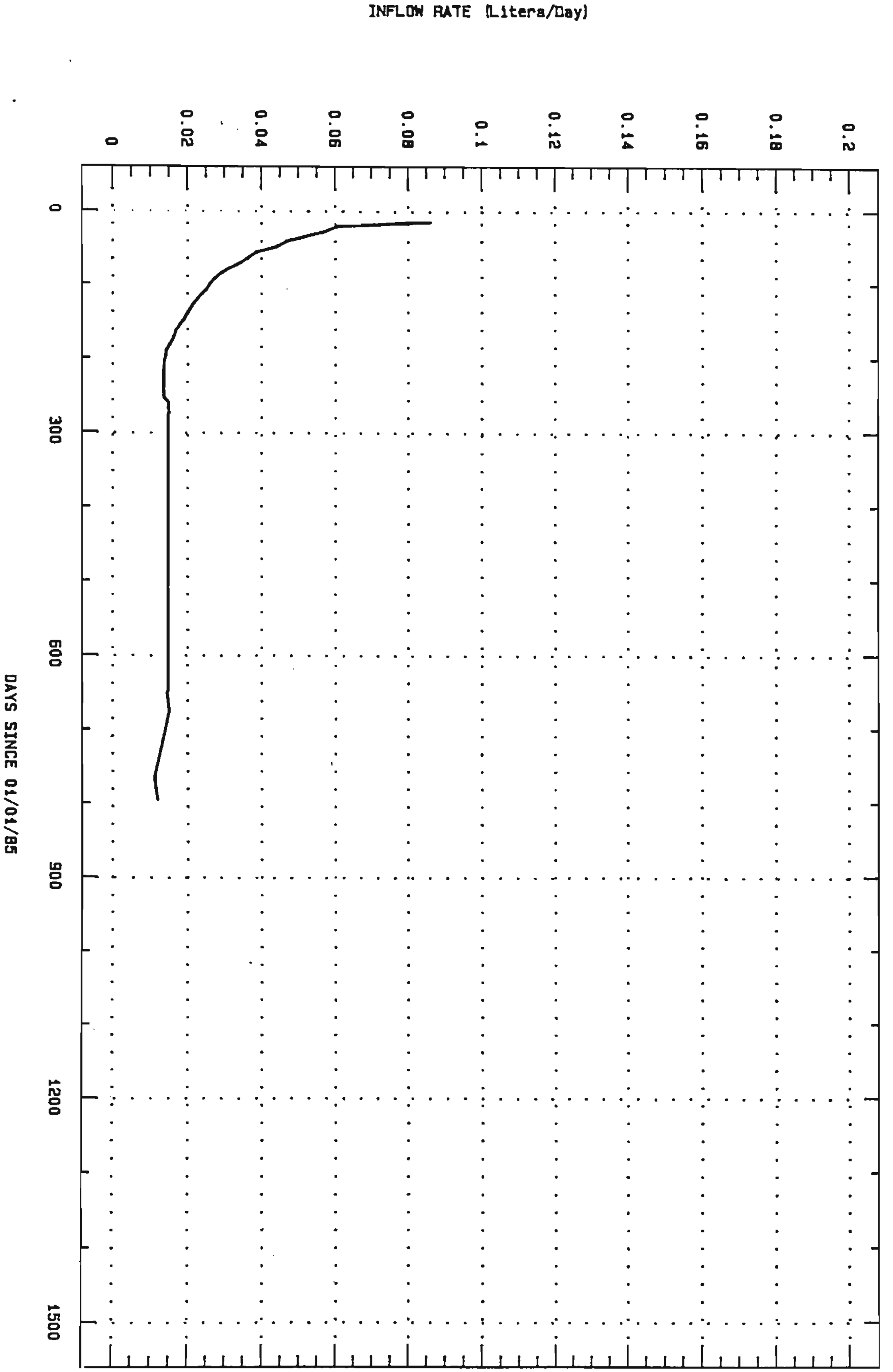

DH215
SIMPLE ELEVEN-POINT MOVING AVERAGE
DAYS SINCE 01/01/85
0
300
600
900
1200
1500
INFLOW RATE (Liters/Day)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2


GSEEP
SIMPLE ELEVEN-POINT MOVING AVERAGE
INFLOW RATE (Liters/Day)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
DAYS SINCE 01/01/85
0
300
600
900
1200
1500

IG201

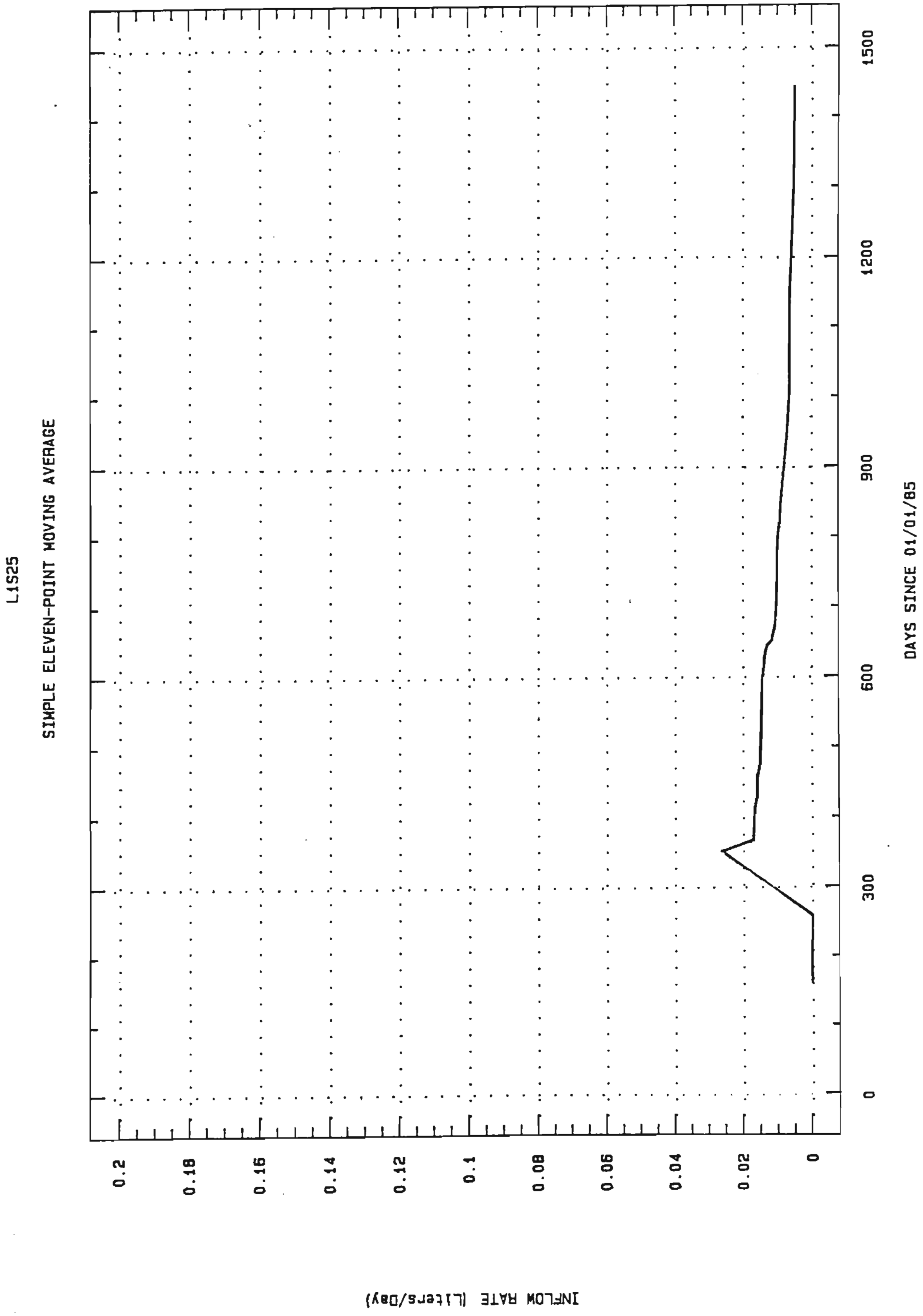
SIMPLE ELEVEN-POINT MOVING AVERAGE





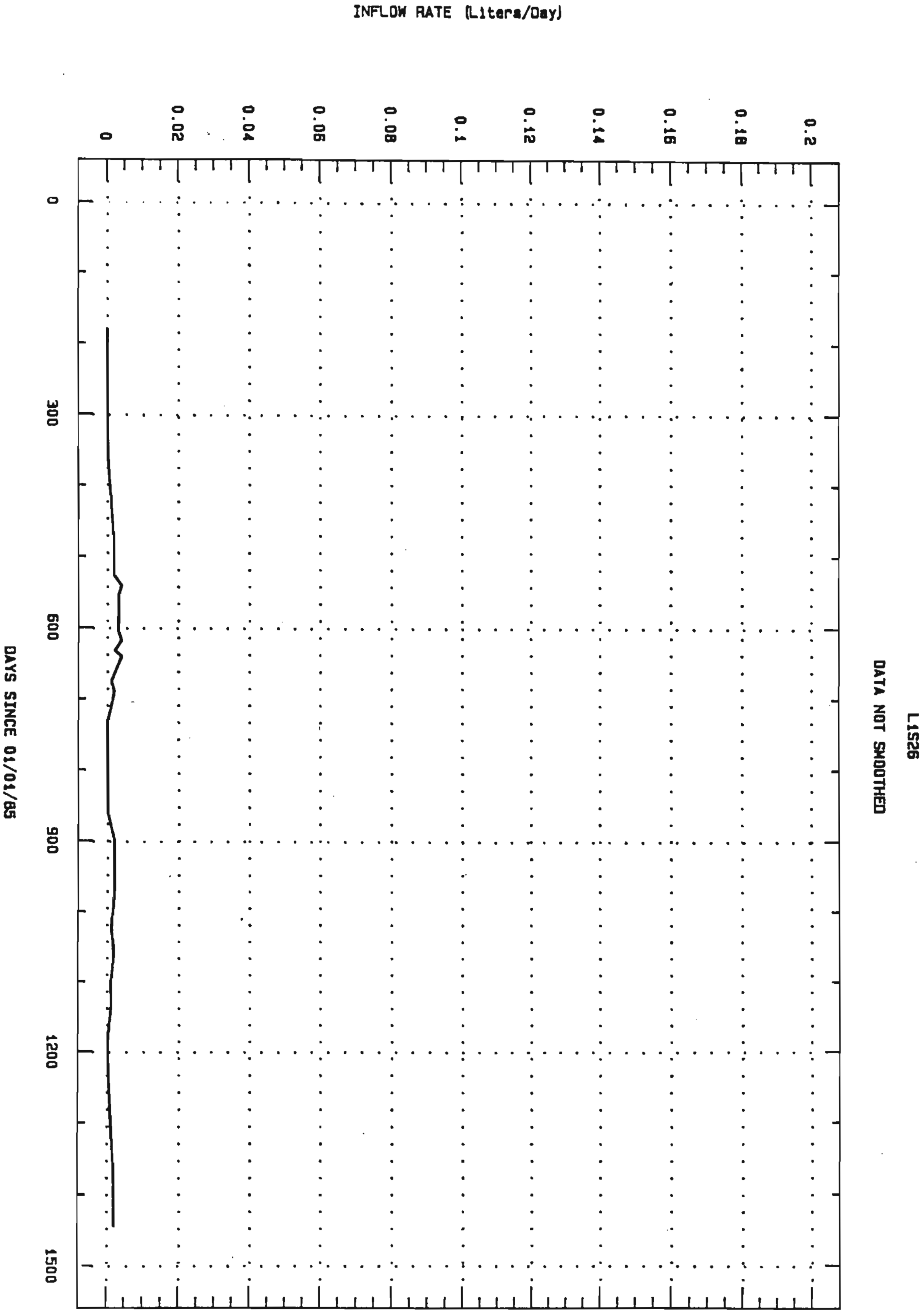
I6202

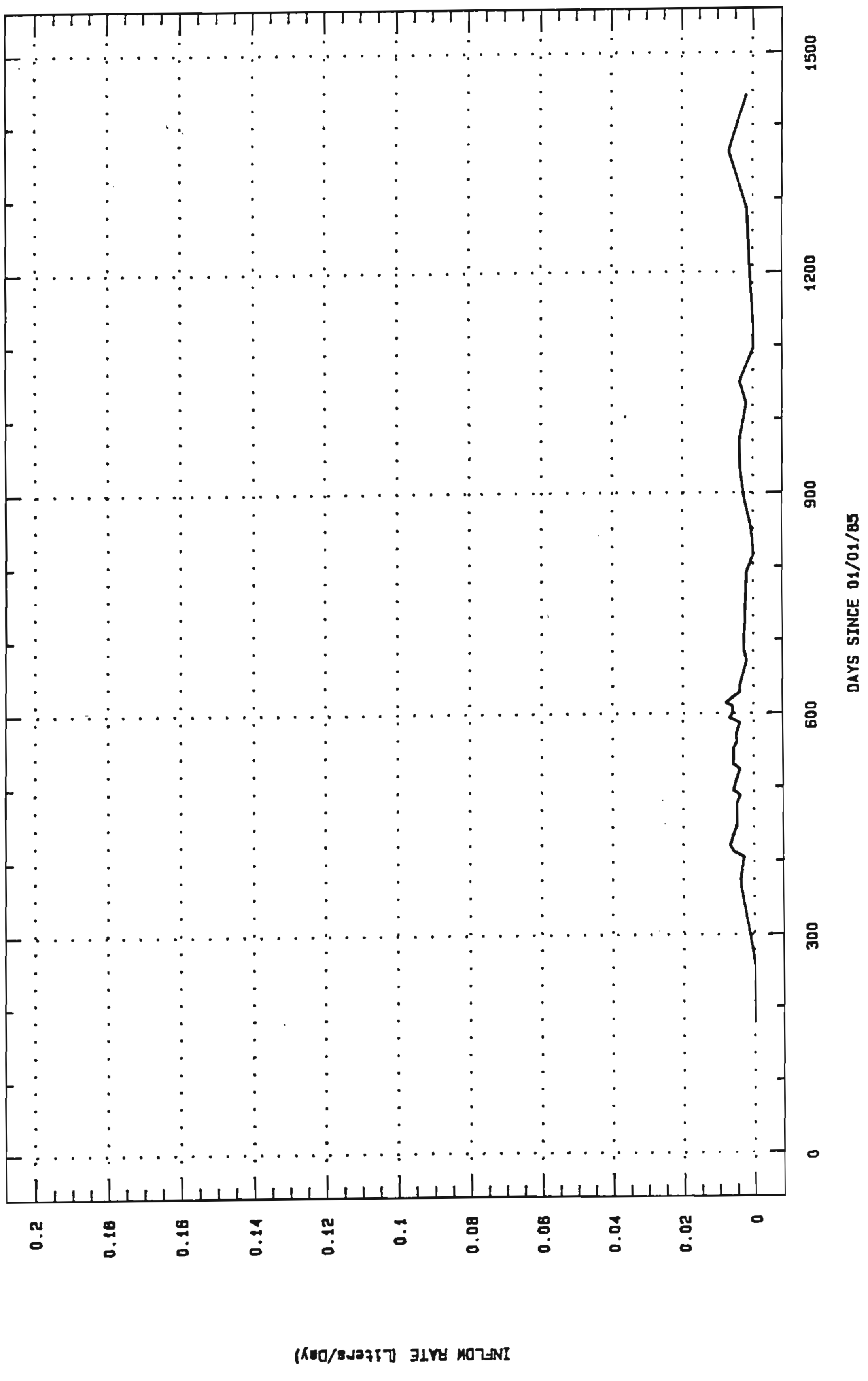
SIMPLE ELEVEN-POINT MOVING AVERAGE

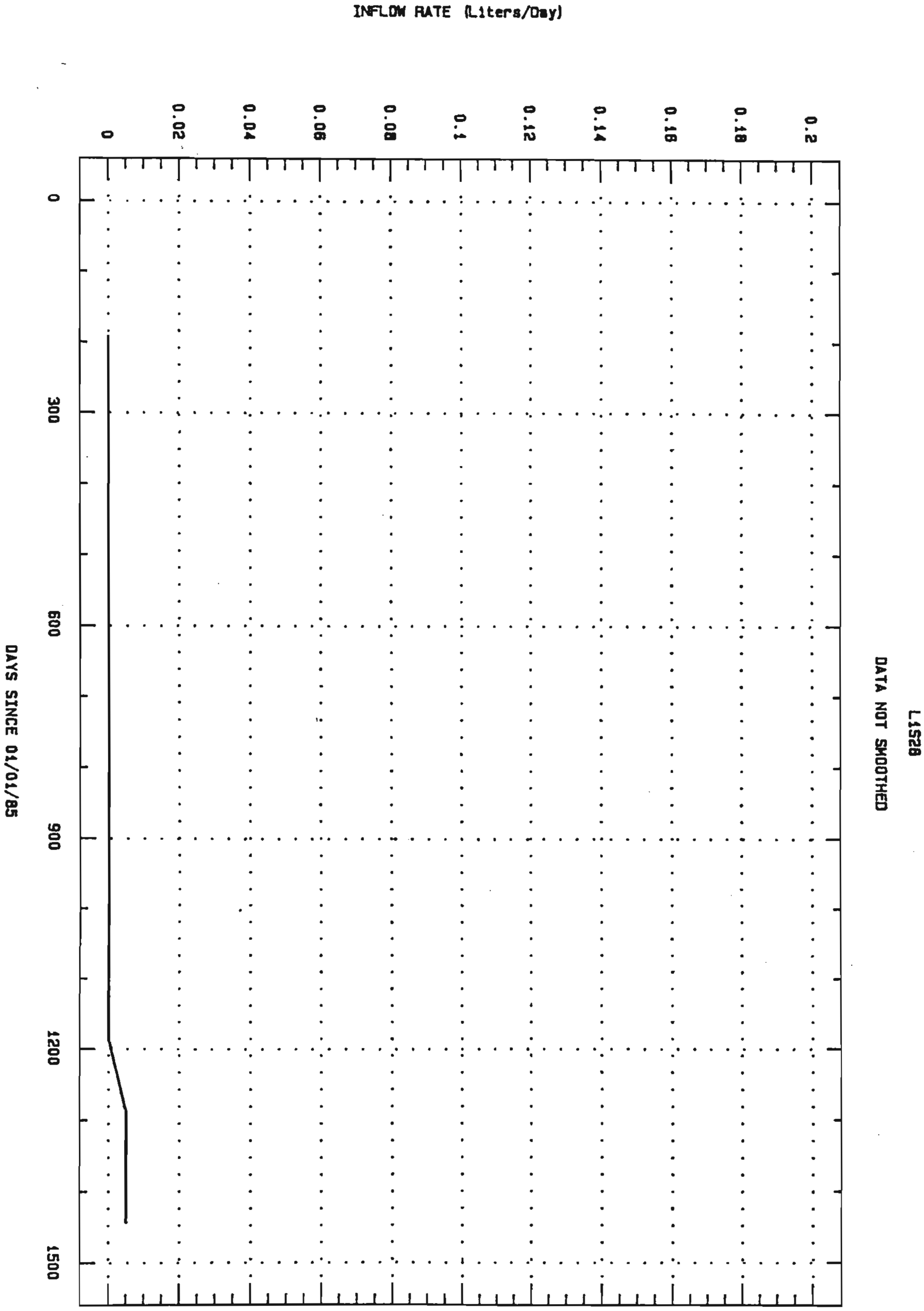


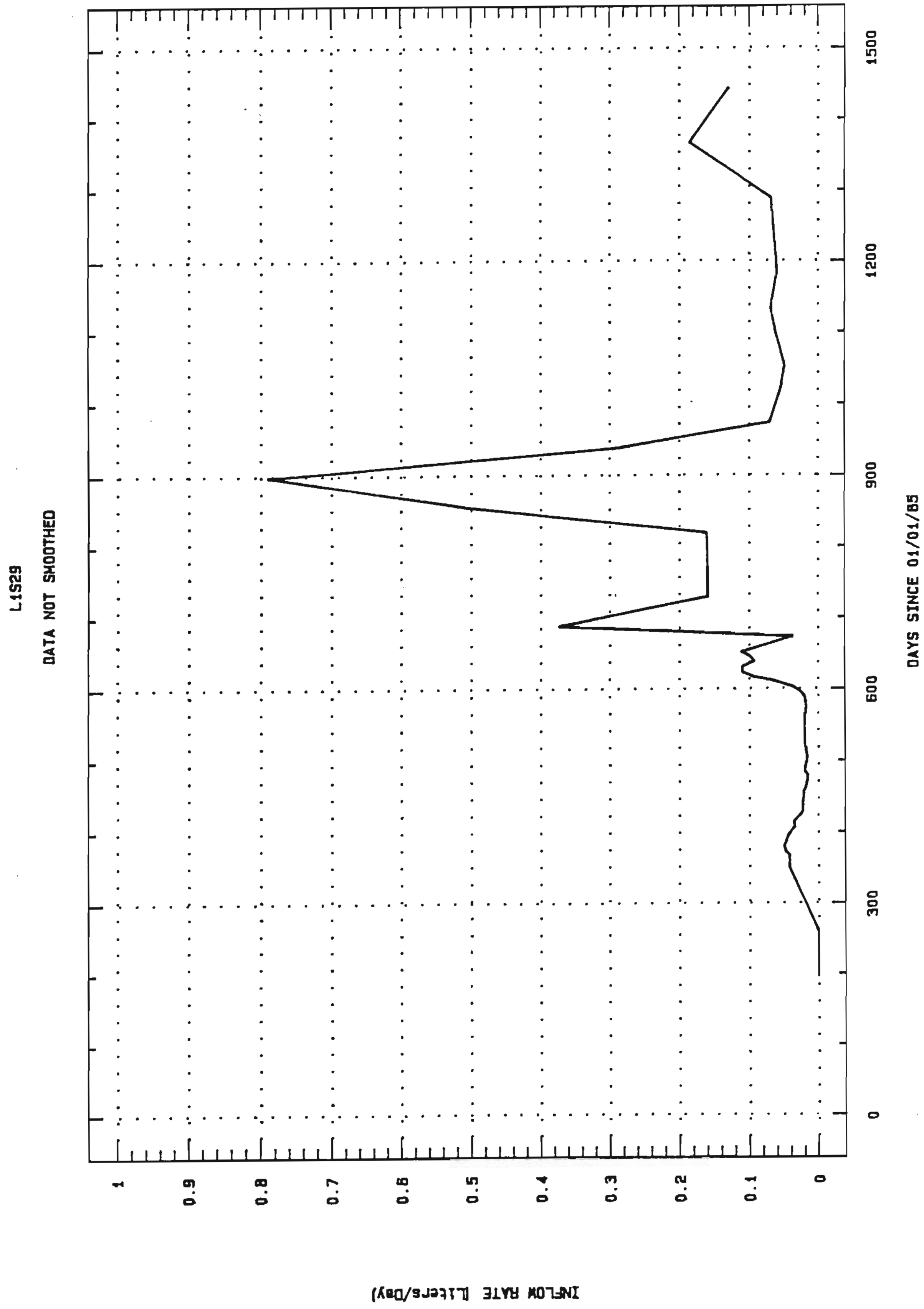
L1S25

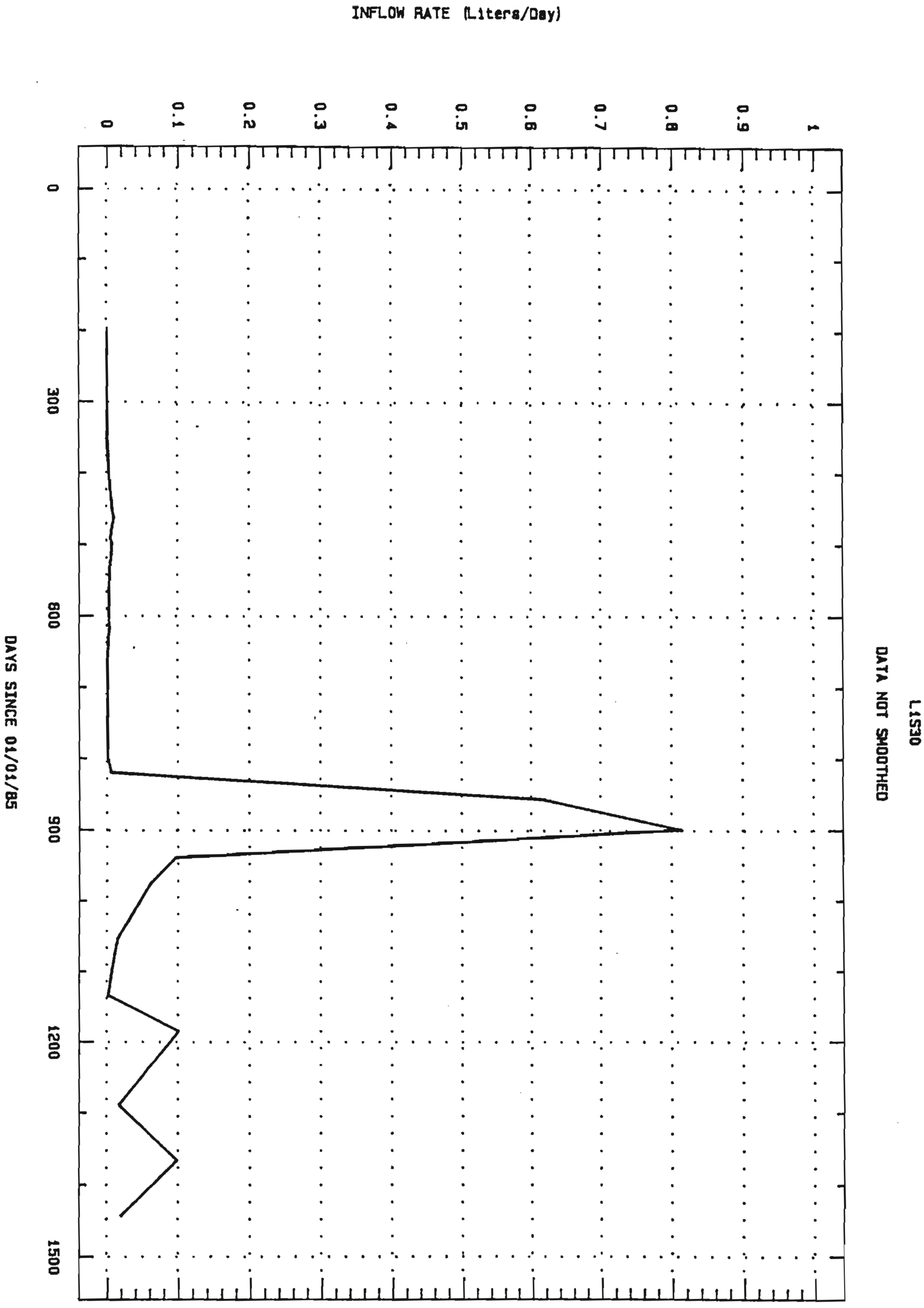
SIMPLE ELEVEN-POINT MOVING AVERAGE


L1S26
DATA NOT SMOOTHED
INFLOW RATE (Liters/Day)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
DAYS SINCE 01/01/85
0
300
600
900
1200
1500



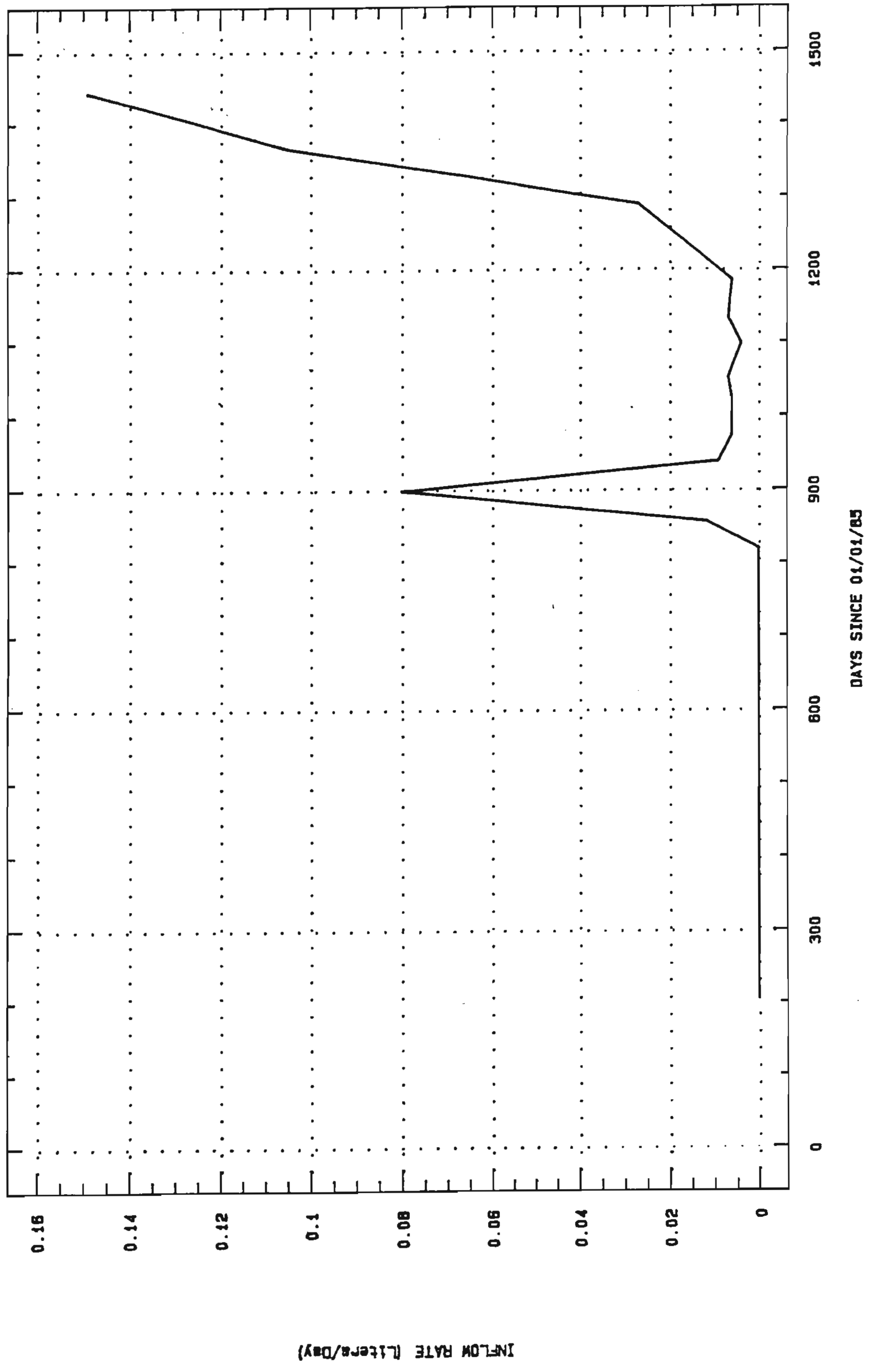

INFLOW RATE (Liters/Day)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
DAYS SINCE 01/01/85
0
300
600
900
1200
1500
L1S28
DATA NOT SMOOTHED

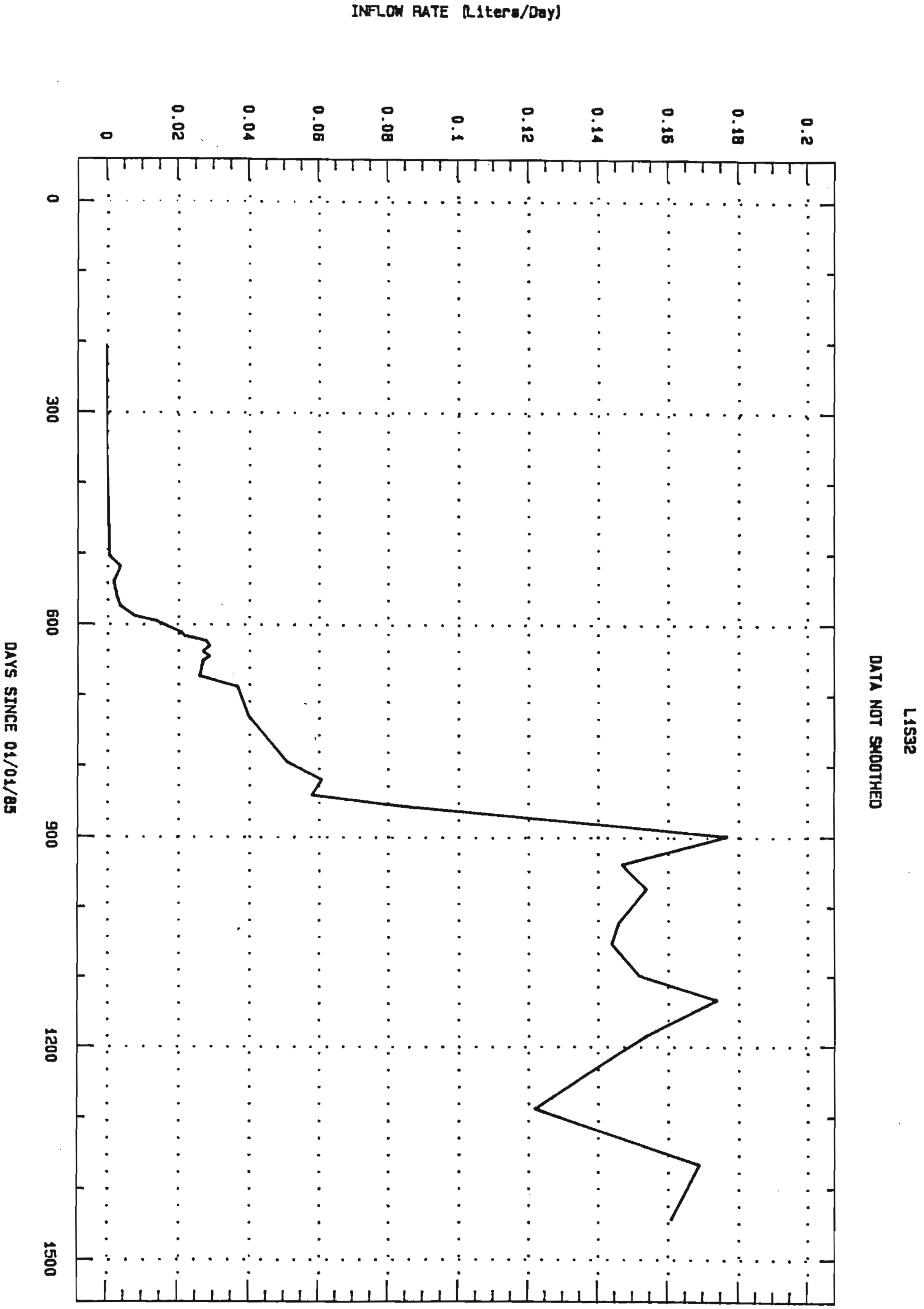

L1S29
DATA NOT SMOOTHED
INFLOW RATE (Liters/Day)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
DAYS SINCE 01/01/85
0
300
600
900
1200
1500


L1S30
DATA NOT SMOOTHED
INFLOW RATE (Liters/Day)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
DAYS SINCE 01/01/85
0
300
600
900
1200
1500

L1531

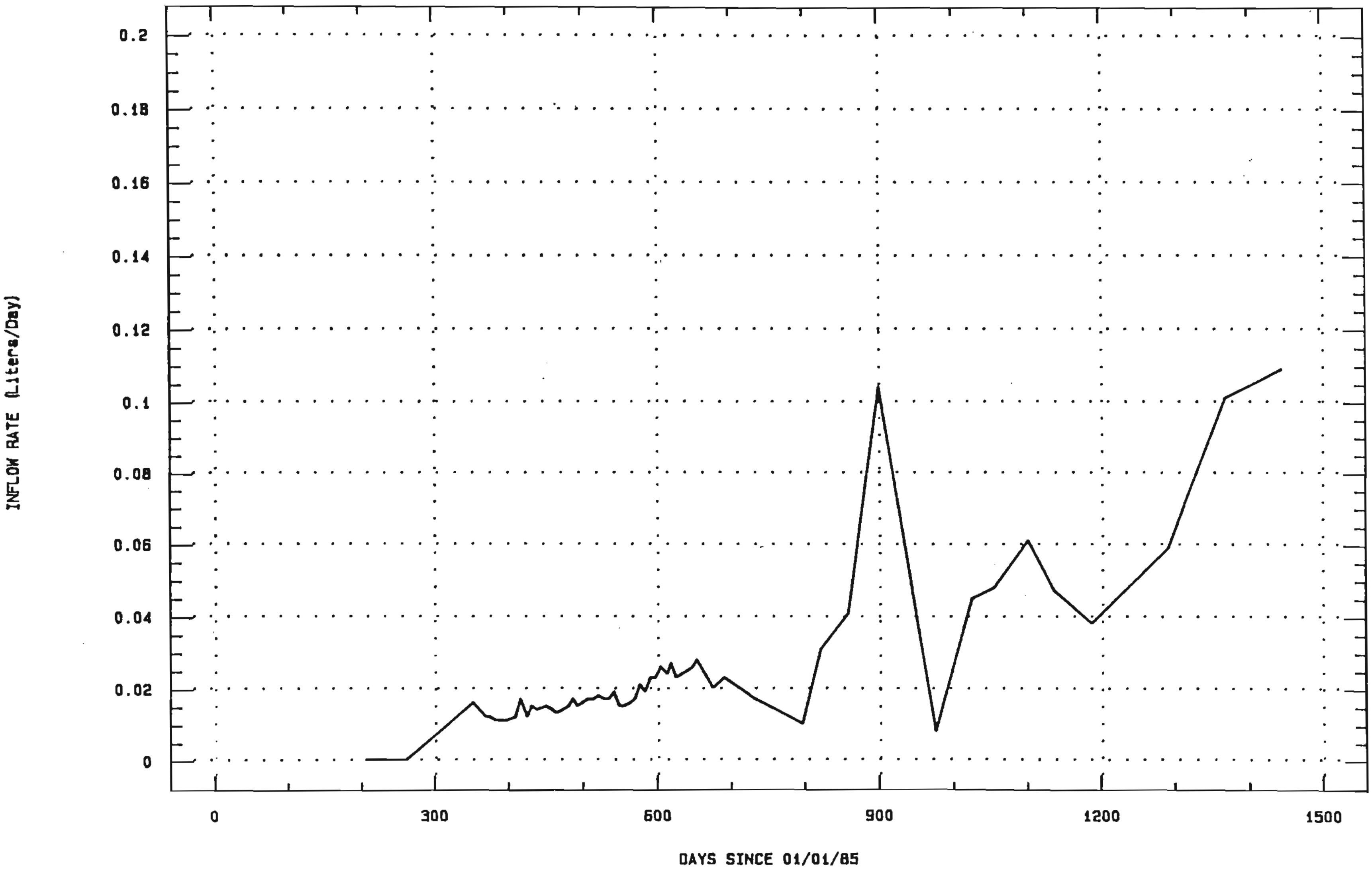
DATA NOT SMOOTHED

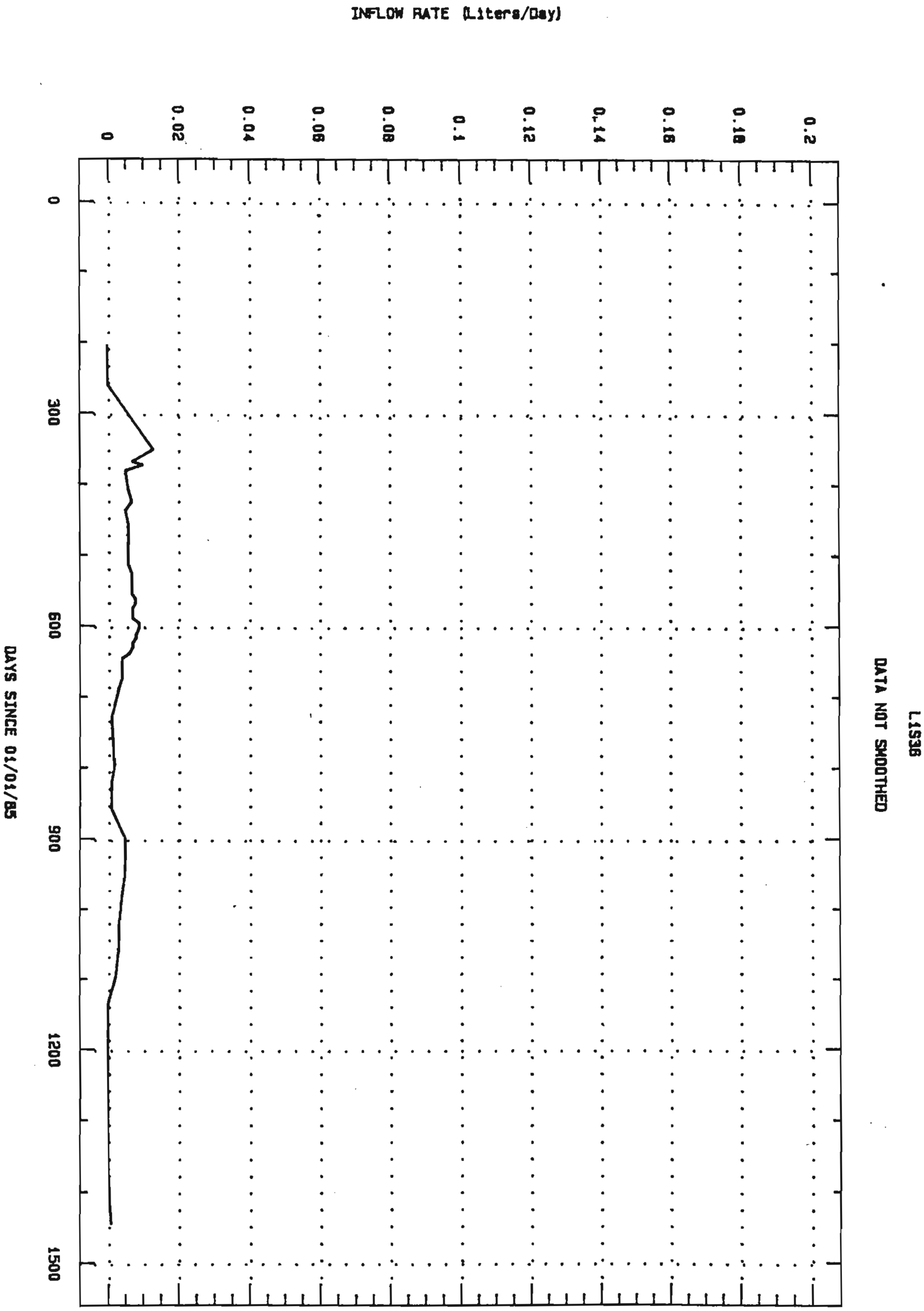


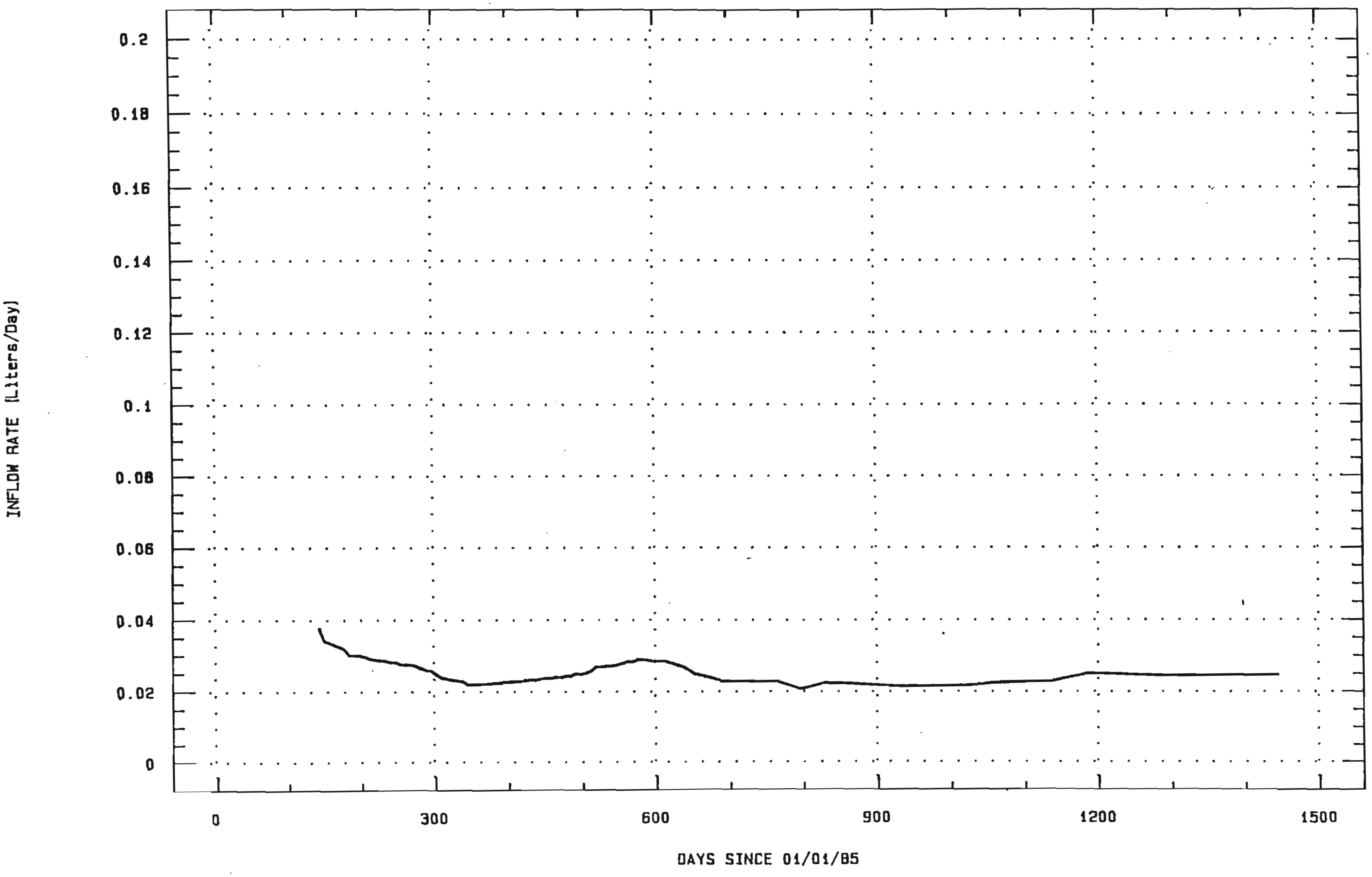

L1S32
DATA NOT SMOOTHED
INFLOW RATE (Liters/Day)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
DAYS SINCE 01/01/85
0
300
600
900
1200
1500

L1S33

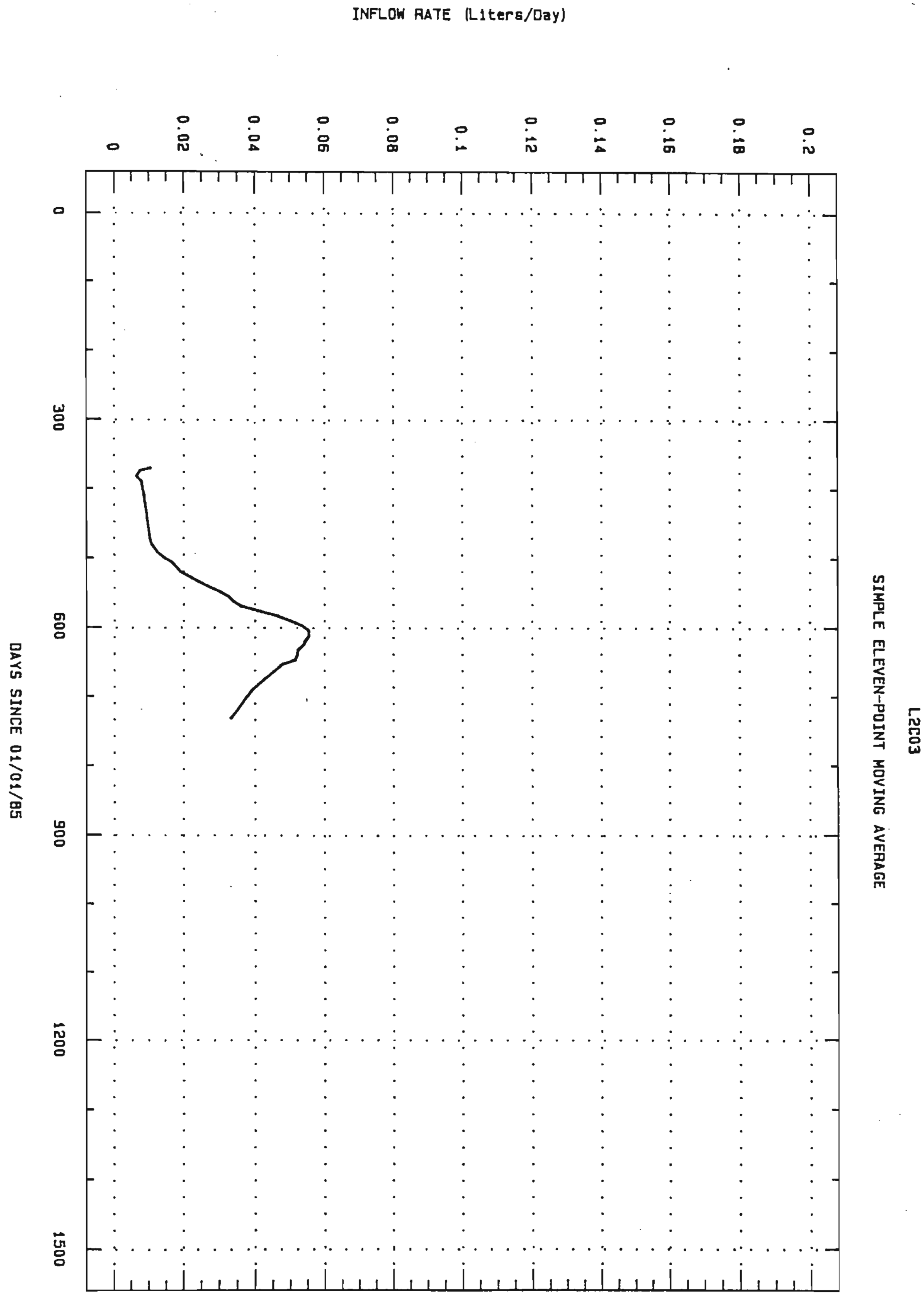
DATA NOT SMOOTHED



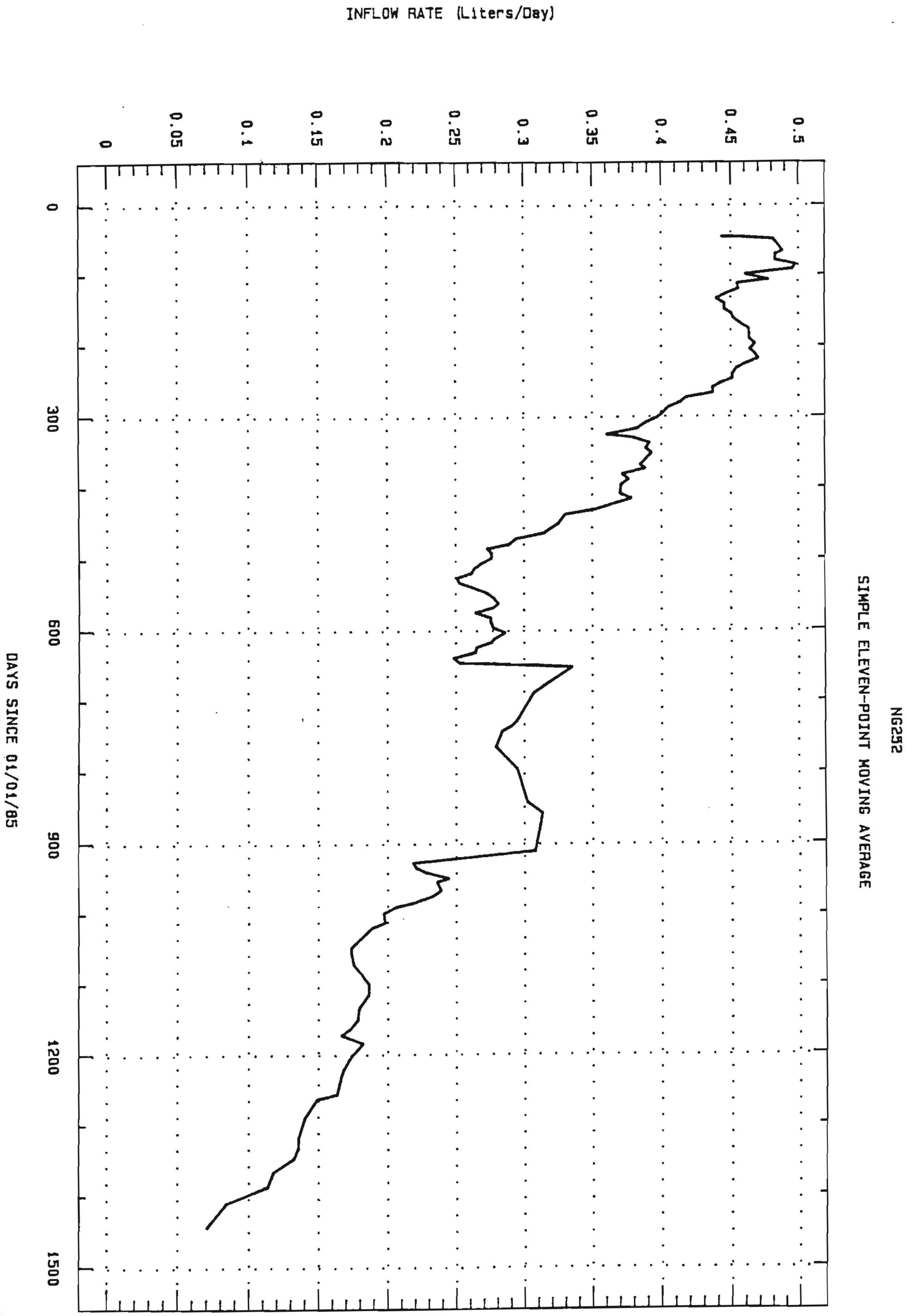

L1S36
DATA NOT SMOOTHED
INFLOW RATE (Liters/Day)
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
DAYS SINCE 01/01/85
0
300
600
900
1200
1500


L1X00

SIMPLE ELEVEN-POINT MOVING AVERAGE



L2C03
SIMPLE ELEVEN-POINT MOVING AVERAGE



NG252

SIMPLE ELEVEN-POINT MOVING AVERAGE

APPENDIX C

ANALYTICAL RESULTS FOR BRINE SAMPLES

TABLE C-1

ANALYTICAL RESULTS

SAMPLE NUMBER	HOLE NUMBER & DIRECTION		LAB	DATE	pH	S.G.	TDS mg/L	EXT ALK[1] mg/L	ALK[2] mg/L	TIC[3] mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO$_3^-$ mg/L	PO$_4^{-3}$ mg/L	SO$_4^{-2}$ mg/L	NH$_4^+$ mg/L
223	A1X01	DN	UNC	11/87	5.9	1.21	369000	945		5.6	1590	191000	8.0	12.0	<10	<1	18400	144
303	A1X01	DN	UNC	2/8/88	6.9	1.24	377000	975		6.1	1390	194000	5.1	14.8	<20	<1	18500	148
390	A1X01	DN	UNC	3/30/88	6.0	1.23	373000	963		2.5	1360	192000	4	13	<10	<10	18700	150
522	A1X01	DN	UNC	9/27/88	6.2	1.23	374000	975		30	1470	194000	7.8	11.5	2	<10	16900	136
349	A1X02	UP	IT	3/29/88	5.7	1.23	341000	719		<5	1600	187000	8	<20	<0.04		23000	110
351	A1X02	UP	IT	3/29/88	5.7	1.22	337000	701		<5	1900	189000	6	<20	<0.04		19100	100
405	A1X02	UP	IT	6/14/88	5.6	1.24	346000	680		<5	2300	195000	8	<20	<0.04		23200	150
406	A1X02	UP	IT	6/14/88	5.6	1.23	346000	670		<5	2200	192000	6	<20	<0.04		18500	110
226	A1X02	UP	UNC	11/87	5.5	1.22	393000	908			2120	197000	9.7	12.8	14	<1	22300	188
299	A1X02	UP	UNC	2/8/88	6.7	1.24	386000	768		2.0	1660	194000	5.0	12.6	22	<1	21700	150
343	A1X02	UP	UNC	3/29/88	5.6	1.23	391000	768		<0.5	1870	197000	6	12	<10	<10	23000	158
345	A1X02	UP	UNC	3/29/88	5.6	1.23	394000	768		<0.5	1860	198000	4	13	<10	<10	22900	154
347	A1X02	UP	UNC	3/29/88	5.6	1.23	392000	768		<0.5	1880	197000	<4	13	<10	<10	22900	163
402	A1X02	UP	UNC	6/14/88	5.5	1.24	402000	852		<5	2050	203000	5.0	12.4	1	<3	21200	141
403	A1X02	UP	UNC	6/14/88	5.6	1.24	400000	849		<5	2070	204000	5.0	11.5	1	<3	21200	146
404	A1X02	UP	UNC	6/14/88	5.6	1.24	400000	934		<5	2060	203000	5.2	11.9	1	**<3**	21000	140
458	A1X02	UP	UNC	7/12/88	5.3	1.23	393000	879		9.7	2120	200000	8.5	14.7	1	**12**	20300	155
514	A1X02	UP	UNC	9/27/88	5.5	1.24	398000	860		<5	1900	199000	7.2	9.9	2	**<10**	21400	145
516	A1X02	UP	UNC	9/27/88	5.5	1.23	397000	853		<5	1900	198000	7.1	12.0	2	<10	21200	142
517	A1X02	UP	UNC	9/27/88	5.4	1.24	399000	857		<5	1900	198000	7.3	10.5	2	<10	21200	140
214	A2X01	DN	UNC	11/87	6.0	1.21	470000	975		54.4	1440	194000	8.7	12.2	<10	<1	16400	144
386	A2X01	DN	UNC	3/30/88	6.0	1.22	381000	1183		58.4	1490	196000	5	14	<10	<10	19000	157
453	A2X01	DN	UNC	7/12/88	5.8	1.22	376000	951		67.6	1450	197000	8.2	15.3	2	<5	16200	195
512	A2X01	DN	UNC	9/27/88	5.7	1.23	380000	912		61.0	1470	195000	7.6	12.3	4	<10	17000	135
295	A2X02	UP	UNC	2/8/88	6.9	1.24	374000	927		8.1	1310	194000	5.8	14.3	<20	<1	18500	142
220	A3X01	DN	UNC	11/87	6.0	1.20	395000	914		88.9	1340	184000	8.1	11.5	<10	<1	15300	138
297	A3X01	DN	UNC	2/8/88	6.9	1.24	381000	927		7.1	1400	192000	6.0	14.7	<20	<1	18600	148
388	A3X01	DN	UNC	3/30/88	6.0	1.22	373000	951		6.1	1430	194000	5	13	<10	<10	18400	149
456	A3X01	DN	UNC	7/12/88	5.8	1.22	372000	938		138.7	1400	196000	8.5	15.6	1	<5	15800	160
232	BTP-A2	DN	IT	11/87	7.1	1.20	341000	2926			1200	180000	5	44	<1		14300	102
187	BTP-B1	DN	IT	11/87	7.2	1.20	338000	171			280	172000	2	<20	6		14400	2.8

[1] Reported as equivalent HCO$_3^-$, solutions titrated to end point pH of 2.5.

[2] Reported as equivalent HCO$_3^-$, solutions titrated to end point pH of 4.5.

[3] Reported as equivalent HCO$_3^-$.

TABLE C-1

ANALYTICAL RESULTS
(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION		LAB	DATE	Al mg/L	As mg/L	Ba mg/L	B mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	% CHARGE BALANCE
223	A1X01	DN	UNC	11/87	0.083	0.016	0.040	1610	330	<0.38	15500	24500	1.40	79500	1.39	1.86	0.68
304	A1X01	DN	UNC	2/8/88	0.280	0.002	0.022	1410	300	0.90	16700	22300	1.38	81400	1.56	1.75	-0.63
391	A1X01	DN	UNC	3/30/88	0.186	0.003	0.019	1440	290	0.44	16100	22500	1.36	78700	1.31	1.62	-1.19
521	A1X01	DN	UNC	9/27/88	1.33	0.003	0.022	1410	283	0.85	16500	23300	1.43	78500	4.82	1.49	-0.79
350	A1X02	UP	IT	3/29/88	<10	0.01	<0.5	1400	260	3	15800	30600	4.9	68300	0.4	6.8	1.02
352	A1X02	UP	IT	3/29/88	<10	0.008	<0.5	1500	270	3	16100	31000	5.0	70100	0.4	6.9	2.21
405	A1X02	UP	IT	6/14/88	<10	<0.025	<0.5	1700	260	2	16000	33500	5.1	66200	0.3	6.9	0.26
406	A1X02	UP	IT	6/14/88	<10	<0.5	<0.5	1800	270	2	16600	35000	5.4	65500	0.3	6.9	2.70
226	A1X02	UP	UNC	11/87	0.105	0.002	0.050	1900	360	<0.38	17100	39000	4.84	59300	1.57	6.39	1.46
300	A1X02	UP	UNC	2/8/88	0.060	0.002	0.039	1340	290	<0.44	15300	29000	4.79	70600	1.11	5.96	-0.80
344	A1X02	UP	UNC	3/29/88	0.061	0.002	0.034	1440	290	<0.29	15000	31600	4.59	66000	1.08	5.83	-1.70
346	A1X02	UP	UNC	3/29/88	0.063	0.002	0.033	1430	290	<0.29	14700	31100	4.59	64200	1.02	5.75	-3.01
348	A1X02	UP	UNC	3/29/88	0.063	0.002	0.034	1400	290	<0.29	15300	32100	4.73	65800	1.02	5.95	-1.34
402	A1X02	UP	UNC	6/14/88	0.081	0.002	0.038	1600	292	0.12	14900	34600	4.58	62200	1.20	5.84	-2.14
403	A1X02	UP	UNC	6/14/88	0.077	0.002	0.039	1610	293	0.12	14800	34600	4.53	62500	1.18	5.87	-2.28
404	A1X02	UP	UNC	6/14/88	0.080	0.002	0.038	1470	293	0.10	14900	34600	4.62	61500	1.21	5.89	-2.37
459	A1X02	UP	UNC	7/12/88	0.362	0.002	0.040	1470	267	0.89	14300	32600	4.76	60000	1.69	5.68	-3.69
515	A1X02	UP	UNC	9/27/88	0.110	0.002	0.039	1490	286	<0.03	15000	32100	4.70	67300	1.18	5.83	-1.09
518	A1X02	UP	UNC	9/27/88	0.111	0.002	0.040	1500	289	<0.03	15100	31900	4.75	67200	1.20	5.85	-0.97
519	A1X02	UP	UNC	9/27/88	0.133	0.002	0.040	1480	287	<0.03	15000	32200	4.75	67400	1.17	5.81	-0.71
214	A2X01	DN	UNC	11/87	0.049	0.001	0.060	1550	360	2.74	15700	24800	1.83	79900	<1	1.29	0.74
385	A2X01	DN	UNC	3/30/88	0.119	<0.001	0.152	1440	400	2.99	16500	23700	1.72	80800	3.66	1.02	-0.47
454	A2X01	DN	UNC	7/12/88	0.724	0.001	0.047	1270	288	18.7	16300	20000	1.92	78400	3.19	0.85	-3.87
513	A2X01	DN	UNC	9/27/88	0.649	<0.001	0.038	1420	285	38.0	16200	23500	1.77	78600	2.00	0.97	-0.92
296	A2X02	UP	UNC	2/8/88	0.054	<0.001	0.039	1430	310	13.90	16200	22800	1.84	79600	<0.89	0.97	-1.04
220	A3X01	DN	UNC	11/87	0.132	0.002	0.050	1520	340	1.80	14800	24500	1.61	77800	1.61	3.85	2.24
298	A3X01	DN	UNC	2/8/88	0.156	0.002	0.024	1440	310	1.90	16000	22800	1.58	81100	1.32	2.13	-0.07
387	A3X01	DN	UNC	3/30/88	0.217	0.002	0.030	1460	310	1.26	16100	23700	1.45	79500	1.77	2.04	-0.46
457	A3X01	DN	UNC	7/12/88	1.74	0.002	0.037	1250	287	1.53	16200	20200	1.57	76600	6.32	2.06	-4.14
232	BTP-A2	DN	IT	11/87	<10	0.030	<0.5	1000	460	2	15400	18300	0.8	76200	1.1	11.0	-1.89
187	BTP-B1	DN	IT	11/87	<10	0.031	<0.5	120	400	1	13900	8000	<0.5	106000	<0.2	39.0	4.50

TABLE C-1

ANALYTICAL RESULTS
(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION		LAB	DATE	pH	S.G.	TDS mg/L	EXT ALK[1] mg/L	ALK[2] mg/L	TIC[3] mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	PO_4^{-3} mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
218	BTP-B1	DN	UNC	11/87	7.5	1.21	359000	414		88.9	483	188000	1.9	<1	25	<1	17900	12.0
244	BTP-B1	DN	UNC	2/8/88	7.9	1.24	358000	402		124.5	476	191000	23.7	1.8	26	<1	20000	22.9
215	BTP-B2	DN	UNC	11/87	6.9	1.21	431000	2438		155.4	1240	187000	5.3	11.1	<10	<1	13900	120
212	BTP-B3	DN	UNC	11/87	8.6	1.18	311000	829		518	446	170000	0.7	2.2		<1	15700	13.4
178	BTP-C1	DN	UNC	09/87	7.2	1.21	354000	500	414		498	188000	1.9				12400	
209	BTP-C1	DN	UNC	11/87	7.7	1.20	345000	402		91.4	371	205000	1.7	1.4	12	<1	12200	13.9
236	BTP-C1	DN	UNC	11/87	8.9	1.19	323000	99		9.1	193	184000	0.3	<1	10	<1	6950	3.2
247	BTP-C1	DN	UNC	2/8/88	8.1	1.22	347000	390		100.6	370	191000	15.1	1.5	22	<1	14700	17.3
206	BTP-C2	DN	UNC	11/87	7.2	1.20	376000	1804		247.4	912	189000	4.3	7.3	11	<1	12900	84.2
227	BTP-C4	UP	UNC	11/87	7.5	1.21	343000	2517		144.3	1010	189000	2.6	6.6	11	<1	16100	78.7
235	BTP-C4	UP	UNC	11/87	7.5	1.21	349000	2682		148.8	1080	191000	2.9	6.8	<10	<1	10000	78.7
476	BTP-C4	UP	UNC	7/12/88	7.4	1.22	361000	2636		133.1	1080	189000	8.0	7.1	2	20	19000	97.4
225	BTR-8&9	Hor.	UNC	11/87	5.9	1.22	378000	762		3.0	1600	195000	7.4	11.1	<10	<1	16800	144
207	BX-01	DN	IT	11/87	6.3	1.23	346000	817			1400	188000	9	<20	<1		17400	127
210	BX-01	DN	IT	11/87	6.0	1.23	352000	817			1400	184000	8	<20	<1		17000	117
287	BX-01	DN	IT	2/8/88	5.9	1.20	342000	805		<5	1300	183000	9	<20	0.12		16700	100
379	BX-01	DN	IT	3/29/88	5.9	1.21	332000	793		<5	1300	184000	9	<20	<0.02		17800	96
449	BX-01	DN	IT	7/12/88	6.0	1.21	339000	805		5	1600	175000	7	<20	0.02		16000	120
198	BX-01	DN	UNC	11/87	5.8	1.21	396000	835		11.7	1440	193000	7.9	13.3	<10	<1	16700	145
201	BX-01	DN	UNC	11/87	5.9	1.21	406000	835		16.3	1430	193000	8.0	13.7	<10	<1	17100	144
204	BX-01	DN	UNC	11/87	5.9	1.22	399000	829		23.4	1460	193000	8.2	13.0	<10	<1	16800	148
289	BX-01	DN	UNC	2/8/88	6.8	1.23	367000	817		7.6	1350	195000	6.1	14.5	<20	<1	18500	151
291	BX-01	DN	UNC	2/8/88	6.8	1.23	373000	817		7.6	1350	196000	5.0	14.7	25	<1	18300	145
383	BX-01	DN	UNC	3/29/88	5.9	1.23	375000	841		1.5	1390	194000	6	14	<10	<10	18600	154
451	BX-01	DN	UNC	7/12/88	5.8	1.22	376000	907		138.7	1460	198000	10.0	15.7	1	<5	16400	180
504	BX-01	DN	UNC	9/27/88	6.2	1.23	382000	880		30	1460	195000	7.7	14.0	3	<10	17000	135
397	DHP-401	UP	IT	3/29/88	6.1	1.21	325000	902		5	1450	180000	8	<20	0.02		17800	110
196	DHP-401	UP	UNC	11/87	5.4	1.23	380000	1134		0.5	2380	200000	13.1	13.6	<10	<1	25600	185
238	DHP-401	UP	UNC	2/8/88	6.6	1.26	398000	1170		5.1	2430	203000	8.7	15.0	21	<1	30200	210
492	DHP-402A	DN	UNC	8/22/88	6.2	1.23	368000	449		20.3	95	192000	6.6	5.0	<2	<2	14800	71.9

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[1] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 2.5.

[2] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 4.5.

[3] Reported as equivalent HCO_3^-.

TABLE C-1

ANALYTICAL RESULTS
(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION		LAB	DATE	Al mg/L	As mg/L	Ba mg/L	B mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	% CHARGE BALANCE
218	BTP-B1	DN	UNC	11/87	0.049	0.004	0.050	143	450	<0.38	13200	8180	0.14	108000	1.95	38.5	0.37
245	BTP-B1	DN	UNC	2/8/88	<0.03	0.002	0.019	127	400	<0.44	13900	8030	0.16	108000	1.67	35.4	-0.73
215	BTP-B2	DN	UNC	11/87	0.148	0.008	0.110	1340	560	0.77	14500	21100	0.84	83700	3.71	14.7	1.36
212	BTP-B3	DN	UNC	11/87	0.070	0.002	0.209	143	470	<0.38	11600	3980	<0.07	102000	1.17	19.0	-0.56
178	BTP-C1	DN	UNC	9/87	<0.100	0.001	<0.3		504	<0.38	10000	8000	2.40	93000	<4.0	49.0	-5.60
209	BTP-C1	DN	UNC	11/87	<0.02	0.003	0.190	118	590	<0.38	9310	6320	0.19	111000	1.89	54.0	-3.70
236	BTP-C1	DN	UNC	11/87	0.048	0.005	0.340	128	620	<0.38	8550	6260	0.20	110000	3.13	51.9	1.93
247	BTP-C1	DN	UNC	2/8/88	<0.03	0.002	0.019	101	500	<0.44	10900	5950	0.24	111000	1.63	48.4	-0.74
206	BTP-C2	DN	UNC	11/87	0.034	0.012	0.170	817	620	<0.38	13200	15400	1.31	91700	3.94	28.1	-0.15
227	BTP-C4	UP	UNC	11/87	0.066	0.002	0.200	1030	420	1.02	11200	18300	0.08	90100	1.51	17.0	0.10
235	BTP-C4	UP	UNC	11/87	0.022	0.002	0.400	1010	910	0.50	10900	16500	<0.07	92200	1.29	37.4	0.34
481	BTP-C4	UP	UNC	7/12/88	0.039	0.001	0.100	740	386	0.63	10100	13800	<0.10	89800	1.18	14.1	-4.19
225	BTR-8&9	Hor.	UNC	11/87	0.062	0.016	0.070	1470	290	<0.38	14800	26500	2.90	75300	2.38	0.83	-0.30
207	BX-01	DN	IT	11/87	<10	0.026	<0.5	1400	250	2	16900	22200	1.4	84200	0.5	3.3	2.04
210	BX-01	DN	IT	11/87	<10	0.024	<0.5	1400	250	2	16800	22000	1.4	82200	0.5	2.8	2.21
288	BX-01	DN	IT	2/8/88	<10	<0.5	<0.5	1500	270	5	17000	21000	1.7	77500	0.4	2.6	0.07
380	BX-01	DN	IT	3/29/88	<10	0.01	<0.5	1500	260	3	17400	21600	1.5	80700	0.8	2.5	1.37
450	BX-01	DN	IT	7/12/88	<10	<0.12	<0.5	1600	280	4	18700	23700	1.5	79500	0.2	2.8	5.33
198	BX-01	DN	UNC	11/87	0.092	0.003	0.030	1570	280	0.97	16400	22800	1.32	81000	1.75	2.11	0.07
201	BX-01	DN	UNC	11/87	0.071	0.002	0.040	1740	330	0.38	16300	25000	1.38	80500	1.69	2.30	1.35
204	BX-01	DN	UNC	11/87	0.067	0.002	0.040	1710	340	<0.38	16400	25200	1.36	80000	1.80	2.32	1.38
290	BX-01	DN	UNC	2/8/88	0.284	0.002	0.025	1580	310	3.16	16900	23200	1.44	82400	1.54	2.37	0.21
292	BX-01	DN	UNC	2/8/88	0.208	0.002	0.026	1480	290	3.78	16100	21500	1.41	79700	1.96	2.34	-2.40
382	BX-01	DN	UNC	3/29/88	0.244	0.001	0.021	1480	290	1.69	16900	22500	1.38	82000	1.35	2.06	-0.22
452	BX-01	DN	UNC	7/12/88	1.88	0.001	0.026	1350	277	2.35	16500	19800	1.50	79700	6.36	1.49	-3.73
505	BX-01	DN	UNC	9/27/88	1.02	0.002	0.024	1460	266	3.23	16500	23300	1.33	81400	3.57	1.85	0.05
398	DHP-401	UP	IT	3/29/88	<10	0.012	<0.5	1500	320	2	19700	17000	1.2	88200	0.4	1.2	2.44
196	DHP-401	UP	UNC	11/87	<0.02	0.008	0.070	2000	300	<0.38	15100	46400	7.33	51200	1.62	4.96	1.75
238	DHP-401	UP	UNC	2/8/88	0.033	0.006	0.030	1570	240	2.48	16500	42100	8.65	50400	1.91	5.53	-2.52
493	DHP-402A	DN	UNC	8/22/88	0.054	0.002	0.074	640	469	23.3	10700	12900	2.24	94600	<0.9	20.0	-2.32

TABL C-1

ANALYTICAL RESULTS
(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION		LAB	DATE	pH	S.G.	TDS mg/L	EXT ALK[1] mg/L	ALK[2] mg/L	TIC[3] mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	PO_4^{-3} mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
494	DHP-402A	DN	UNC	8/22/88	6.2	1.23	369000	447		20.8	94	193000	6.0	4.6	<2	<2	14800	74.8
496	DHP-402A	DN	UNC	8/22/88	6.2	1.23	369000	456		20.3	96	192000	5.6	4.8	<2	<2	14800	77.8
498	DHP-402A	DN	UNC	9/27/88	5.6	1.24	399000	677		10	1370	194000	5.5	10.1	1	<10	17700	115
500	DHP-402A	DN	UNC	9/27/88	5.9	1.23	378000	538		5	1380	194000	7.2	11.1	1	<10	17800	110
502	DHP-402A	DN	UNC	9/27/88	5.9	1.23	376000	660		5	1390	194000	6.9	10.2	2	<10	17900	113
217	DH-15	UP	UNC	11/87	5.7	1.22	393000	1018		11.2	2010	196000	8.6	11.8	<10	<1	21500	168
208	DH-36	DN	IT	11/87	6.1	1.23	353000	853			1300	187000	6	22	2		15600	138
211	DH-36	DN	IT	11/87	6.1	1.22	341000	853			1300	178000	6	21	2		15200	127
261	DH-36	DN	IT	2/8/88	6.0	1.22	341000	829		<5	1200	208000	7	<20	<0.04		16400	120
267	DH-36	DN	IT	2/8/88	6.0	1.19	348000	829		<5	1300	179000	6	<20	0.05		16800	115
374	DH-36	DN	IT	3/29/88	6.0	1.22	374000	793		5	1600	184000	6	<20	<0.02		17400	110
377	DH-36	DN	IT	3/29/88	6.0	1.21	350000	793		<5	1700	187000	5	<20	<0.02		17200	110
422	DH-36	DN	IT	7/12/88	6.0	1.22	340000	756		<5	1400	173000	5	<20	0.05		15200	130
424	DH-36	DN	IT	7/12/88	6.0	1.20	345000	756		5	1400	169000	<1	<20	0.05		15700	140
426	DH-36	DN	IT	7/12/88	6.0	1.22	341000	758		5	1400	170000	4	<20	0.05		15900	130
114	DH-36	DN	UNC	6/87	6.2	1.22	379000	988	810		2150	196000	6.1				16100	
127	DH-36	DN	UNC	6/87	6.1	1.22	372000	994	815		1900	192000	5.4				15600	
153	DH-36	DN	UNC	9/87	5.6	1.23	375000	830	790		1400	195000	5.0				15800	
158	DH-36	DN	UNC	9/87	5.8	1.23	375000	830	782		1370	194000	5.1				15300	
167	DH-36	DN	UNC	9/87	5.8	1.22	374000	842	796		1420	196000	5.1				16000	
199	DH-36	DN	UNC	11/87	6.0	1.21	442000	841		6.1	1400	195000	5.5	14.3	12	<1	16300	159
205	DH-36	DN	UNC	11/87	6.0	1.21	381000	835		5.1	1370	193000	5.5	15.0	<10	<1	15700	145
263	DH-36	DN	UNC	2/8/88	6.9	1.24	365000	829		6.1	1340	195000	3.4	15.9	<20	<1	17600	159
269	DH-36	DN	UNC	2/8/88	6.9	1.24	366000	829		46.2	1300	195000	3.2	16.3	<20	<1	17800	166
368	DH-36	DN	UNC	3/29/88	5.8	1.24	376000	866		3.6	1370	194000	<4	15	<10	<10	17900	164
370	DH-36	DN	UNC	3/29/88	5.9	1.23	375000	866		3.0	1370	194000	<4	16	<10	<10	17800	170
372	DH-36	DN	UNC	3/29/88	6.0	1.23	375000	841		3.6	1370	194000	<4	15	<10	<10	17900	169
428	DH-36	DN	UNC	7/12/88	5.8	1.22	373000	807		134.1	1370	196000	7.0	16.6	1	<5	15300	168
430	DH-36	DN	UNC	7/12/88	5.8	1.22	374000	790		132.6	1380	196000	6.3	17.5	3	<5	15300	163
432	DH-36	DN	UNC	7/12/88	5.8	1.22	374000	796		134.1	1380	196000	6.3	17.6	1	<5	15400	172

[1] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 2.5.

[2] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 4.5.

[3] Reported as equivalent HCO_3^-.

TABLE C-1

ANALYTICAL RESULTS
(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION	LAB	DATE	Al mg/L	As mg/L	Ba mg/L	B mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	% CHARGE BALANCE
495	DHP-402A DN	UNC	8/22/88	0.054	0.002	0.067	640	469	22.6	10700	12900	2.26	94300	<0.9	20.0	-2.68
497	DHP-402A DN	UNC	8/22/88	0.053	0.004	0.072	640	469	24.8	10700	12800	2.26	94100	<0.9	20.1	-2.59
499	DHP-402A DN	UNC	9/27/88	<0.03	0.001	0.064	1180	377	25.2	14300	23400	2.02	82200	<0.07	7.36	0.14
501	DHP-402A DN	UNC	9/27/88	<0.03	0.002	0.064	1170	378	19.5	14400	23300	2.01	82100	<0.07	7.55	0.05
503	DHP-402A DN	UNC	9/27/88	<0.03	0.002	0.065	1180	375	18.0	14200	23100	2.04	81600	<0.07	7.24	-0.36
217	DH-15 UP	UNC	11/87	0.106	0.012	0.030	1960	270	<0.38	18900	42500	5.26	52300	1.84	2.27	2.03
208	DH-36 DN	IT	11/87	<10	0.024	<0.5	1600	320	2	20200	20200	1.1	86300	0.71	0.7	2.75
211	DH-36 DN	IT	11/87	<10	0.025	<0.5	1400	290	2	18600	18200	1.0	85800	0.7	1.9	3.17
262	DH-36 DN	IT	2/8/88	<10	<0.5	<0.5	1600	330	2	19300	17900	1.3	76700	0.8	1.5	-7.95
268	DH-36 DN	IT	2/8/88	<10	<0.5	<0.5	1600	320	3	19000	18000	1.3	75700	0.9	1.5	-1.43
375	DH-36 DN	IT	3/29/88	<10	0.009	<0.5	1500	310	2	19200	17800	1.1	90600	0.8	1.5	2.84
378	DH-36 DN	IT	3/29/88	<10	0.011	<0.5	1500	310	2	19400	17900	1.0	86700	0.8	1.5	0.77
423	DH-36 DN	IT	7/12/88	<10	<0.12	<0.5	1600	340	1	20200	19100	1.1	88000	0.5	1.7	6.33
425	DH-36 DN	IT	7/12/88	<10	<0.12	<0.5	1500	340	1	20000	18800	1.0	87200	0.5	1.8	6.77
427	DH-36 DN	IT	7/12/88	<10	<0.12	<0.5	1500	340	2	19900	18600	1.0	88200	0.5	1.8	6.66
114	DH-36 DN	UNC	6/87	0.039	0.009	<0.07		325	<0.42	18200	19100	0.96	84300	2.19	1.36	-1.61
127	DH-36 DN	UNC	6/87	0.087	0.011	<0.07		320	<0.42	18300	19300	1.00	84300	2.12	1.41	-0.37
153	DH-36 DN	UNC	9/87	<0.100	0.015	<0.3		341	0.04	18000	18100	1.00	89000	<4	1.30	-0.20
158	DH-36 DN	UNC	9/87	<0.100	0.014	<0.3		329	0.06	18200	19000	1.00	89000	<4	1.30	0.81
167	DH-36 DN	UNC	9/87	<0.100	0.015	<0.3		320	0.04	17800	18200	1.00	88000	<4	1.20	-0.83
199	DH-36 DN	UNC	11/87	0.062	0.002	0.030	1800	380	<0.38	18000	20600	1.00	86200	2.19	1.36	0.44
205	DH-36 DN	UNC	11/87	0.199	0.016	0.020	1720	370	<0.38	18600	20400	1.03	86900	2.70	1.38	1.28
264	DH-36 DN	UNC	2/8/88	0.150	0.014	0.030	1520	340	<0.44	18500	18400	1.05	87500	2.37	1.40	-0.75
270	DH-36 DN	UNC	2/8/88	0.158	0.012	0.043	1500	340	<0.44	18500	18000	1.02	88000	3.01	1.45	-0.87
369	DH-36 DN	UNC	3/29/88	0.222	0.013	0.017	1560	340	<0.29	18700	18900	1.00	87100	2.05	1.30	-0.32
371	DH-36 DN	UNC	3/29/88	0.217	0.014	0.018	1530	340	<0.29	18500	19000	1.03	87600	2.18	1.36	-0.09
373	DH-36 DN	UNC	3/29/88	0.226	0.014	0.019	1510	340	<0.29	18500	18700	1.00	88400	2.35	1.34	-0.02
429	DH-36 DN	UNC	7/12/88	1.48	0.012	0.033	1320	334	0.69	18200	15800	1.01	85100	5.85	1.55	-3.47
431	DH-36 DN	UNC	7/12/88	1.432	0.012	0.032	1310	336	0.60	17700	16300	1.01	89100	5.80	1.49	-1.66
433	DH-36 DN	UNC	7/12/88	0.932	0.011	0.030	1310	332	0.30	17200	16400	1.02	86700	3.87	1.47	-2.64

TABLE C-1

ANALYTICAL RESULTS
(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION		LAB	DATE	pH	S.G.	TDS mg/L	EXT ALK[1] mg/L	ALK[2] mg/L	TIC[3] mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	PO_4^{-3} mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
434	DH-36	DN	UNC	7/12/88	5.7	1.22	374000	803		138.2	1360	197000	6.1	17.1	1	<5	15300	163
538	DH-36	DN	UNC	9/27/88	6.3	1.22	367000	862		107	1370	193000	5.3	12.3	5	<10	15500	165
365	DH-38	DN	IT	3/29/88	6.1	1.21	338000	866		5	1600	182000	4	<20	<0.02		17200	110
417	DH-38	DN	IT	7/12/88	6.1	1.20	322000	829		5	1400	169000	5	<20	0.04		15600	125
109	DH-38	DN	UNC	6/87	6.2	1.22	378000		856		2710	189000	10.3				15500	
230	DH-38	DN	UNC	11/87	6.1	1.21	357000	896		6.1	1350	192000	5.7	14.3	10	<1	15500	171
258	DH-38	DN	UNC	2/8/88	6.9	1.23	360000	902		40.1	1320	195000	3.4	16.4	<20	<1	17500	162
363	DH-38	DN	UNC	3/29/88	6.0	1.24	377000	914		4.6	1350	196000	<4	15	<10	<10	17800	168
419	DH-38	DN	UNC	7/12/88	5.7	1.23	374000	840		39.6	1360	196000	6.5	17.4	1	<5	15200	169
536	DH-38	DN	UNC	9/27/88	6.3	1.22	370000	894		25	1360	193000	5.5	12.8	3	<10	15400	153
257	DH-40	DN	UNC	2/8/88	7.1	1.23	362000	1219		91.4	1370	195000	3.3	16.2	<20	<1	17500	176
229	DH-42	DN	UNC	11/87	6.5	1.21	364000	1573		75.2	1330	193000	5.5	14.3	10	<1	14800	170
255	DH-42	DN	UNC	2/8/88	7.0	1.23	366000	902		9.1	1270	192000	3.5	16.5	<20	<1	17100	166
323	DH-42	DN	UNC	3/29/88	6.1	1.23	371000	927		6.1	1340	192000	<4	14	<10	<10	17500	165
415	DH-42	DN	UNC	7/12/88	5.9	1.22	373000	912		263.1	1390	195000	6.8	17.5	4	<5	15300	172
530	DH-42	DN	UNC	9/27/88	6.3	1.23	368000	906		122	1350	193000	5.2	17.0	5	<10	15200	152
233	DH-42A	DN	IT	11/87	6.5	1.23	339000	853			850	180000	7	21	1		16100	138
250	DH-42A	DN	IT	2/8/88	6.0	1.21	344000	853		<5	1200	180000	6	<20	0.06		16700	130
320	DH-42A	DN	IT	3/29/88	6.0	1.22	341000	853		5	1600	190000	5	<20	<0.02		12700	120
407	DH-42A	DN	IT	7/12/88	6.1	1.22	341000	805		<5	1400	175000	5	<20	0.05		15400	170
409	DH-42A	DN	IT	7/12/88	6.1	1.17	343000	805		<5	1400	173000	3	<20	0.05		15300	140
115	DH-42A	DN	UNC	6/87	6.3	1.22	376000		820		2270	196000	10.8				15600	
118	DH-42A	DN	UNC	6/87	6.1	1.22	377000		845		2160	193000	5.6				15500	
154	DH-42A	DN	UNC	9/87	6.0	1.22	376000	878	824		1390	197000	5.0				15600	
228	DH-42A	DN	UNC	11/87	6.1	1.21	364000	853		5.1	1340	193000	5.1	14.5	11	<1	15200	172
252	DH-42A	DN	UNC	2/8/88	7.0	1.23	371000	878		12.7	1320	196000	3.6	16.7	<20	<1	17700	174
316	DH-42A	DN	UNC	3/29/88	6.1	1.24	377000	878		4.1	1360	197000	<4	16	<10	<10	17900	178
318	DH-42A	DN	UNC	3/29/88	6.0	1.23	377000	890		6.1	1370	196000	<4	14	<10	<10	18000	175
411	DH-42A	DN	UNC	7/12/88	5.8	1.23	374000	801		6.6	1350	195000	6.1	17.0	1	<5	15000	177
413	DH-42A	DN	UNC	7/12/88	5.9	1.23	374000	817		8.1	1340	193000	6.1	16.7	5	<5	15000	171

[1] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 2.5.

[2] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 4.5.

[3] Reported as equivalent HCO_3^-.

TABLE C-1

ANALYTICAL RESULTS
(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION		LAB	DATE	Al mg/L	As mg/L	Ba mg/L	B mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	% CHARGE BALANCE
435	DH-36	DN	UNC	7/12/88	0.812	0.010	0.031	1310	341	0.62	17900	16400	1.03	92200	4.23	1.51	-0.61
537	DH-36	DN	UNC	9/27/88	0.316	0.012	0.038	1430	344	0.44	18100	18200	0.98	83500	5.01	1.54	-1.66
366	DH-38	DN	IT	3/29/88	<10	0.006	<0.5	1600	320	2	19800	17900	1.1	89300	0.8	1.0	3.10
418	DH-38	DN	IT	7/12/88	<10	<0.12	<0.5	1500	340	2	20300	18800	1.1	87500	0.5	1.1	6.95
109	DH-38	DN	UNC	6/87	0.148	0.004	<0.07		322	<0.42	18200	18600	0.95	84300	2.28	0.87	-0.21
230	DH-38	DN	UNC	11/87	0.076	0.005	0.030	1650	360	<0.38	17800	19500	0.99	86400	2.35	0.85	0.56
259	DH-38	DN	UNC	2/8/88	0.484	0.004	0.025	1460	330	<0.44	18700	17500	1.07	88200	2.97	1.00	-1.07
364	DH-38	DN	UNC	3/29/88	0.386	0.004	0.022	1530	340	<0.29	18300	18300	1.00	85900	2.51	0.89	-1.75
420	DH-38	DN	UNC	7/12/88	0.442	0.004	0.027	1340	334	0.36	18100	15700	1.02	84500	3.49	0.82	-3.79
535	DH-38	DN	UNC	9/27/88	0.944	0.004	0.026	1440	330	0.39	18000	18200	0.97	85300	2.67	0.90	-0.98
257	DH-40	DN	UNC	2/8/88	0.206	0.002	0.070	1510	380	<0.44	18400	17700	1.25	88000	3.62	0.98	-1.10
229	DH-42	DN	UNC	11/87	0.118	0.009	0.170	1680	510	<0.38	17600	19000	1.07	88900	9.61	1.51	0.95
256	DH-42	DN	UNC	2/8/88	0.286	0.007	0.022	1460	330	0.68	18900	17400	1.20	87700	2.37	0.92	-0.49
324	DH-42	DN	UNC	3/29/88	0.752	0.007	0.024	1460	350	1.25	18300	17600	1.08	85500	2.96	1.02	-1.39
416	DH-42	DN	UNC	7/12/88	2.27	0.005	0.039	1320	363	1.23	18100	15600	1.26	87900	4.56	0.92	-2.31
531	DH-42	DN	UNC	9/27/88	2.72	0.006	0.032	1430	354	1.38	18200	17700	1.09	86000	6.22	1.02	-0.98
233	DH-42A	DN	IT	11/87	<10	0.025	<0.5	1400	280	2	18800	17000	1.0	87200	0.7	1.1	2.24
251	DH-42A	DN	IT	2/8/88	<10	<0.5	<0.5	1600	320	2	19900	17100	1.3	81900	0.9	1.1	0.36
321	DH-42A	DN	IT	3/29/88	<10	0.014	<0.5	1600	320	2	20000	17300	1.2	89900	1.0	0.9	1.76
408	DH-42A	DN	IT	7/12/88	<10	<0.12	<0.5	1500	330	2	20600	18000	1.0	89100	0.7	1.0	5.47
410	DH-42A	DN	IT	7/12/88	<10	<0.12	<0.5	1800	400	2	24900	21800	1.3	88700	0.7	1.1	9.35
115	DH-42A	DN	UNC	6/87	0.107	0.003	<0.07		324	<0.42	19100	18900	0.98	85600	2.29	0.91	-0.97
118	DH-42A	DN	UNC	6/87	0.182	0.003	<0.07		334	<0.42	18200	18400	0.96	84300	2.14	0.87	-1.27
154	DH-42A	DN	UNC	9/87	<0.100	0.004	<0.3		328	0.04	18800	18000	1.00	90000	<4	1.00	-0.18
228	DH-42A	DN	UNC	11/87	0.070	0.004	<0.020	1620	360	<0.38	18000	19000	0.99	88200	2.43	0.85	0.74
253	DH-42A	DN	UNC	2/8/88	0.246	0.005	0.018	1210	350	<0.44	19500	18200	1.09	89200	2.99	0.97	-0.29
317	DH-42A	DN	UNC	3/29/88	0.124	0.005	0.020	1540	340	<0.29	18400	18800	1.04	86000	2.56	0.89	-1.58
319	DH-42A	DN	UNC	3/29/88	0.118	0.004	0.019	1570	340	<0.29	18300	18400	1.00	85400	2.61	0.85	-1.90
412	DH-42A	DN	UNC	7/12/88	0.125	0.004	0.018	1330	332	0.32	18400	15600	0.99	84200	2.56	0.78	-3.64
414	DH-42A	DN	UNC	7/12/88	0.179	0.004	0.020	1320	338	0.38	18200	15400	0.98	87800	2.55	0.80	-1.92

TABLE C-1

ANALYTICAL RESULTS

(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION	LAB	DATE	pH	S.G.	TDS mg/L	EXT ALK[1] mg/L	ALK[2] mg/L	TIC[3] mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	PO_4^{-3} mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
528	DH-42A DN	UNC	9/27/88	6.3	1.23	364000	853		<5	1330	190000	4.9	13.7	3	<10	15100	148
231	G-SEEP DN	IT	11/87	6.1	1.24	370000	1012			1300	175000	6	24.0	<1		32600	170
271	G-SEEP DN	IT	2/8/88	6.0	1.22	350000	1024		<5	1300	181000	7	20	0.13		35000	160
277	G-SEEP DN	IT	2/8/88	6.0	1.23	356000	1000		<5	1300	179000	8	20	0.12		34700	150
283	G-SEEP DN	IT	2/8/88	6.0	1.21	357000	1000		<5	1400	177000	7	20	0.03		36900	150
333	G-SEEP DN	IT	3/29/88	6.0	1.23	342000	927		<5	1600	177000	4	<20	0.02		30900	145
335	G-SEEP DN	IT	3/29/88	6.0	1.23	351000	939		<5	1400	173000	5	<20	0.02		31300	140
437	G-SEEP DN	IT	7/12/88	6.1	1.21	330000	805		<5	1400	164000	4	<20	0.06		31700	150
439	G-SEEP DN	IT	7/12/88	6.1	1.19	354000	805		<5	1300	167000	1	<20	0.06		32600	150
441	G-SEEP DN	IT	7/12/88	6.1	1.20	338000	817		<5	1300	164000	5	<20	0.06		31900	140
165	G-SEEP DN	UNC	9/87	5.9	1.23	383000	952	890		1430	188000	4.8				29800	
168	G-SEEP DN	UNC	9/87	6.0	1.23	384000	940	932		1520	188000	4.8				29500	
202	G-SEEP DN	UNC	11/87	6.0	1.22	433000	1012		2.0	1650	184000	5.5	18.6	10	<1	32100	203
219	G-SEEP DN	UNC	11/87	6.0	1.22	383000	1000		2.0	1540	190000	5.6	17.9	<10	<1	32000	199
273	G-SEEP DN	UNC	2/8/88	6.9	1.25	386000	1024		3.6	1570	186000	3.8	22.5	<20	<1	36300	213
279	G-SEEP DN	UNC	2/8/88	6.9	1.24	382000	1036		3.6	1430	187000	3.8	22.2	<20	<1	35900	217
285	G-SEEP DN	UNC	2/8/88	6.9	1.24	382000	1049		3.0	1550	186000	3.9	22.1	<20	<1	36200	217
327	G-SEEP DN	UNC	3/29/88	6.0	1.24	390000	975		1.0	1540	187000	4	17	13	<10	34700	202
329	G-SEEP DN	UNC	3/29/88	6.0	1.24	390000	963		<0.5	1500	187000	<4	17	<10	<10	34800	202
331	G-SEEP DN	UNC	3/29/88	6.0	1.24	386000	975		<0.5	1520	187000	4	16	<10	<10	34800	212
443	G-SEEP DN	UNC	7/12/88	6.0	1.23	378000	879		5.1	1400	187000	6.1	20.4	1	<5	29700	204
445	G-SEEP DN	UNC	7/12/88	6.0	1.23	378000	846		4.1	1400	188000	6.2	20.5	<1	<5	29600	193
447	G-SEEP DN	UNC	7/12/88	5.9	1.23	380000	884		4.6	1400	188000	6.1	18.2	2	<5	29300	195
552	G-SEEP DN	UNC	9/27/88	6.4	1.23	376000	888		<5	1360	185000	4.9	12.7	3	<10	27800	170
553	G-SEEP DN	UNC	9/27/88	6.3	1.23	377000	900		<5	1360	186000	4.8	11.3	5	<10	27700	168
554	G-SEEP DN	UNC	9/27/88	6.3	1.23	376000	902		<5	1370	185000	5.0	13.5	2	<10	28000	173
463	L1X00 DN	IT	7/12/88	5.8	1.23	367000	1079		<5	1800	178000	5	20	0.05		18700	180
200	L1X00 DN	UNC	11/87	5.8	1.21	388000	1097		2.5	1620	194000	7.2	15.8	<10	<1	18800	168
311	L1X00 DN	UNC	2/8/88	6.7	1.25	413000	1646		4.1	2280	201000	7.0	25.3	<20	<1	27100	260
392	L1X00 DN	UNC	3/30/88	5.7	1.23	398000	1329		0.5	2000	197000	5	19	<10	<10	24700	234

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[1] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 2.5.

[2] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 4.5.

[3] Reported as equivalent HCO_3^-.

TABLE C-1

ANALYTICAL RESULTS
(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION	LAB	DATE	Al mg/L	As mg/L	Ba mg/L	B mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	% CHARGE BALANCE
529	DH-42A DN	UNC	9/27/88	0.502	0.004	0.023	1420	322	<0.3	18400	16400	0.94	83800	3.72	0.82	-2.00
231	G-SEEP DN	IT	11/87	<10	0.023	<0.5	1800	240	2	16500	16700	0.7	96400	0.4	3.6	3.03
272	G-SEEP DN	IT	2/8/88	<10	<0.5	<0.5	2000	250	2	17600	16900	1.0	81500	0.5	3.0	-4.17
278	G-SEEP DN	IT	2/8/88	<10	<0.5	<0.5	2000	260	2	17700	16900	1.0	105000	0.5	3.0	5.06
284	G-SEEP DN	IT	2/8/88	<10	<0.5	<0.5	2000	250	2	17900	17100	1.0	124000	0.5	3.0	11.29
334	G-SEEP DN	IT	3/29/88	<10	0.008	<0.5	1900	250	2	16700	16100	0.8	95700	0.5	3.4	2.20
336	G-SEEP DN	IT	3/29/88	<10	0.012	<0.5	1900	250	2	16900	16300	0.8	96600	0.5	3.3	3.66
438	G-SEEP DN	IT	7/12/88	<10	<0.12	<0.5	1700	280	1	16000	15500	0.7	95600	0.3	3.0	4.83
440	G-SEEP DN	IT	7/12/88	<10	<0.12	<0.5	1700	280	1	16300	15800	0.7	97800	0.3	3.0	4.96
442	G-SEEP DN	IT	7/12/88	<10	<0.12	<0.5	1700	280	1	16300	15900	0.7	95900	<0.2	3.0	5.26
165	G-SEEP DN	UNC	9/87	<0.100	0.002	<0.3		277	0.40	14800	15900	0.70	98000	<4	3.00	0.05
168	G-SEEP DN	UNC	9/87	<0.100	0.002	<0.3		278	0.40	14800	15800	0.60	99000	<4	3.00	0.39
202	G-SEEP DN	UNC	11/87	0.413	0.003	<0.020	2140	310	0.45	16000	19100	0.71	93700	2.55	2.57	1.47
219	G-SEEP DN	UNC	11/87	0.360	0.002	<0.020	2080	300	0.38	15400	18700	0.70	97100	2.51	2.58	0.89
274	G-SEEP DN	UNC	2/8/88	0.433	0.002	0.013	1970	270	<0.44	17600	17800	0.73	94400	2.74	2.78	-0.04
280	G-SEEP DN	UNC	2/8/88	0.180	0.003	0.012	1880	280	<0.44	17200	17700	0.68	93400	1.84	2.63	-0.70
286	G-SEEP DN	UNC	2/8/88	0.290	0.002	0.013	1990	260	<0.44	17100	18200	0.72	94100	2.28	2.76	0.03
328	G-SEEP DN	UNC	3/29/88	<0.04	0.002	0.016	1840	280	<0.29	15700	16800	0.66	91800	1.31	2.96	-2.05
330	G-SEEP DN	UNC	3/29/88	0.047	0.002	0.015	1890	270	<0.29	15800	17100	0.67	93000	1.40	2.98	-1.38
332	G-SEEP DN	UNC	3/29/88	<0.04	0.002	0.015	1820	280	<0.29	16200	17000	0.69	92100	1.34	2.99	-1.70
444	G-SEEP DN	UNC	7/12/88	0.119	0.002	0.016	1580	286	0.30	14600	13400	0.69	93300	1.68	2.27	-3.29
446	G-SEEP DN	UNC	7/12/88	0.145	0.002	0.018	1490	290	0.36	14600	13600	0.70	96500	1.67	2.38	-2.12
448	G-SEEP DN	UNC	7/12/88	0.132	0.003	0.016	1510	292	0.34	14800	13000	0.68	96600	1.64	2.46	-2.42
551	G-SEEP DN	UNC	9/27/88	<0.03	0.004	0.016	1590	274	<0.3	13800	14800	0.59	97900	1.12	2.45	0.12
555	G-SEEP DN	UNC	9/27/88	<0.03	0.004	0.016	1570	273	<0.3	13900	14300	0.57	97100	1.15	2.41	-0.74
556	G-SEEP DN	UNC	9/27/88	<0.03	0.004	0.016	1570	273	<0.3	13700	14700	0.57	86500	1.12	2.43	-4.45
464	L1X00 DN	IT	7/12/88	<10	<0.12	<0.5	1900	340	2	24600	27700	1.3	74600	0.7	2.1	6.19
200	L1X00 DN	UNC	11/87	1.53	0.002	0.040	2070	380	0.93	20800	27100	1.25	74200	7.22	1.76	0.89
312	L1X00 DN	UNC	2/8/88	1.57	0.002	0.016	2050	270	1.08	27000	30900	1.66	65800	6.85	0.09	-1.46
393	L1X00 DN	UNC	3/30/88	0.331	0.001	0.017	2100	320	<0.29	24600	29100	1.31	68100	3.56	1.44	-0.96

TABLE C-1

ANALYTICAL RESULTS

(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION	LAB	DATE	pH	S.G.	TDS mg/L	EXT ALK[1] mg/L	ALK[2] mg/L	TIC[3] mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	PO_4^{-3} mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
465	L1X00 DN	UNC	7/12/88	5.4	1.23	388000	1183		3.6	1810	198000	8.4	16.2	2	<5	19700	209
525	L1X00 DN	UNC	9/27/88	6.1	1.23	372000	1008		30	1550	195000	6.6	14.8	5	<10	17600	152
234	NG252 DN	IT	11/87	6.2	1.23	347000	841			1300	180000	7	<20	<1		16600	117
305	NG252 DN	IT	2/8/88	6.0	1.22	328000	817		<5	1300	183000	7	<20	0.04		16500	100
340	NG252 DN	IT	3/29/88	6.1	1.21	333000	805		<5	1300	181000	6	<20	<0.02		16500	98
467	NG252 DN	IT	7/12/88	6.0	1.19	343000	744		<5	1200	173000	3	<20	<0.02		14700	115
102	NG252 DN	UNC	04/87	6.0	1.22	377000		781		1150	195000					16800	
103	NG252 DN	UNC	4/87	6.1	1.22	377000		666		871	197000					16200	
104	NG252 DN	UNC	4/87	6.1	1.22	377000		793		1140	197000					17300	
116	NG252 DN	UNC	6/87	6.2	1.22	379000		784		2020	193000	7.5				16100	
131	NG252 DN	UNC	6/87	6.1	1.22	376000		895		2100	190000	7.0				16700	
171	NG252 DN	UNC	9/87	5.9	1.22	380000	830	776		1430	195000	5.6				16300	
221	NG252 DN	UNC	11/87	6.0	1.21	390000	823		5.6	1360	193000	6.2	13.4	11	<1	15800	149
307	NG252 DN	UNC	2/8/88	6.9	1.23	373000	829		8.6	1310	194000	4.2	15.5	<20	<1	17700	146
338	NG252 DN	UNC	3/29/88	5.9	1.23	374000	817		5.1	1390	195000	<4	13	<10	<10	18400	151
469	NG252 DN	UNC	7/12/88	5.7	1.22	368000	789		9.7	1360	195000	6.9	13.4	2	<5	15500	160
543	NG252 DN	UNC	9/27/88	6.2	1.22	370000	823		5	1400	194000	5.8	12.2	3	<10	16100	137
238	STANDARD	IT	11/87	7.1	1.17	245000	41			32	137000	2	<20	<1		2070	1.3
314	STANDARD	IT	2/8/88	8.0	1.15	239000	24		27.9	30	140000	2	<20	<0.2		2100	3.6
399	STANDARD	IT	3/29/88	7.9	1.15	241000	30		30	81	79000	<1	<20	0.05		2200	1.2
477	STANDARD	IT	7/12/88	7.8	1.14	259000	28		36	28	132000	<1	<20	0.11		1800	3.2
401	STANDARD	UNC	3/30/88	8.0	1.16	251000	46		18.3	<10	148000	<2	<1	<10	<10	2010	<0.10
482	AIS WATER+	UNC	7/29/88	7.1	1.21	330000	122		94.0	37	190000	4	<0.1	5	<1	6150	4.3
484	AIS WATER+	UNC	7/29/88	7.1	1.21	333000	116		94.5	44	188000	<1	<0.1	6	<1	6180	4.0
486	AIS WATER+	UNC	7/29/88	7.1	1.21	333000	128		91.9	44	187000	<1	<0.1	6	<1	6170	4.5
479	BLIND	UNC	7/12/88	7.6	1.16	250000	39		26.4	10	148000	<1	<0.1	9	<5	1890	0.06

[1] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 2.5.

[2] Reported as equivalent HCO_3^-, solutions titrated to end point pH of 4.5.

[3] Reported as equivalent HCO_3^-.

TABLE C-1

ANALYTICAL RESULTS
(CONTINUED)

SAMPLE NUMBER	HOLE NUMBER & DIRECTION	LAB	DATE	Al mg/L	As mg/L	Ba mg/L	B mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	% CHARGE BALANCE
466	L1X00 DN	UNC	7/12/88	0.978	0.002	0.017	1670	333	0.58	22000	23300	1.33	71400	4.21	1.76	-3.74
524	L1X00 DN	UNC	9/27/88	0.537	0.002	0.032	1520	398	0.35	19300	23700	1.14	79400	3.68	2.20	0.12
234	NG252 DN	IT	11/87	<10	0.023	<0.5	1400	270	2	17600	20000	1.1	84800	0.4	1.9	3.06
306	NG252 DN	IT	2/8/88	<10	<0.5	<0.5	1500	310	4	18200	19700	1.4	77300	0.6	2.0	-0.65
341	NG252 DN	IT	3/29/88	<10	0.01	<0.5	1500	300	4	18200	19800	1.3	85100	0.6	1.8	2.94
468	NG252 DN	IT	7/12/88	<10	<0.12	<0.5	1500	310	4	18800	20800	1.1	82000	0.4	1.9	5.11
102	NG252 DN	UNC	4/87					302		16900	21000		82400	<2	1.67	-1.02
103	NG252 DN	UNC	4/87					302		16900	20600		82400	<2	1.78	-1.63
104	NG252 DN	UNC	4/87					302		16900	20900		81800	<2	1.72	-1.88
116	NG252 DN	UNC	6/87	0.582	<0.001	<0.07		299	17.6	16800	20400	1.39	79400	<1.1	1.65	-2.12
131	NG252 DN	UNC	6/87	<0.03	<0.001	<0.07		307	49.2	16900	20000	1.37	79400	<1.1	1.65	-1.79
171	NG252 DN	UNC	9/87	<0.100	<0.001	<0.3		302	2.20	16800	19800	1.10	87000	<4	1.60	-0.12
221	NG252 DN	UNC	11/87	0.125	0.002	0.020	1660	350	3.55	16900	22400	1.08	86000	2.15	1.69	1.94
308	NG252 DN	UNC	2/8/88	0.033	0.002	0.025	1400	320	2.66	17800	19800	1.13	84800	1.61	1.83	-0.70
339	NG252 DN	UNC	3/29/88	0.043	0.002	0.024	1440	320	2.20	17400	20400	1.14	81300	1.55	1.71	-2.06
470	NG252 DN	UNC	7/12/88	0.176	0.002	0.029	1330	300	2.54	16600	18200	1.07	81800	2.01	1.62	-3.16
542	NG252 DN	UNC	9/27/88	0.034	0.002	0.032	1420	304	2.47	17200	20300	1.02	82900	1.39	1.59	-0.93
238	STANDARD	IT	11/87	<10	0.025	<0.5	5	380	<1	455	170	<0.5	96000	<0.19	14	3.84
315	STANDARD	IT	2/8/88	<10	<0.5	<0.5	5	420	<1	455	165	<0.5	93700	<0.2	12	1.58
400	STANDARD	IT	3/29/88	<10	0.026	<0.5	7	420	<1	460	170	<0.5	97100	<0.2	12	30.47
478	STANDARD	IT	7/12/88	<10	<0.12	<0.5	7	440	<1	460	180	<0.5	94400	<0.2	11.7	4.97
402	STANDARD	UNC	3/30/88	<0.04	<0.001	0.163	2	440	<0.29	342	165	<0.13	96400	<0.84	9.96	0.24
483	AIS WATER+	UNC	7/29/88	0.167	0.002	0.236	13	950	0.13	1720	1040	0.39	118000	3.32	30.7	-1.67
485	AIS WATER+	UNC	7/29/88	0.163	0.002	0.239	12	950	0.12	1720	1040	0.39	118000	3.33	30.5	-1.16
487	AIS WATER+	UNC	7/29/88	0.169	0.002	0.215	13	960	0.12	1720	1040	0.4	118000	3.26	30.5	-0.89
480	BLIND	UNC	7/12/88	<0.02	<0.001	0.143	3	454	<0.3	352	166	<0.1	94000	<0.9	10.1	-0.97

APPENDIX D

STATISTICAL RESULTS FOR BRINE SAMPLES

PART I - SIMPLE STATISTICS

PART II - MULTIVARIATE ANALYSIS

APPENDIX D

STATISTICAL RESULTS FOR BRINE SAMPLES

PART I - SIMPLE STATISTICS

TABLE D-1

STATISTICAL RESULTS

Simple Statistics, UNC Geotech

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
HOLE: A1X01-DN													
N	4	4	4	4	NA	4	4	4	4	4	1	4	4
X	6.3	1.23	373000	965		11.2	1450	193000	6.2	12.8	2	18100	145
S	0.4	0.01	3000	13		11.2	90	1000	1.7	1.3		700	5
MIN	5.9	1.21	369000	945		2.5	1360	191000	4.0	11.5		16900	136
MAX	6.9	1.24	377000	975		30.5	1590	194000	8.0	14.8		18700	150
HOLE: A1X02-UP													
N	12	12	12	12	NA	2	12	12	11	12	9	12	12
X	5.6	1.23	395000	839		5.8	1950	199000	6.4	12.2	5	21700	152
S	0.3	0.01	4000	55		3.8	130	3000	1.7	1.2	7	800	13
MIN	5.3	1.22	386000	768		2.0	1660	194000	4.0	9.9	1	20300	140
MAX	6.7	1.24	402000	934		9.7	2120	204000	9.7	14.7	22	23000	188
HOLE: A2X01-DN													
N	4	4	4	4	NA	4	4	4	4	4	2	4	4
X	5.9	1.22	402000	1005		60.3	1460	196000	7.4	13.5	3	17200	158
S	0.1	0.01	39000	105		4.8	20	1000	1.4	1.3	1	1100	23
MIN	5.7	1.21	376000	912		54.4	1440	194000	5.0	12.2	2	16200	135
MAX	6.0	1.23	470000	1183		67.6	1490	197000	8.7	15.3	4	19000	195

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
HOLE: A1X01-DN													
N	4	4	4	4	4	3	4	4	4	4	4	4	4
X	0.137	0.006	1470	0.026	301	0.73	16200	23200	1.39	79500	2.27	1.68	-0.34
S	0.106	0.006	80	0.008	18	0.21	500	900	0.03	1100	1.48	0.14	0.70
MIN	0.000	0.002	1410	0.019	283	0.44	15500	22300	1.36	78500	1.31	1.49	-1.05
MAX	0.280	0.016	1610	0.040	330	0.90	16700	24500	1.43	81400	4.82	1.86	0.81
HOLE: A1X02-UP													
N	12	12	12	12	12	4	12	12	12	12	12	12	12
X	0.109	0.002	1510	0.039	294	0.31	15100	22000	4.69	64500	1.22	5.89	-1.26
S	0.080	0.000	140	0.004	21	0.34	700	2000	0.10	3300	0.20	0.17	1.37
MIN	0.060	0.002	1340	0.033	267	0.10	14300	29000	4.53	59300	1.02	5.68	-3.49
MAX	0.362	0.002	1900	0.050	360	0.89	17100	39000	4.84	70600	1.69	6.39	1.65
HOLE: A2X01-DN													
N	4	2	4	4	4	4	4	4	4	4	4	4	4
X	0.385	0.001	1420	0.074	333	15.6	16200	23000	1.81	79400	2.95	1.03	-0.99
S	0.303	0.000	100	0.046	49	14.5	300	1800	0.07	1000	0.70	0.16	1.69
MIN	0.049	0.001	1270	0.038	285	2.7	15700	20000	1.72	78400	2.00	0.85	-3.73
MAX	0.724	0.001	1550	0.152	400	38.0	16500	24800	1.92	80800	3.66	1.29	0.87

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
HOLE: A3X01-DN													
N	4	4	4	4	NA	4	4	4	4	4	1	4	4
X	6.2	1.22	380000	932		60.2	1390	192000	6.9	13.7	1	17000	149
S	0.4	0.01	9000	14		56.4	30	5000	1.5	1.6		1500	8
MIN	5.8	1.20	372000	914		6.1	1340	184000	5.0	11.5		15300	138
MAX	6.9	1.24	395000	951		138.7	1430	196000	8.5	15.6		18600	160
HOLE: BX-01-DN													
N	8	8	8	8	NA	8	8	8	8	8	3	8	8
X	6.1	1.22	384000	845		29.7	1420	195000	7.4	14.1	10	17400	150
S	0.4	0.01	13000	30		42.1	50	2000	1.5	0.8	11	800	12
MIN	5.8	1.21	367000	817		1.5	1350	193000	5.0	13.0	1	16400	135
MAX	6.8	1.23	406000	907		138.7	1460	198000	10.0	15.7	25	18600	180
HOLE: DHP-401-UP													
N	2	2	2	2	NA	2	2	2	2	2	1	2	2
X	6.0	1.25	389000	1152		2.8	2410	202000	10.9	14.3	21	27900	198
S	0.6	0.01	9000	18		2.3	30	2000	2.2	0.7		2300	13
MIN	5.4	1.23	380000	1134		0.5	2380	200000	8.7	13.6		25600	185
MAX	6.6	1.26	398000	1170		5.1	2430	203000	13.1	15.0		30200	210

EALK, ALK and TIC reported as HCO_3^-.

N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
HOLE: A3X01-DN													
N	4	4	4	4	4	4	4	4	4	4	4	4	4
X	0.561	0.002	1420	0.035	312	1.62	15800	22800	1.55	78800	2.76	2.52	-0.47
S	0.681	0.000	100	0.010	19	0.25	600	1600	0.06	1700	2.06	0.77	2.28
MIN	0.132	0.002	1250	0.024	287	1.26	14800	20200	1.45	76600	1.32	2.04	-4.00
MAX	1.740	0.002	1520	0.050	340	1.90	16200	24500	1.61	81100	6.32	3.85	2.37
HOLE: BX-01-DN													
N	8	8	8	8	8	7	8	8	8	8	8	8	8
X	0.483	0.002	1550	0.029	298	2.22	16500	22900	1.39	80800	2.50	2.11	-0.28
S	0.603	0.001	120	0.007	25	1.17	300	1600	0.06	1000	1.59	0.29	1.66
MIN	0.067	0.001	1350	0.021	266	0.38	16100	19800	1.32	79700	1.35	1.49	-3.60
MAX	1.880	0.003	1740	0.040	340	3.78	16900	25200	1.50	82400	6.36	2.37	1.51
HOLE: DHP-401-UP													
N	1	2	2	2	2	1	2	2	2	2	2	2	2
X	0.033	0.007	1790	0.050	270	2.48	15800	44300	7.99	50800	1.77	5.25	-0.15
S		0.001	220	0.020	30		700	2200	0.66	400	0.14	0.29	2.13
MIN		0.006	1570	0.030	240		15100	42100	7.33	50400	1.62	4.96	-2.28
MAX		0.008	2000	0.070	300		16500	46400	8.65	51200	1.91	5.53	1.97

EALK, ALK and TIC reported as HCO_3^-.

N = Number of samples; X = Sample mean; S = Sample standard deviation;

BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
HOLE: DHP-402A-DN 8/22/88													
N	3	3	3	3	NA	3	3	3	3	3	BDL	3	3
X	6.2	1.23	369000	451		20.5	95	192000	6.1	4.8		14800	75
S	0.0	0.00	<1000	4		0.2	1	<1000	0.4	0.2		0	2
MIN	6.2	1.23	3680000	447		20.3	94	192000	5.6	4.6		14800	72
MAX	6.2	1.23	399000	456		20.8	96	193000	6.6	5.0		14800	78
HOLE: DHP-402A-DN 9/27/88													
N	3	3	3	3	NA	3	3	3	3	3	BDL	3	3
X	5.8	1.23	384000	625		6.8	1380	194000	6.5	10.5	1	17800	113
S	0.1	<0.01	10000	62		2.4	10	0	0.7	0.4	<1	100	2
MIN	5.6	1.23	376000	538		5.1	1370	194000	5.5	10.1	1	17700	110
MAX	5.9	1.24	399000	677		10.2	1390	194000	7.2	11.1	2	17900	115
HOLE: DH-36-DN													
N	17	17	17	15	5	12	17	17	14	12	5	17	12
X	6.0	1.22	377000	831	799	59.9	1450	195000	5.4	15.7	4	16300	164
S	0.3	0.01	21000	23	12	60.0	300	9000	1.5	1.4	4	1000	20
MIN	5.6	1.20	322000	790	782	3.0	1300	169000	3.2	12.3	1	15200	110
MAX	6.9	1.24	442000	866	15	138.2	2150	197000	7.0	17.6	12	17900	172

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
HOLE: DHP-402A-DN 9/27/88													
N	3	3	3	3	3	3	3	3	3	3	BDL	3	3
X	0.054	0.003	640	0.071	469	23.57	10700	12900	2.25	94300		20.03	-2.45
S	<0.001	0.001	0	0.003	0	0.92	0	<100	0.01	200		0.05	0.16
MIN	0.053	0.002	640	0.067	469	22.60	10700	12800	2.24	94100		20.00	-2.60
MAX	0.054	0.004	640	0.074	469	24.80	10700	12900	2.26	94600		20.10	-2.23
HOLE: DHP-402A-DN													
N	BDL	3	3	3	3	3	3	3	3	3	BDL	3	3
X		0.002	1180	0.064	377	20.9	14300	23300	2.02	82000		7.38	0.08
S		<0.001	10	<0.001	1	3.1	100	100	0.01	300		0.13	0.21
MIN		0.001	1170	0.064	375	18.0	14200	23100	2.01	81600		7.24	-0.22
MAX		0.002	1180	0.065	378	25.2	14400	23400	2.04	82200		7.55	0.27
HOLE: DH-36-DN													
N	14	17	12	12	17	8	17	17	17	17	14	17	17
X	0.452	0.012	1490	0.028	340	0.35	18200	18300	1.01	87200	3.28	1.40	-0.62
S	0.439	0.004	130	0.007	15	0.75	800	1100	0.04	1900	1.35	0.25	2.83
MIN	0.039	0.002	1310	0.017	310	0.04	17200	15800	0.95	83500	1.00	0.85	-3.36
MAX	1.480	0.016	1800	0.043	380	0.69	18700	20600	1.05	92200	5.85	1.55	1.38

EALK, ALK and TIC reported as HCO_3^-.

N = Number of samples;
X = Sample mean;
S = Sample standard deviation;
BDL = Below detection limit;
NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
HOLE: DH-38-DN													
N	6	6	6	5	1	5	6	6	5	5	3	6	5
X	6.2	1.23	369000	889	856	23.2	1580	194000	6.3	15.2	5	16200	165
S	0.4	0.01	8000	26		15.5	510	3000	2.3	1.6	4	1100	7
MIN	5.7	1.21	357000	840		4.6	1320	189000	3.4	12.8	1	15200	153
MAX	6.9	1.24	378000	914		40.1	2710	196000	10.3	17.4	10	17800	171
HOLE: DH-42-DN													
N	5	5	5	5	NA	5	5	5	4	5	3	5	5
X	6.4	1.22	368000	1044		95.1	1340	193000	5.3	15.9	6	16000	165
S	0.4	0.01	3000	265		94.5	40	1000	1.2	1.4	3	1100	7
MIN	5.9	1.21	364000	902		6.1	1270	192000	3.5	14.0	4	14800	152
MAX	7.0	1.23	373000	1573		263.1	1390	195000	6.8	17.5	10	17500	172
HOLE: DH-42A-DN													
N	10	10	10	8	3	6	10	10	8	7	4	10	7
X	6.2	1.23	373000	856	830	7.1	1520	195000	5.9	15.5	5	16100	171
S	0.3	0.01	5000	30	11	2.8	300	2000	2.0	1.3	4	1200	10
MIN	5.8	1.21	364000	801	820	4.1	1320	190000	3.6	13.7	1	15000	148
MAX	7.0	1.24	377000	890	845	12.7	2270	197000	10.8	17.0	11	18000	178

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
HOLE: DH-38-DN													
N	6	6	6	6	6	2	6	6	6	6	6	6	6
X	0.413	0.004	1480	0.026	336	0.38	18200	18000	1.00	85800	2.71	0.89	-1.11
S	0.281	<0.001	100	0.003	12	0.02	300	1200	0.04	1300	0.41	0.06	1.35
MIN	0.076	0.004	1340	0.022	322	0.36	17800	15700	0.95	84300	2.28	0.82	-3.68
MAX	0.944	0.005	1650	0.030	360	0.39	18700	19500	1.07	88200	3.49	1.00	0.66
HOLE: DH-42-DN													
N	5	5	5	5	5	4	5	5	5	5	5	5	5
X	0.685	0.007	1470	0.057	381	1.14	18200	17500	1.14	87200	5.14	1.08	-0.73
S	0.833	0.001	120	0.057	65	0.27	400	1100	0.08	1300	2.60	0.22	1.07
MIN	0.000	0.005	1320	0.022	330	0.68	17600	15600	1.07	85500	2.37	0.92	-2.20
MAX	2.270	0.009	1680	0.170	510	1.38	18900	19000	1.26	88900	9.61	1.51	1.05
HOLE: DH-42A-DN													
N	9	10	7	6	10	3	10	10	10	10	9	10	10
X	0.184	0.004	1430	0.020	337	0.25	18500	17700	1.00	86500	2.65	0.87	-1.19
S	0.123	0.001	140	0.002	11	0.15	400	1300	0.04	2100	0.44	0.07	1.15
MIN	0.070	0.003	1210	0.018	322	0.04	18000	15400	0.94	83800	2.14	0.78	-3.53
MAX	0.502	0.005	1620	0.023	360	0.38	19500	19000	1.09	90000	3.72	1.00	0.84

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
HOLE: G-SEEP-DN													
N	16	16	16	16	2	9	16	16	15	14	7	16	14
X	6.2	1.23	385000	952	911	3.2	1470	187000	4.9	17.9	5	31800	198
S	0.4	0.01	13000	61	21	1.2	90	1000	0.8	3.4	4	3100	16
MIN	5.9	1.22	376000	846	890	1.0	1360	184000	3.8	11.3	1	27700	168
MAX	6.9	1.25	433000	1049	932	5.1	1650	190000	6.2	22.5	13	36300	217
HOLE: L1X00-DN													
N	5	5	5	5	NA	5	5	5	5	5	2	5	5
X	5.9	1.23	392000	1253		8.2	1850	197000	6.8	15.0	4	21600	205
S	0.4	0.01	13000	233		11.2	270	2000	1.1	8.3	2	3700	40
MIN	5.4	1.21	372000	1008		0.5	1550	194000	5.0	15.8	2	17600	152
MAX	6.7	1.25	413000	1646		30.5	2280	201000	8.4	25.3	5	27100	260
HOLE: NG252-DN													
N	11	11	11	6	6	5	11	11	7	5	3	11	5
X	6.1	1.22	376000	818	783	6.8	1410	194000	6.2	13.5	5	16600	149
S	0.3	0.01	6000	14	66	1.9	340	2000	1.0	1.1	4	800	7
MIN	5.7	1.21	368000	789	666	5.1	870	190000	4.2	12.2	2	15500	137
MAX	6.9	1.23	390000	830	895	9.7	2100	197000	7.5	15.5	11	18400	160

EALK, ALK and TIC reported as HCO_3^-.

N = Number of samples; X = Sample mean; S = Sample standard deviation;

BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
HOLE: G-SEEP-DN													
N	9	16	14	12	16	7	16	16	16	16	14	16	16
X	0.235	0.003	1780	0.015	281	0.38	15400	16200	0.67	94700	1.74	2.67	-0.87
S	0.133	0.001	220	0.002	12	0.04	1200	1910	0.05	3000	0.54	0.25	1.54
MIN	0.047	0.002	1490	0.012	260	0.30	13700	13000	0.57	86500	1.12	2.27	-4.35
MAX	0.433	0.004	2140	0.018	310	0.45	17600	19100	0.73	99000	2.74	3.00	1.56
HOLE: L1X00-DN													
N	5	5	5	5	5	4	5	5	5	5	5	5	5
X	0.989	0.002	1880	0.024	340	0.74	22700	26800	1.34	71800	5.10	1.61	-0.87
S	0.504	<0.001	240	0.010	45	0.29	2700	3000	0.17	4800	1.60	0.43	1.58
MIN	0.331	0.001	1520	0.016	270	0.35	19300	23300	1.14	65800	3.56	0.90	-3.59
MAX	1.570	0.002	2100	0.040	398	1.08	27000	30900	1.66	79400	7.22	2.20	1.03
HOLE: NG252-DN													
N	6	5	5	5	11	8	11	11	8	11	5	11	11
X	0.165	0.002	1450	0.026	310	10.3	17000	20300	1.16	82700	1.74	1.68	-1.11
S	0.194	0.000	110	0.004	15	15.5	300	1000	0.13	2300	0.29	0.07	1.27
MIN	0.033	0.002	1330	0.020	299	2.2	16600	18200	1.02	79400	1.39	1.59	-3.04
MAX	0.582	0.002	1660	0.032	350	49.2	17800	22400	1.39	87000	2.15	1.83	2.05

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
HOLE: AIS WATER													
N	3	3	3	3	NA	3	3	3	1	BDL	3	3	3
X	7.1	1.21	332000	122		93.5	42	188000	4.0		6	6170	4.3
S	0.0	0.00	1000	6		1.4	3	1000			1	10	0.3
MIN	7.1	1.21	330000	116		91.9	37	187000			5	6150	4.0
MAX	7.1	1.21	333000	128		94.5	44	190000			6	6180	4.5

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, UNC Geotech

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
HOLE: AIS WATER													
N	3	3	3	3	3	3	3	3	3	3	3	3	3
X	0.166	0.002	13	0.230	953	0.12	1720	1040	0.39	118000	3.30	30.6	-1.23
S	0.002	0.000	<1	0.011	5	<0.01	0	0	<0.01	0	0.03	0.1	0.32
MIN	0.163	0.002	12	0.215	950	0.12	1720	1040	0.39	118000	3.26	30.5	-1.66
MAX	0.169	0.002	13	0.239	960	0.13	1720	1040	0.40	118000	3.33	30.6	-0.88

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, IT-Export

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
HOLE: A1X02-UP													
N	4	4	4	4	NA	BDL	4	4	4	BDL	BDL	4	4
X	5.7	1.23	343000	693			2000	191000	7			21000	118
S	0.1	0.01	4000	19			270	3000	1			2200	20
MIN	5.6	1.22	337000	670			1600	187000	6			18500	100
MAX	5.7	1.24	346000	719			2300	195000	8			23200	150
HOLE: BX-01-DN													
N	5	5	5	5	NA	1	5	5	5	BDL	2	5	5
X	6.0	1.22	342000	807		5	1400	183000	8		0.07	17000	112
S	0.1	0.01	7000	9			110	4000	1		0.07	600	12
MIN	5.9	1.20	332000	793			1300	175000	7		0.02	16000	96
MAX	6.3	1.23	352000	817			1600	188000	9		0.12	17800	127
HOLE: DH-36-DN													
N	9	9	9	9	NA	3	9	9	8	2	6	9	9
X	6.0	1.21	348000	802		5	1400	182000	5	22	0.70	16000	125
S	<0.1	0.01	10000	38		0	150	11000	2	1	1.01	800	10
MIN	6.0	1.19	340000	756		5	1200	169000	2	21	0.05	15200	110
MAX	6.1	1.23	374000	853		5	1700	208000	7	22	2.00	17400	140

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, IT-Export

HOLE: A1X02-UP

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
N	BDL	2	4	BDL	4	4	4	4	4	4	4	4	4
X		0.009	1600		265	3	16100	32500	5.1	67500	0.4	6.9	1.78
S		0.001	160		5	1	300	1800	0.2	1800	0.1	0.1	0.57
MIN		0.008	1400		260	2	15800	30600	4.9	65500	0.3	6.8	1.20
MAX		0.010	1800		270	3	16600	15000	5.4	70100	0.4	6.9	2.35

HOLE: BX-01-DN

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
N	BDL	3	5	BDL	5	5	5	5	5	5	5	5	5
X		0.020	1480		262	3	17400	22100	1.5	80800	0.5	2.8	2.47
S		0.010	80		12	1	700	900	0.1	2300	0.2	0.3	1.74
MIN		0.010	1400		250	2	16800	21000	1.4	77500	0.2	2.5	0.20
MAX		0.026	1600		280	5	18700	23700	1.7	84200	0.8	3.3	5.47

HOLE: DH-36-DN

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
N	BDL	4	9	BDL	9	9	9	9	9	9	9	9	9
X		0.017	1530		322	2	19500	18500	1.1	85000	0.7	1.6	2.41
S		0.010	70		16	1	500	700	0.1	4900	0.1	0.1	4.46
MIN		0.009	1400		290	1	18600	17800	1.0	75700	0.5	1.5	-7.83
MAX		0.025	1600		340	3	20200	20200	1.3	90600	0.9	1.9	6.89

EALK, ALK and TIC reported as HCO_3^-.
N = Number of samples; X = Sample mean; S = Sample standard deviation;
BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, IT-Export

HOLE: DH-38-DN

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
N	2	2	2	2	NA	2	2	2	2	BDL	1	2	2
X	6.1	1.21	330000	847		5	1500	176000	5		0.04	16400	120
S	0.0	<0.01	8000	18		0	100	7000	1			800	10
MIN	6.1	1.20	322000	829		5	1400	169000	4			15600	110
MAX	6.1	1.21	338000	866		5	1600	182000	5			17200	125

HOLE: DH-42A-DN

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
N	5	5	5	5	NA	1	5	5	5	1	4	5	5
X	6.1	1.21	342000	834		5	1290	180000	5	21	0.29	15200	140
S	0.2	0.02	2000	24			250	6000	1		0.47	1400	20
MIN	6.0	1.17	339000	805			850	173000	3		0.05	12700	120
MAX	6.5	1.23	344000	853			1600	190000	7		1.00	16700	170

HOLE: G-SEEP-DN

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
N	9	9	9	9	NA	BDL	9	9	9	4	8	9	9
X	6.0	1.22	350000	925			1370	173000	5	21	0.06	33100	150
S	0.1	0.02	11000	88			100	6000	2	2	0.04	1900	10
MIN	6.0	1.19	330000	805			1300	164000	1	20	0.02	30900	140
MAX	6.1	1.24	370000	1024			1600	181000	8	24	0.13	36900	170

EALK, ALK and TIC reported as HCO_3^-.

N = Number of samples; X = Sample mean; S = Sample standard deviation;

BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, IT-Export

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
HOLE: DH-38-DN													
N	BDL	1	2	BDL	2	2	2	2	2	2	2	2	2
X		0.006	1550		330	2	20100	18400	1.1	88400	0.7	1.1	5.15
S			50		10	0	300	500	0.0	900	0.2	0.1	1.92
MIN			1500		320	2	19800	17900	1.1	87500	0.5	1.0	3.22
MAX			1600		340	2	20300	18800	1.1	89300	0.8	1.1	7.07
HOLE: DH-42A-DN													
N	BDL	2	5	BDL	5	5	5	5	5	5	5	5	5
X		0.020	1580		330	2	20800	18200	1.2	87400	0.8	1.0	4.05
S		0.010	130		39	0	2100	1800	0.1	2900	0.1	0.1	3.18
MIN		0.014	1400		280	2	18800	17000	1.0	81900	0.7	0.9	0.48
MAX		0.025	1800		400	2	24900	21800	1.3	89900	1.0	1.1	9.48
HOLE: G-SEEP-DN													
N	BDL	3	9	BDL	9	9	9	9	9	9	9	9	9
X		0.014	1860		260	2	16900	16400	0.8	98700	0.4	3.1	4.20
S		0.008	130		15	0	700	500	0.1	10600	0.1	0.2	3.76
MIN		0.008	1700		240	1	16000	15500	0.7	81500	0.3	3.0	-4.05
MAX		0.023	2000		280	2	17900	17100	1.0	12400	0.5	3.6	11.39

EALK, ALK and TIC reported as HCO_3^-.

N = Number of samples;

X = Sample mean;

S = Sample standard deviation;

BDL = Below detection limit;

NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, IT-Export

HOLE: NG252-DN

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
N	4	4	4	4	NA	BDL	4	4	4	BDL	2	4	4
X	6.1	1.21	338000	802			1280	179000	6		0.03	16100	108
S	0.1	0.01	8000	36			40	4000	2		0.01	800	9
MIN	6.0	1.19	328000	744			1200	173000	3		0.02	14700	98
MAX	6.2	1.23	347000	841			1300	183000	7		0.04	16600	117

HOLE: STANDARD

	pH	S.G. g/cc	TDS mg/L	EALK mg/L	ALK mg/L	TIC mg/L	Br mg/L	Cl mg/L	F mg/L	I mg/L	NO_3^- mg/L	SO_4^{-2} mg/L	NH_4^+ mg/L
N	4	4	4	4	NA	3	4	4	2	BDL	2	4	4
X	7.7	1.15	246000	31		31	43	122000	2		0.08	2000	2.3
S	0.4	0.01	8000	6		3	22	25000	0		0.04	150	1.1
MIN	7.1	1.14	239000	24		28	28	79000	2		0.05	1800	1.2
MAX	8.0	1.17	259000	41		36	81	140000	2		0.11	2200	3.6

EALK, ALK and TIC reported as HCO_3^-.

N = Number of samples; X = Sample mean; S = Sample standard deviation;

BDL = Below detection limit; NA = Not analyzed

TABLE D-1

STATISTICAL RESULTS
(CONTINUED)

Simple Statistics, IT-Export

	Al mg/L	As mg/L	B mg/L	Ba mg/L	Ca mg/L	Fe mg/L	K mg/L	Mg mg/L	Mn mg/L	Na mg/L	Si mg/L	Sr mg/L	%CHARGE BALANCE
HOLE: NG252-DN													
N	BDL	2	4	BDL	4	4	4	4	4	4	4	4	4
X		0.017	1480		298	4	18200	20100	1.2	82300	0.5	1.9	2.83
S		0.009	40		16	1	400	400	0.1	3100	0.1	0.1	2.10
MIN		0.010	1400		270	2	17600	19700	1.1	77300	0.4	1.8	-0.52
MAX		0.023	1500		310	4	18800	20800	1.4	85100	0.6	2.0	5.24
HOLE: STANDARD													
N	BDL	2	4	BDL	4	BDL	4	4	BDL	4	BDL	4	4
X		0.026	6		415		458	170		95300		12.4	10.21
S		0.001	1		22		3	5		1300		0.9	11.75
MIN		0.025	5		380		455	165		93700		11.7	1.58
MAX		0.026	7		440		460	180		97100		14.0	30.45

EALK, ALK and TIC reported as HCO_3^-.

N = Number of samples;
X = Sample mean;
S = Sample standard deviation;
BDL = Below detection limit;
NA = Not analyzed

APPENDIX D

STATISTICAL RESULTS FOR BRINE SAMPLES

PART II - MULTIVARIATE ANALYSIS

Multivariate-analysis-of-variance calculations were carried out on analytical results obtained from WIPP brines sampled over the period November 1987 through July 1988. For each analytical group, the GLM procedure evaluates the model hypothesis that significant differences exist in the mean parameter concentrations among the holes - that is, some linear function of the parameter means is different from zero. The null hypothesis states there is no significant difference in the mean parameter concentrations between holes. Rejection of the null hypothesis occurs when the calculated F value (alpha = 0.05) exceeds that predicted for the indicated degrees of freedom. A small significance probability (e.g., Pr > F = 0.0001) indicates that some linear function of the parameter means is significantly different from zero (i.e. at the 99.99% confidence level when Pr > F = 0.0001). R-square can range from 0 to 1 and, in general, the larger the value of R-square, the better the model's fit. Duncan's multiple-range test groups those holes which do not have significantly different parameter means.

Statistical Analysis Software (SAS), General-Linear-Model (GLM) Procedure (SAS Institute, Inc., 1985).

Abbreviations as follows: DF = degrees of freedom; CV = coefficient of variation; MSE = mean square for error.

TABLE D-2

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE, UNC GEOTECH

Class	Levels	Values
HOLE	13	a1x01 a1x02 a2x01 a3x01 bx01 dh36 dh38 dh42 dh42a dhp401 gseep l1x00 ng252

Number of observations in data set = 72

Critical value for the F distribution: F0.05(12,59) = 1.93

Dependent Variable: pH

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	2.6	0.2	1.02	0.4428
Error	59	12.5	0.2		
Corrected Total	71	15.1			

R-Square	C.V.	Root MSE	pH Mean
0.1716	7.58	0.5	6.1

Dependent Variable: Br

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	5008290	417360	42.92	0.0001
Error	59	573660	9720		
Corrected Total	71	5581950			

R-Square	C.V.	Root MSE	Br Mean
0.8972	6.44	100	1530

Dependent Variable: Cl

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	1012008000	84334000	16.12	0.0001
Error	59	308603000	5231000		
Corrected Total	71	1320611000			

R-Square	C.V.	Root MSE	Cl Mean
0.7663	1.17	2000	194000

TABLE D-2

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE, UNC GEOTECH

Dependent Variable: SO_4^{-2}

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	2536470600	211372600	60.99	0.0001
Error	59	204459300	3465400		
Corrected Total	71	2740929900			

R-Square	C.V.	Root MSE	SO_4^{-2} Mean
0.9254	9.03	1900	20600

Dependent Variable: NH_4^+

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	33774	2814	15.49	0.0001
Error	59	10717	182		
Corrected Total	71	44491			

R-Square	C.V.	Root MSE	NH_4^+ Mean
0.7591	7.88	13	171

Dependent Variable: B

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	2012070	167670	5.66	0.0001
Error	59	1746440	29600		
Corrected Total	71	3758510			

R-Square	C.V.	Root MSE	B Mean
0.5353	10.93	170	1570

Dependent Variable: Ca

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	60964	5080	5.71	0.0001
Error	59	52501	890		
Corrected Total	71	113465			

R-Square	C.V.	Root MSE	Ca Mean
0.5373	9.33	30	320

TABLE D-2

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE, UNC GEOTECH

Dependent Variable: Mg

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	3044750700	253729200	56.19	0.0001
Error	59	266407100	4515400		
Corrected Total	71	3311157800			

R-Square	C.V.	Root MSE	Mg Mean
0.9195	9.59	2100	22200

Dependent Variable: Mn

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	18317	15.26	697.66	0.0001
Error	59	1.29	0.02		
Corrected Total	71	184.46			

R-Square	C.V.	Root MSE	Mn Mean
0.9930	8.37	0.15	1.77

Dependent Variable: K

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	271739500	22645000	27.51	0.0001
Error	59	48570400	823200		
Corrected Total	71	320309900			

R-Square	C.V.	Root MSE	K Mean
0.8484	5.28	900	17200

Dependent Variable: Si

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	91.02	7.58	4.18	0.0001
Error	59	107.13	1.82		
Corrected Total	71	198.15			

R-Square	C.V.	Root MSE	Si Mean
0.4593	51.55	1.35	2.61

TABLE D-2

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE, UNC GEOTECH

Dependent Variable: Na

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	7983015600	665251300	140.56	0.0001
Error	59	279244300	4733000		
Corrected Total	71	8262259900			

R-Square	C.V.	Root MSE	Na Mean
0.9662	2.67	2200	81400

Dependent Variable: Sr

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	12	181.08	15.09	170.02	0.0001
Error	59	5.24	0.09		
Corrected Total	71	186.32			

R-Square	C.V.	Root MSE	Sr Mean
0.9719	12.71	0.30	2.34

TABLE D-3

STATISTICAL RESULTS

MULTIVARIATE ANALYSIS OF VARIANCE
DUNCAN'S MULTIPLE-RANGE TEST, UNC GEOTECH

NOTE: This test controls the type I comparisonwise error rate,
not the experimentwise error rate

WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes = 4.305891

Alpha = 0.05 df = 59

Means with the same letter are not significantly different.
Asterisk indicates group used to calculate composite chemistry in Table 3-5.

Ph

Duncan Grouping	Mean	N	HOLE
*A	6.4	4	dh42
A	6.3	3	a1x01
A	6.2	11	gseep
A	6.2	4	a3x01
A	6.2	4	dh38
A	6.2	6	dh42a
A	6.1	7	bx01
A	6.1	4	ng252
A	6.1	11	dh36
A	6.0	2	dhp401
A	5.9	3	a2x01
A	5.9	4	l1x00
A	5.7	9	a1x02

Br

Duncan Grouping		Mean	N	HOLE
	A	2410	2	dhp401
	B	1970	9	a1x02
	B	1930	4	l1x00
	C	1500	11	gseep
*D	C	1460	3	a2x01
D	C	1450	3	a1x01
D	C	1410	7	bx01
D	C	1390	4	a3x01
D	C	1360	11	dh36
D	C	1360	4	ng252
D	C	1350	6	dh42a
D	C	1350	4	dh38
D		1330	4	dh42

TABLE D-3

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE
DUNCAN'S MULTIPLE-RANGE TEST, UNC GEOTECH

Cl

Duncan Grouping			Mean	N	HOLE
	A		202000	2	dhp401
B	A		199000	9	a1x02
B	C		198000	4	l1x00
*D	C		196000	3	a2x01
D	C	E	195000	6	dh42a
D	C	E	195000	11	dh36
D	C	E	195000	4	dh38
D	C	E	195000	7	bx01
D	C	E	194000	4	ng252
D		E	193000	4	dh42
D		E	192000	3	a1x01
		E	192000	4	a3x01
	F		187000	11	gseep

SO_4^{-2}

Duncan Grouping	Mean	N	HOLE
A	33200	11	gseep
B	27900	2	dhp401
C	22600	4	l1x00
C	21800	9	a1x02
*D	18500	3	a1x01
D	17500	7	bx01
D	17200	3	a2x01
D	17000	4	a3x01
D	16900	4	ng252
D	16600	11	dh36
D	16500	4	dh38
D	16500	6	dh42a
D	16200	4	dh42

TABLE D-3

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE DUNCAN'S MULTIPLE-RANGE TEST, UNC GEOTECH

NH_4^+

Duncan Grouping		Mean	N	HOLE
	A	218	4	l1x00
B	A	205	11	gseep
B		198	2	dhp401
	C	175	6	dh42a
*D	C	168	4	dh42
D	C	168	4	dh38
D	C	165	3	a2x01
D	C	163	11	dh36
D	C	155	9	a1x02
D		152	7	bx01
D		152	4	ng252
D		149	4	a3x01
D		147	3	a1x01

B

Duncan Grouping		Mean	N	HOLE
	A	1970	4	l1x00
	A	1840	11	gseep
B	A	1790	2	dhp401
B	*C	1560	7	bx01
	C	1520	9	a1x02
	C	1500	4	dh38
	C	1490	11	dh36
	C	1490	3	a1x01
	C	1480	4	dh42
	C	1460	4	ng252
	C	1430	6	dh42a
	C	1420	3	a2x01
	C	1420	4	a3x01

TABLE D-3

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE
DUNCAN'S MULTIPLE-RANGE TEST, UNC GEOTECH

Ca

Duncan Grouping				Mean	N	HOLE
	A			388	4	dh42
*B	A			349	3	a2x01
B				345	11	dh36
B				343	6	dh42a
B		C		341	4	dh38
B		C	D	326	4	l1x00
B		C	D	323	4	ng252
B	E	C	D	312	4	a3x01
B	E	C	D	307	3	a1x01
B	E	C	D	302	7	bx01
	E	C	D	296	9	a1x02
	E		D	283	11	gseep
	E			270	2	dhp401

Mg

Duncan Grouping		Mean	N	HOLE
	A	44300	2	dhp401
	B	33200	9	a1x02
	C	27600	4	l1x00
	D	23100	3	a1x01
	D	22900	7	bx01
	D	22800	3	a2x01
	D	22800	4	a3x01
*E	D	20200	4	ng252
E	F	18100	11	dh36
E	F	17800	4	dh38
E	F	17600	6	dh42a
E	F	17400	4	dh42
	F	16600	11	gseep

TABLE D-3

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE
DUNCAN'S MULTIPLE-RANGE TEST, UNC GEOTECH

Mn

Duncan Grouping	Mean	N	HOLE
A	8.00	2	dhp401
B	4.67	9	a1x02
C	1.80	3	a2x01
D	1.58	4	a3x01
D	1.40	7	bx01
D	1.40	4	l1x00
D	1.40	3	a1x01
*E	1.18	4	dh42
E	1.10	4	ng252
E	1.03	4	dh38
E	1.02	6	dh42a
E	1.00	11	dh36
F	0.70	11	gseep

K

Duncan Grouping		Mean	N	HOLE
	A	23600	4	l1x00
	*B	18500	6	dh42a
	B	18200	4	dh38
	B	18200	4	dh42
	B	18200	11	dh36
C	B	17200	4	ng252
C	D	16500	7	bx01
C	D	16200	3	a2x01
C	D	16100	3	a1x01
C	D	15900	11	gseep
C	D	15800	2	dhp401
C	D	15800	4	a3x01
	D	15100	9	a1x02

TABLE D-3

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE DUNCAN'S MULTIPLE-RANGE TEST, UNC GEOTECH

Si

Duncan Grouping		Mean	N	HOLE
	A	5.48	4	l1x00
B	A	4.90	4	dh42
B	*C	3.35	11	dh36
	C	2.85	4	dh38
	C	2.75	4	a3x01
	C	2.63	6	dh42a
	C	2.63	3	a2x01
	C	2.37	7	bx01
	C	1.90	11	gseep
	C	1.85	4	ng252
	C	1.75	2	dhp401
	C	1.43	3	a1x01
	C	1.23	9	a1x02

Na

Duncan Grouping		Mean	N	HOLE
	A	94200	11	gseep
	*B	87700	11	dh36
	B	87500	4	dh42
	B	86800	6	dh42a
C	B	86300	4	dh38
C	*D	83500	4	ng252
E	D	80800	7	bx01
E		79900	3	a1x01
E		79700	3	a2x01
E		78800	4	a3x01
	F	69900	4	l1x00
	G	63600	9	a1x02
	H	50800	2	dhp401

TABLE D-3

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE DUNCAN'S MULTIPLE-RANGE TEST, UNC GEOTECH

Sr Duncan Grouping		Mean	N	HOLE
	A	5.92	9	a1x02
	B	5.25	2	dhp401
	C	2.69	11	gseep
D	C	2.53	4	a3x01
D	E	2.14	7	bx01
*F	E	1.77	3	a1x01
F		1.70	4	ng252
F	G	1.48	4	l1x00
F	G	1.44	11	dh36
*H	G	1.08	4	dh42
H	G	1.07	3	a2x01
H		0.90	4	dh38
H		0.88	6	dh42a

TABLE D-4

STATISTICAL RESULTS

MULTIVARIATE ANALYSIS OF VARIANCE, IT- EXPORT

Class	Levels	Values
HOLE	7	a1x02 bx01 dh36 dh38 dh42a gseep ng252

Number of observations in data set = 38

Critical value for the F distribution: F0.05(6,31) = 2.41

Dependent Variable: pH

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	0.6	0.1	9.43	0.0001
Error	31	0.4	0.01		
Corrected Total	37	1.0			

R-Square	C.V.	Root MSE	pH Mean
0.6459	1.78	0.1	6.0

Dependent Variable: Br

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	1551880	258650	8.10	0.0001
Error	31	989500	31920		
Corrected Total	37	2541380			

R-Square	C.V.	Root MSE	Br Mean
0.6106	12.59	180	1430

TABLE D-4

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE, IT-EXPORT

Dependent Variable: Cl

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	1010342000	168390000	2.71	0.0310
Error	31	1924000000	62065000		
Corrected Total	37	2934342000			

R-Square	C.V.	Root MSE	Cl Mean
0.3443	4.38	8000	180000

Dependent Variable: SO_4^{-2}

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	1903252900	317208800	136.88	0.0001
Error	31	71839700	2317400		
Corrected Total	37	1975092600			

R-Square	C.V.	Root MSE	SO_4^{-2} Mean
0.9636	7.37	1500	20700

Dependent Variable: NH_4^+

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	8987	1498	8.09	0.0001
Error	31	5740	185		
Corrected Total	37	14728			

R-Square	C.V.	Root MSE	NH_4^+ Mean
0.6102	10.62	14	128

Dependent Variable: B

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	765070	127510	9.62	0.0001
Error	31	410720	13250		
Corrected Total	37	1175790			

R-Square	C.V.	Root MSE	B Mean
0.6507	7.15	120	1610

TABLE D-4

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE, IT-EXPORT

Dependent Variable: Ca

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	35076	5846	12.96	0.0001
Error	31	14011	452		
Corrected Total	37	49087			

R-Square	C.V.	Root MSE	Ca Mean
0.7146	7.27	21	292

Dependent Variable: Mg

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	810131300	135021900	99.11	0.0001
Error	31	42234200	1362400		
Corrected Total	37	852365500			

R-Square	C.V.	Root MSE	Mg Mean
0.9505	5.82	1200	20100

Dependent Variable: Mn

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	58.6	9.8	476.62	0.0001
Error	31	0.6	0.02		
Corrected Total	37	59.2			

R-Square	C.V.	Root MSE	Mn Mean
0.9893	9.36	0.1	1.5

Dependent Variable: K

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	93645000	15607500	14.95	0.0001
Error	31	32372100	1044300		
Corrected Total	37	126017100			

R-Square	C.V.	Root MSE	K Mean
0.7431	5.58	1000	18300

TABLE D-4

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE, IT-EXPORT

Dependent Variable: Si

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	0.9	0.1	6.83	0.0001
Error	31	0.7	0.02		
Corrected Total	37	1.6			

R-Square	C.V.	Root MSE	Si Mean
0.5695	26.42	0.1	0.6

Dependent Variable: Na

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	3040099500	506683300	11.64	0.0001
Error	31	1349718600	43539300		
Corrected Total	37	4389818200			

R-Square	C.V.	Root MSE	Na Mean
0.6925	7.67	6600	86100

Dependent Variable: Sr

Source	DF	Sum of Squares	Mean Square	F Value	Pr >F
Model	6	103.1	17.2	498.37	0.0001
Error	31	1.1	0.03		
Corrected Total	37	104.2			

R-Square	C.V.	Root MSE	Sr Mean
0.9897	7.09	0.2	2.6

TABLE D-5

STATISTICAL RESULTS

MULTIVARIATE ANALYSIS OF VARIANCE DUNCAN'S MULTIPLE-RANGE TEST, IT-EXPORT

NOTE: This test controls the type I comparisonwise error rate, not the experimentwise error rate

WARNING: Cell sizes are not equal.
Harmonic Mean of cell sizes = 4.315068

Alpha = 0.05 df = 31

Means with the same letter are not significantly different.
Asterisk indicates group used to calculate composite chemistry in Table 3-5.

pH

Duncan Grouping	Mean	N	HOLE
*A	6.1	5	dh42a
A	6.1	2	dh38
A	6.1	4	ng252
A	6.0	9	gseep
A	6.0	9	dh36
A	6.0	5	bx01
B	5.7	4	a1x02

Br

Duncan Grouping	Mean	N	HOLE
A	2000	4	a1x02
*B	1500	2	dh38
B	1400	9	dh36
B	1400	5	bx01
B	1370	9	gseep
B	1290	5	dh42a
B	1280	4	ng252

Cl

Duncan Grouping		Mean	N	HOLE
	*A	191000	4	a1x02
B	A	183000	5	bx01
B	A	182000	9	dh36
B	A	180000	5	dh42a
B	A	179000	4	ng252
B		176000	2	dh38
B		173000	9	gseep

TABLE D-5

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE
DUNCAN'S MULTIPLE-RANGE TEST, IT-EXPORT

SO_4^{-2}

Duncan Grouping	Mean	N	HOLE
A	33100	9	gseep
B	21000	4	a1x02
*C	17000	5	bx01
C	16400	2	dh38
C	16200	9	dh36
C	16100	4	ng252
C	15200	5	dh42a

NH_4^+

Duncan Grouping		Mean	N	HOLE
	A	151	9	gseep
B	A	140	5	dh42a
B	*C	124	9	dh36
	C	118	2	dh38
	C	118	4	a1x02
	C	112	5	bx01
	C	108	4	ng252

B

Duncan Grouping	Mean	N	HOLE
A	1860	9	gseep
*B	1600	4	a1x02
B	1580	5	dh42a
B	1550	2	dh38
B	1530	9	dh36
B	1480	5	bx01
B	1480	4	ng252

Ca

Duncan Grouping		Mean	N	HOLE
	*A	330	5	dh42a
	A	330	2	dh38
B	A	322	9	dh36
B		398	4	ng252
	C	265	4	a1x02
	C	262	5	bx01
	C	260	9	gseep

TABLE D-5

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE DUNCAN'S MULTIPLE-RANGE TEST, IT-EXPORT

Mg

Duncan Grouping		Mean	N	HOLE
	A	32500	4	a1x02
	B	22100	5	bx01
	C	20100	4	ng252
*D	C	18500	9	dh36
D		18400	2	dh38
D		18200	5	dh42a
	E	16400	9	gseep

Mn

Duncan Grouping	Mean	N	HOLE
A	5.1	4	a1x02
B	1.5	5	bx01
*C	1.2	4	ng252
C	1.2	5	dh42a
C	1.1	2	dh38
C	1.1	9	dh36
D	0.8	9	gseep

K

Duncan Grouping		Mean	N	HOLE
	*A	20800	5	dh42a
	A	20100	2	dh38
B	A	19500	9	dh36
B	C	18200	4	ng252
D	C	17400	5	bx01
D	C	16900	9	gseep
D		16100	4	a1x02

Si

Duncan Grouping		Mean	N	HOLE
	A	0.8	5	dh42a
*B	A	0.7	9	dh36
B	A	0.7	2	dh38
B		0.5	4	ng252
B	C	0.5	5	bx01
	C	0.4	9	gseep
	C	0.4	4	a1x02

TABLE D-5

STATISTICAL RESULTS
(CONTINUED)

MULTIVARIATE ANALYSIS OF VARIANCE
DUNCAN'S MULTIPLE-RANGE TEST, IT-EXPORT

Na

Duncan Grouping	Mean	N	HOLE
A	98700	9	gseep
*B	88400	2	dh38
B	87400	5	dh42a
B	85000	9	dh36
B	82300	4	ng252
B	80800	5	bx01
C	67500	4	a1x02

Sr

Duncan Grouping	Mean	N	HOLE
A	6.9	4	a1x02
B	3.1	9	gseep
C	2.8	5	bx01
*D	1.9	4	ng252
D	1.6	9	dh36
*E	1.1	2	dh38
E	1.0	5	dh42a

APPENDIX E

DUSSAULT'S STAIN PROCEDURE

APPENDIX E

DUSSAULT'S STAIN PROCEDURE

Apply loopful of 0.75% formalin in 20% brine to a clean glass slide.

Place colony in drop.

Air dry.

Immerse in 2% acetic acid (5 minutes).

Pat dry.

Add a drop of crystal violet solution (3 minutes).

Rinse with iodine.

Rinse with 95% ethyl alcohol.

Rinse with tap water.

Apply a drop of basic fuchsin solution (1 minute).

Rinse with tap water.

Air dry.

Examine under Phase Contrast Microscope.

APPENDIX F

BACTERIA ISOLATES

PART I - ISOLATE CHARACTERISTICS

PART II - ISOLATES PER SAMPLE ON HIGH SALT MEDIA

PART III - DESCRIPTION OF ISOLATES ON MEDIA SELECTIVE FOR SPECIAL ORGANISMS

TABLE F-1

BACTERIA ISOLATES

PART I -ISOLATE CHARACTERISTICS

TABLE F-1

ISOLATE CHARACTERISTICS

	MICROSCOPIC EXAMINATION[a]	MACROSCOPIC APPEARANCE ON AGAR
W-1	Small curved bacilli[b]	Pinpoint, grey, transparent, flat
W-2	Streptococci[c] (all greater than 4 individual cells)	Small, while, opaque, not circular, raised
W-3	Single cocci[d], cocci in pairs and streptococci	Pinpoint, white, opaque, convex
W-4*	Long thin bacilli in chains/ streptococci	Pinpoint, off-white/grey, opaque, raised
W-5*	Streptococci (all less than 6 individual cells)/large cocci	Large, yellow, not circular, raised
W-6	Staphylococci[e]	Pinpoint, yellow, opaque, raised
W-7	Long, fat bacilli in chains	Small, off-white, opaque, flat
W-8	Streptococci (all greater than 6 individual cells)	Pinpoint, off-white, opaque, convex
W-9	Cocci, diplococci[f]	Pinpoint, blue/grey, transparent, flat
W-10	Streptococci (large)	Minute, yellow, transparent, flat
W-11	Small streptococci (chains of 3 individual cells)	Pinpoint, yellow, transparent, flat
W-12	Large streptococci (chains of 3-6 individual cells)	Small, white, opaque, convex
W-13	Cocci, diplococci, streptococci	Pinpoint, pink, transparent, convex
W-14	Small, short bacilli, paired	Pinpoint, grey/yellow, transparent, iregular, flat
W-15	Small staphylococci	Very pinpoint, fiery red, transparent, flat
W-16	Cocci (chains of 6-8 individual cells)	Pinpoint, peach, opaque, raised
W-17	Small individual cocci	Large, amber, flat
W-18	Small Staphylococci	White/pink, liquified agar
W-19	Large cocci (single cells)	Small pink, transparent, convex
W-20*	Small individual cocci/large staphylococci	Pinpoint, orange/red, transparent, flat
W-21	Large staphylococci	Pinpoint, off-white, opaque, raised
W-22	Small streptococci	Off-white, opaque, raised/convex
W-23*	Large cocci/small streptococci	Off-white, opaque, raised/convex

TABLE F-1

ISOLATE CHARACTERISTICS
(CONTINUED)

	MICROSCOPIC EXAMINATION*	MACROSCOPIC APPEARANCE ON AGAR
W-24	Small diplococci	Off-white, opaque, flat
W-25	Small streptococci (chains of greater than 8 individual cells)	Small, grey/yellow, transparent, raised
W-26	Small cocci (single cells)	Pinpoint, pink/white, transparent, flat
W-27	Small cocci	Very pinpoint, pink, transparent
W-28	Large staphylococci, aggregates	Pinpoint, pink/grey, transparent, flat
W-29	Small cocci (groups of cells greater than 4 individual cells)	Small, off-white, opaque, flat
W-30	Very long curved bacilli in chains	Small, yellow centers with grey edges, raised
W-31	Very small single bacilli	Pinpoint, grey, transparent, flat
W-32*	Short bacilli chains (spores)	Large, yellow/orange, irregular edges, flat
W-33	Bacilli in chains of 2-6	Yellow/orange, opaque irregular edges
W-34	Small streptococci	Small, peach, opaque, convex
W-35	Very small single bacilli	Pinpoint, orange/pink, convex
W-36	Streptococci in chains (4-6 cells)	Grey/orange, transparent, raised
W-37	Streptococci in chains (4-6 cells)	Small, peach/orange, opaque, convex
W-38	Very small streptococci in chains (2-6 cells)	Very pinpoint, grey, transparent, flat
W-39	Long curved bacilli, chains of greater than 4 individual cells	Off-white, opaque, raised
W-40	Cocci	Orange, opaque, convex
W-41	Very small bacilli in chains	Yellow, opaque, irregular, flat
W-42	Streptococci in chains of greater than 20 individual cells	Large, peach, opaque, irregular, convex
W-43	Very small single bacilli	Small, grey/blue, transparent, raised
W-44	Very small bacilli (chains of 3-6 individual cells)	Very pinpoint, off-white, transparent, raised
W-45	Cocci	Small, pink, opaque, raised

TABLE F-1

ISOLATE CHARACTERISTICS
(CONTINUED)

	MICROSCOPIC EXAMINATION[a]	MACROSCOPIC APPEARANCE ON AGAR
W-46	Single bacilli	Yellow/grey, transparent, raised
W-47	Streptococci of 4-10 individual cells	Large, orange, irregular edges, flat
W-48	Bacilli chains of 2-4 individual cells	Large, grey/blue, opaque, irregular edges, flat

---

(a)The terms used here are general.
(b)"Bacilli" means rod-like cells.
(c)"Streptococci" means long chains of cocci.
(d)"Cocci" means spherical cells.
(e)"Staphylococci" means grape-like clusters.
(f)"Diplococci" means cocci in pairs.
*Organisms that could not be separated -- probably symbionts.

TABLE F-2

BACTERIA ISOLATES

PART II - ISOLATES PER SAMPLE ON HIGH SALT MEDIA

TABLE F-2

ISOLATES PER SAMPLE ON HIGH SALT MEDIA

SAMPLE #/ LOCATION	ISOLATES	ISOLATION MEDIUM	CELL COUNTS*
<u>BRINES</u>			
AIS Brine - 1[(a)] S90/W200	W-1	1176	15
		974	125
	W-2	1176	1
	W-3	974	2
	W-8	1176	36
		974	22
	W-10	213	40
AIS Brine - 2[(b)] S90/W200	W-1	974	220
	W-2	974	2
		1176	6
	W-3	974	35
	W-4	974	20
	W-5	974	23
	W-6	974	100
	W-7	1176	250
	W-8	1176	41
		974	20
	W-9	1176	55
		974	110
	W-11	1176	6
	W-12	974	4
	W-13	1176	300
	W-21	974	15
	W-22	1176	30
		974	15

TABLE F-2

ISOLATES PER SAMPLE ON HIGH SALT MEDIA (CONTINUED)

SAMPLE #/ LOCATION	ISOLATES	ISOLATION MEDIUM	CELL COUNTS*
	W-23	1176	30
		974	15
	W-24	1176	500
		974	225
	W-25	1176	175
DHP-402A (floor) S1950/E1320	W-13	1176	6
		974	6
	W-14	1176	20
	W-15	1176	14
		974	20
	W-17	974	**
	W-18	213	1140
	W-26	1176	100
		974	150
		213	540
BTP-C1 (floor) S1600/W170	W-13	1176	100
	W-14	1176	35
	W-18	213	4500
	W-19	974	150
	W-20	974	100
BTP-C4 (roof) S1600/W170	W-16	1176	75
		974	570
	W-17	974	**
A1X02 (roof) N1130/E1220	W-15	974	3600
	W-16	974	250
BTP-A2 (floor) S1600/W170	W-13	1176	22
		974	50

TABLE F-2

ISOLATES PER SAMPLE ON HIGH SALT MEDIA
(CONTINUED)

SAMPLE #/ LOCATION	ISOLATES	ISOLATION MEDIUM	CELL COUNTS*
	W-15	1176	33
	W-17	974	**
<u>MUCK</u>			
S1620/W170 (floor)	W-27	974	**
	W-28	974	40
S2200/W30 (floor)	W-29	974	10
Surface Muck Pile	W-48	MORS	30
S90/W200[(c)] (floor)	W-29	974	15
	W-30	MORS	5
	W-31	1176 974	1500 5
	W-32	213	5
	W-33	213	5
	W-34	974	750
	W-35	974	450
	W-36	974	125
	W-37	974	**
	W-38	1176	4000
	W-39	1176	425
	W-40	974	40
	W-41	974	20
	W-42	974	40
	W-43	974	50

TABLE F-2

ISOLATES PER SAMPLE ON HIGH SALT MEDIA
(CONTINUED)

SAMPLE #/ LOCATION	ISOLATES	ISOLATION MEDIUM	CELL COUNTS*
	W-44	974	**
	W-45	1176	2500
	W-46	1176	250
	W-47	213	1750

ALL RIB SURFACE AND RIB CORE SAMPLES SHOWED NO GROWTH

---

* = Counts are CFU per 100 ml of liquid sample, or per gram of salt.
CFU = Colony Forming Units (1 CFU = 1 microorganism).

** = Too many to count (complete overgrowth).

[a] Sampled 7-25-88 (WIPP sample No. 93).

[b] Sampled 8-15-88 (WIPP sample No. 93-B).

[c] Sampled 9-8-88 (AIS Brine saturated muck).

TABLE F-3

BACTERIA ISOLATES

PART III - DESCRIPTION OF ISOLATES ON MEDIA SELECTIVE FOR SPECIAL ORGANISMS

TABLE F-3

DESCRIPTION OF ISOLATES ON MEDIA SELECTIVE FOR SPECIAL ORGANISMS

		MACROMORPHOLOGY ON AGAR PLATES	
SAMPLE NUMBER	ISOLATION MEDIUM	COLONY TYPE	GRAM STAIN REACTION
AIS Brine-1(a)	SDA(b)	White, round, irregular edges	cocci; gram indeterminate
		White, round, smooth edges	cocci; stained black
		Yellow, small, round edges	gram (+) rods and cocci
	S-110(c)	Light yellow, round edges, flat	cocci; gram indeterminate
		Red, round edges, raised	cocci; gram indeterminate
		Yellow, round edges, flat	cocci; stained black
		Large, white, round edges, raised	cocci; stained black
		White, round edges, flat	cocci; gram indeterminate
		Yellow, irregular edges, flat	cocci; stained black
AIS Brine-2(d)	SDA	White, round edges, raised	cocci; gram indeterminate
		Yellow-white, round irregular edges, small	cocci; gram indeterminate
		Yellow, round, irregular edges	cocci; stained black
	S-110	Yellow, round edges, raised	cocci; gram indeterminate
		Yellow-white, round edges, flat	cocci; stained black

TABLE F-3

DESCRIPTION OF ISOLATES ON MEDIA SELECTIVE FOR SPECIAL ORGANISMS
(CONTINUED)

SAMPLE NUMBER	ISOLATION MEDIUM	MACROMORPHOLOGY ON AGAR PLATES COLONY TYPE	GRAM STAIN REACTION
	S-110 (cont'd)	White, round edges, raised	cocci; stained black
		Large, white, irregular edges	cocci; gram indeterminate
	Blood agar	Large, white, round edges, -hemolysis	rods; gram indeterminate
		White, opaque, irregular edges, medium	cocci; stained black
		White, round edges, small, flat, -hemolysis	rods; stained black
		Yellow, wrinkled, irregular edges, small	cocci; gram indeterminate
		Orange, round edges raised, medium	cocci; gram indeterminate
	EMB[e]	Purple, round edges, small (no metallic sheen)	short rods; gram indeterminate
	TSA[f] + 2% cellulose	White, round edges, small	large rods; stained black
		Yellow-white, round edges, small	large rods; gram indeterminate
		Brown, round edges, small	rods; stained black
Muck Pile	SDA	White, swarming	rods; gram (-)
	S-110	White, swarming	rods; gram indeterminate
	Blood agar	Large, opaque, irregular edges, -hemolysis	large rods; indeterminate

TABLE F-3

DESCRIPTION OF ISOLATES ON MEDIA SELECTIVE FOR SPECIAL ORGANISMS
(CONTINUED)

SAMPLE NUMBER	ISOLATION MEDIUM	MACROMORPHOLOGY ON AGAR PLATES COLONY TYPE	GRAM STAIN REACTION
Muck Pile (cont'd)	* EMB	Large, white colonies with small dark individual colonies inside	large rods/cocci; stained black
	TSA + 2% cellulose	Large, white, swarming	rods; gram indeterminate
AIS Brine[g] Saturated	S110	White, large, round edges, raised	cocci; gram indeterminate
Muck S90/W 200		Peach, round edges, raised	cocci; gram indeterminate
		Brown, round edges, flat	cocci; gram indeterminate
	Blood agar	Red, round edges, raised	rods; stained black
		Brown, irregular edges, flat	rods; gram indeterminate
	TSA + 2% cellulose	Brown, mucoid, irregular edges	cocci; stained black
		Orange, round edges, flat	gram (-) rods
		Peach, round edges, raised	gram (-) cocci
BTP-C4	1090 Marine Methanol agar	White, very small, round edges	short rods; stained black
	NOTE:	This same organism grew on EMB, TSA + 2% cellulose, SDA, Blood agar, and McConkey's agar.	

---

* - organisms that could not be separated - probable symbionts.

(a)Sampled 7-25-88 (WIPP sample No. 93).

(b)SDA = Sabouraud's Dextrose Agar.

(c)S-110 = Staphylococcus 110 Medium Agar.

(d)Sampled 8-15-88 (WIPP sample No. 93-B).

(e)EMB = Eosine Methylene Blue Agar.

(f)TSA = Tryptocase Soy Agar.

(g)Sampled 9-8-88 (AIS Brine saturated muck).

APPENDIX G

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT	
				95°C	150°C
MCR 01A	W170/S1957	UNIT 0	37	0.28	0.33
MCR 01B	W170/S1957	UNIT 0	37	0.25	0.29
MCR 02A	W176/S1900	UNIT 0	96	1.10	1.20
MCR 02B	W176/S1900	UNIT 0	96	1.20	1.20
MCR 03A	E310/S2065	UNIT 0	287	0.41	0.45
MCR 03B	E310/S2065	UNIT 0	287	0.63	0.70
MCR 04A	E310/S2140	UNIT 0	287	0.12	0.12
MCR 04B	E310/S2140	UNIT 0	287	0.54	0.57
MCR 05A	E630/S1920	UNIT 0	287	0.37	0.48
MCR 05B	E630/S1920	UNIT 0	395	0.34	0.38
MCR 06A	E1180/S1940	UNIT 0	223	0.65	0.71
MCR 06B	E1180/S1940	UNIT 0	223	0.26	0.26
MCR 07A	E250/S1620	UNIT 0	972	0.99	1.00
MCR 07B	E250/S1620	UNIT 0	972	0.31	0.32
MCR 08A	W176/S1900	UNIT 0	201	0.35	0.38
MCR 08B	W176/S1900	UNIT 0	201	2.36	2.53
MCR 09A	W176/S1880	UNIT 0	201	0.67	0.74
MCR 09B	W176/S1880	UNIT 0	201	0.68	0.74
MCR 10A	W176/S1875	UNIT 0	202	2.15	2.30
MCR 10B	W176/S1875	UNIT 0	202	0.35	0.40
MCR 11A	E922/S1600	UNIT 0	561	0.46	0.51
MCR 11B	E922/S1600	UNIT 0	561	0.66	0.71
MCR 12A	E790/S1600	UNIT 0	596	0.75	0.80
MCR 12B	E790/S1600	UNIT 0	596	0.65	0.69
MCR 13A	E656/S1600	UNIT 0	615	0.86	0.94
MCR 13B	E656/S1600	UNIT 0	615	0.21	0.24
MCR 14A	E790/S1620	UNIT 0	207	0.35	0.38
MCR 14B	E790/S1620	UNIT 0	207	0.71	0.78
MCR 15A	E790/S1720	UNIT 0	215	0.33	0.36
MCR 15B	E790/S1720	UNIT 0	215	0.25	0.27
MCR 16A	E790/S1820	UNIT 0	225	0.35	0.38
MCR 16B	E790/S1820	UNIT 0	225	0.47	0.51
MCR 17A	E790/S1920	UNIT 0	231	0.22	0.26
MCR 17B	E790/S1920	UNIT 0	231	0.73	0.79

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 18A	E790/S1960	UNIT 0	427	0.37	0.41
MCR 18B	E790/S1960	UNIT 0	427	0.21	0.23
MCR 19A	E922/S1960	UNIT 0	426	0.59	0.63
MCR 19B	E922/S1960	UNIT 0	426	0.71	0.74
MCR 20A	E656/S1960	UNIT 0	430	0.50	0.52
MCR 20B	E656/S1960	UNIT 0	430	0.58	0.61
MCR 21A	E712/S1960	UNIT 0	429	0.61	0.64
MCR 21B	E712/S1960	UNIT 0	429	2.76	2.88
MCR 22A	E852/S1960	UNIT 0	427	0.33	0.36
MCR 22B	E852/S1960	UNIT 0	427	0.81	0.83
MCR 23A	E1022/S1590	UNIT 0	567	0.90	0.93
MCR 23B	E1022/S1590	UNIT 0	567	0.65	0.68
MCR 24A	E972/S1590	UNIT 0	568	0.44	0.47
MCR 24B	E972/S1590	UNIT 0	568	0.30	0.31
MCR 25A	E860/S1590	UNIT 0	589	0.60	0.64
MCR 25B	E860/S1590	UNIT 0	589	0.22	0.24
MCR 26A	E729/S1590	UNIT 0	622	0.67	0.69
MCR 26B	E729/S1590	UNIT 0	622	0.41	0.44
MCR 27A	E800/S1670	UNIT 0	232	0.76	0.78
MCR 27B	E800/S1670	UNIT 0	232	0.57	0.60
MCR 28A	E800/S1770	UNIT 0	235	0.57	0.59
MCR 28B	E800/S1770	UNIT 0	235	0.78	0.81
MCR 29A	E800/S1870	UNIT 0	247	0.52	0.54
MCR 29B	E800/S1870	UNIT 0	247	0.34	0.36
MCR 30A	W225/S92	UNIT 0	0	0.15	0.16
MCR 30B	W225/S92	UNIT 0	0	0.60	0.62
MCR 31A	E650/S1620	UNIT 0	260	0.27	0.28
MCR 31B	E650/S1620	UNIT 0	260	0.33	0.34
MCR 32A	E650/S1670	UNIT 0	261	0.56	0.58
MCR 32B	E650/S1670	UNIT 0	261	0.55	0.57
MCR 33A	E650/S1720	UNIT 0	262	0.44	0.45
MCR 33B	E650/S1720	UNIT 0	262	0.48	0.50
MCR 34A	E650/S1770	UNIT 0	265	0.89	0.93

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT	
				95°C	150°C
MCR 34B	E650/S1770	UNIT 0	265	1.13	1.17
MCR 35A	W225/S88	UNIT 0	0	0.35	0.39
MCR 35B	W225/S88	UNIT 0	0	0.91	0.96
MCR 36A	W268/S88	UNIT 0	0	2.99	3.13
MCR 36B	W268/S88	UNIT 0	0	1.61	1.67
MCR 37A	W268/S92	UNIT 0	0	0.52	0.56
MCR 37B	W268/S92	UNIT 0	0	1.59	1.64
MCR 38A	E650/S1820	UNIT 0	268	0.62	0.64
MCR 39A	E650/S1870	UNIT 0	269	0.46	0.47
MCR 39B	E650/S1870	UNIT 0	269	1.31	1.34
MCR 40A	E650/S1920	UNIT 0	270	0.38	0.59
MCR 40B	E650/S1920	UNIT 0	270	0.81	0.85
MCR 41A	W295/S88	UNIT 0	0	0.36	0.39
MCR 41B	W295/S88	UNIT 0	0	0.96	0.99
MCR 42A	W295/S92	UNIT 0	0	1.12	1.17
MCR 42B	W295/S92	UNIT 0	0	0.65	0.68
MCR 43A	E165/N974	UNIT 0	56	0.54	0.59
MCR 43B	E165/N974	UNIT 0	56	0.28	0.31
MCR 44A	E165/N964	UNIT 0	56	1.30	1.36
MCR 44B	E165/N964	UNIT 0	56	1.58	1.64
MCR 44C	E165/N964	UNIT 0	56	0.30	0.33
MCR 45A	E165/N954	UNIT 0	56	0.29	0.34
MCR 45B	E165/N954	UNIT 0	56	0.59	0.63
MCR 46A	E165/N944	UNIT 0	56	0.14	0.16
MCR 46B	E165/N944	UNIT 0	56	0.40	0.46
MCR 46C	E165/N944	UNIT 0	56	0.30	0.34
MCR 50B	E160/N936	UNIT 0	56	0.23	0.26
MCR 54A	E143/N949	UNIT 0	56	0.46	0.53
MCR 54B	E143/N949	UNIT 0	56	0.52	0.55
MCR 55A	E145/N959	UNIT 0	56	0.22	0.23
MCR 55B	E145/N959	UNIT 0	56	0.53	0.53
MCR 56A	E145/N969	UNIT 0	56	6.67	6.85
MCR 56B	E145/N969	UNIT 0	56	0.36	0.36

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	CUMULATIVE PERCENT WEIGHT LOSS AT 150°C
MCR 57A	E145/N979	UNIT 0	56	0.57	0.59
MCR 57B	E145/N979	UNIT 0	56	0.94	0.98
MCR 61A	E140/N996	UNIT 0	57	0.26	0.26
MCR 61B	E140/N996	UNIT 0	57	0.44	0.45
MCR 62A	E140/N1030	UNIT 0	1744	0.24	0.27
MCR 62B	E140/N1030	UNIT 0	1744	0.70	0.74
MCR 63A	E140/N1040	UNIT 0	1744	0.39	0.43
MCR 63B	E140/N1040	UNIT 0	1744	0.58	0.60
MCR 64A	E140/N1050	UNIT 0	1744	0.57	0.61
MCR 64B	E140/N1050	UNIT 0	1744	0.59	0.62
MCR 65A	W610/S72	UNIT 0	34	0.38	0.41
MCR 65B	W610/S72	UNIT 0	34	0.51	0.53
MCR 68A	W615/S2	UNIT 0	1	0.37	0.40
MCR 68B	W615/S2	UNIT 0	1	0.51	0.54
MCR 69A	W615/N17	UNIT 0	1	0.17	0.20
MCR 69B	W615/N17	UNIT 0	1	0.42	0.45
MCR 72A	W630/S115	UNIT 0	34	0.35	0.36
MCR 72B	W630/S115	UNIT 0	34	1.09	1.11
MCR 73A	W620/S125	UNIT 0	34	0.41	0.43
MCR 73B	W620/S125	UNIT 0	34	0.92	0.96
MCR 74A	W570/S90	UNIT 0	43	0.32	0.35
MCR 74B	W570/S80	UNIT 0	43	0.79	0.82
MCR 75A	W560/S80	UNIT 0	43	0.41	0.45
MCR 75B	W560/S80	UNIT 0	43	0.20	0.22
MCR 76A	W550/S80	UNIT 0	43	0.45	0.47
MCR 76B	W550/S80	UNIT 0	43	0.38	0.40
MCR 77B	W198/N310	UNIT 0	2	0.32	0.35
MCR 78A	W208/N305	UNIT 0	1	0.47	0.52
MCR 78B	W208/N305	UNIT 0	1	0.17	0.23
MCR 79A	W333/N305	UNIT 0	1	0.53	0.57
MCR 79B	W333/N305	UNIT 0	1	0.08	0.09
MCR 83A	W632/S115	UNIT 0	3	0.83	0.88
MCR 83B	W632/S115	UNIT 0	3	1.59	1.65

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 84B	W600/N150	UNIT 0	1	0.51	0.58
MCR 85A	E586/N1410	UNIT 0	145	10.71	0.80
MCR 85B	E586/N1410	UNIT 0	145	10.49	0.55
MCR 01C	W170/S1957	UNIT 1	37	0.03	0.03
MCR 02C	W176/S1900	UNIT 1	96	0.05	0.07
MCR 03C	E310/S2065	UNIT 1	287	0.09	0.12
MCR 04C	E310/S2140	UNIT 1	287	0.18	0.21
MCR 05C	E630/S1920	UNIT 1	395	0.19	0.25
MCR 07C	E250/S1620	UNIT 1	972	0.17	0.22
MCR 08C	W176/S1900	UNIT 1	201	0.13	0.15
MCR 10C	W176/S1875	UNIT 1	202	0.18	0.20
MCR 11C	E922/S1600	UNIT 1	561	0.27	0.30
MCR 12C	E790/S1600	UNIT 1	596	0.39	0.43
MCR 13C	E656/S1600	UNIT 1	615	0.21	0.24
MCR 14C	E790/S1620	UNIT 1	207	0.19	0.22
MCR 15C	E790/S1720	UNIT 1	215	0.10	0.11
MCR 16C	E790/S1820	UNIT 1	225	0.71	0.74
MCR 17C	E790/S1920	UNIT 1	231	0.41	0.44
MCR 18C	E790/S1960	UNIT 1	427	0.16	0.17
MCR 20C	E656/S1960	UNIT 1	430	0.35	0.36
MCR 21C	E712/S1960	UNIT 1	429	0.30	0.31
MCR 23C	E1022/S1590	UNIT 1	567	0.94	0.99
MCR 24C	E972/S1590	UNIT 1	568	0.19	0.19
MCR 25C	E860/S1590	UNIT 1	589	0.14	0.14
MCR 26C	E729/S1590	UNIT 1	622	0.28	0.29
MCR 27C	E800/S1670	UNIT 1	232	0.30	0.31
MCR 28C	E800/S1770	UNIT 1	235	0.18	0.18
MCR 29C	E800/S1870	UNIT 1	247	0.19	0.19
MCR 30C	W225/S92	UNIT 1	0	0.08	0.09
MCR 31C	E650/S1620	UNIT 1	260	0.31	0.32
MCR 32C	E650/S1670	UNIT 1	261	0.33	0.35
MCR 33C	E650/S1720	UNIT 1	262	0.21	0.22

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES (CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT	
				95°C	150°C
MCR 34C	E650/S1770	UNIT 1	265	0.43	0.45
MCR 35C	W225/S88	UNIT 1	0	0.06	0.08
MCR 36C	W268/S88	UNIT 1	0	0.07	0.08
MCR 37C	W268/S92	UNIT 1	0	0.10	0.12
MCR 38C	E650/S1820	UNIT 1	268	0.19	0.19
MCR 39C	E650/S1870	UNIT 1	269	0.13	0.13
MCR 40C	E650/S1920	UNIT 1	270	0.42	0.44
MCR 41C	W295/S88	UNIT 1	0	0.07	0.08
MCR 42C	W295/S92	UNIT 1	0	0.17	0.19
MCR 43C	E165/N974	UNIT 1	56	0.16	0.19
MCR 45C	E165/N954	UNIT 1	56	0.06	0.08
MCR 47C	E163/N942	UNIT 1	56	0.18	0.19
MCR 48C	E162/N940	UNIT 1	56	0.36	0.40
MCR 49C	E161/N938	UNIT 1	56	0.17	0.19
MCR 51C	E160/N865	UNIT 1	1744	0.16	0.20
MCR 53C	E160/N845	UNIT 1	1744	0.14	0.16
MCR 54C	E143/N949	UNIT 1	56	0.14	0.16
MCR 55C	E145/N959	UNIT 1	56	0.18	0.18
MCR 56C	E145/N969	UNIT 1	56	0.16	0.16
MCR 57C	E145/N979	UNIT 1	56	0.10	0.10
MCR 58C	E144/N984	UNIT 1	56	0.15	0.16
MCR 59C	E143/N988	UNIT 1	56	0.24	0.24
MCR 60C	E142/N992	UNIT 1	56	0.19	0.19
MCR 61C	E140/N996	UNIT 1	57	0.10	0.11
MCR 62C	E140/N1030	UNIT 1	1744	0.19	0.22
MCR 63C	E140/N1040	UNIT 1	1744	0.19	0.20
MCR 65C	W610/S72	UNIT 1	34	0.16	0.17
MCR 68C	W615/S2	UNIT 1	1	0.08	0.10
MCR 69C	W615/N17	UNIT 1	1	0.06	0.07
MCR 72C	W630/S115	UNIT 1	34	0.15	0.15
MCR 73C	W620/S125	UNIT 1	34	0.14	0.18
MCR 74C	W570/S80	UNIT 1	43	0.22	0.23
MCR 75C	W560/S80	UNIT 1	43	0.12	0.13

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 76C	W550/S80	UNIT 1	43	0.11	0.12
MCR 77C	W198/N310	UNIT 1	2	0.17	0.19
MCR 78C	W208/N305	UNIT 1	1	0.10	0.13
MCR 79C	W333/N305	UNIT 1	1	0.09	0.12
MCR 83C	W632/S115	UNIT 1	3	0.06	0.09
MCR 84C	W600/N150	UNIT 1	1	0.20	0.25
MCR 85C	E586/N1410	UNIT 1	1451	0.26	0.32
MCR 01D	W170/S1957	UNIT 2	37	1.20	1.20
MCR 06C	E1180/S1940	UNIT 2	223	1.70	1.80
MCR 08D	W176/S1900	UNIT 2	201	0.60	0.64
MCR 10D	W176/S1875	UNIT 2	202	0.51	0.56
MCR 12D	E790/S1600	UNIT 2	596	0.63	0.67
MCR 14D	E790/S1620	UNIT 2	207	0.34	0.38
MCR 17D	E790/S1920	UNIT 2	231	0.39	0.42
MCR 18D	E790/S1960	UNIT 2	427	0.22	0.23
MCR 19C	E922/S1960	UNIT 2	426	0.51	0.53
MCR 19D	E922/S1960	UNIT 2	426	0.39	0.41
MCR 20D	E656/S1960	UNIT 2	430	0.36	0.38
MCR 22C	E852/S1960	UNIT 2	427	1.20	1.25
MCR 23D	E1022/S1590	UNIT 2	567	1.17	1.23
MCR 24D	E972/S1590	UNIT 2	569	0.73	0.77
MCR 25D	E860/S1590	UNIT 2	589	0.91	0.94
MCR 28D	E800/S1770	UNIT 2	235	0.72	0.75
MCR 29D	E800/S1870	UNIT 2	247	1.47	1.52
MCR 30D	W225/S92	UNIT 2	0	1.11	1.17
MCR 31D	E650/S1620	UNIT 2	260	0.98	1.01
MCR 32D	E650/S1670	UNIT 2	261	1.21	1.23
MCR 33D	E650/S1720	UNIT 2	262	0.42	0.43
MCR 34D	E650/S1770	UNIT 2	265	0.30	0.30
MCR 35D	W225/S88	UNIT 2	0	0.51	0.54
MCR 36D	W268/S88	UNIT 2	0	0.72	0.76
MCR 37D	W268/S92	UNIT 2	0	0.78	0.81

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 38D	E650/S1820	UNIT 2	268	0.94	0.97
MCR 39D	E650/S1870	UNIT 2	269	0.31	0.32
MCR 40D	E650/S1920	UNIT 2	270	0.42	0.43
MCR 41D	W295/S88	UNIT 2	0	1.65	1.71
MCR 42D	W295/S92	UNIT 2	0	0.48	0.51
MCR 43D	E165/N974	UNIT 2	56	0.49	0.52
MCR 44D	E165/N964	UNIT 2	56	0.49	0.52
MCR 45D	E165/N954	UNIT 2	56	0.87	0.92
MCR 52D	E160/N855	UNIT 2	1744	1.40	1.47
MCR 53D	E160/N845	UNIT 2	1744	1.15	1.25
MCR 54D	E143/N949	UNIT 2	56	0.43	0.45
MCR 57D	E145/N979	UNIT 2	56	1.33	1.37
MCR 61D	E140/N996	UNIT 2	57	0.58	0.59
MCR 62D	E140/N1030	UNIT 2	1744	0.59	0.62
MCR 63D	E140/N1040	UNIT 2	1744	0.89	0.93
MCR 65D	W610/S72	UNIT 2	34	0.68	0.70
MCR 68D	W615/S2	UNIT 2	1	0.52	0.56
MCR 69D	W615/N17	UNIT 2	1	0.27	0.30
MCR 72D	W630/S115	UNIT 2	34	0.79	0.81
MCR 73D	W620/S125	UNIT 2	34	0.97	1.01
MCR 75D	W560/S80	UNIT 2	43	0.52	0.54
MCR 76D	W550/S80	UNIT 2	43	0.67	0.69
MCR 77D	W198/N310	UNIT 2	2	0.79	0.84
MCR 78D	W208/N305	UNIT 2	1	0.45	0.52
MCR 79D	W333/N305	UNIT 2	1	0.39	0.41
MCR 83D	W632/S115	UNIT 2	3	1.09	1.14
MCR 84D	W600/N150	UNIT 2	1	0.75	0.82
MCR 85D	E586/N1410	UNIT 2	1451	0.45	0.52
MCR 01E	W170/S1957	UNIT 3	37	0.01	0.04
MCR 02E	W176/S1900	UNIT 3	96	0.04	0.04
MCR 03E	E310/S2065	UNIT 3	287	0.06	0.10
MCR 03D	E310/S2065	UNIT 3	287	0.20	0.24

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 04D	E310/S2140	UNIT 3	287	0.34	0.38
MCR 05D	E630/S1920	UNIT 3	395	0.24	0.29
MCR 05E	E630/S1920	UNIT 3	395	0.14	0.17
MCR 06E	E1180/S1940	UNIT 3	223	0.12	0.14
MCR 06D	S1180/S1940	UNIT 3	223	0.13	0.14
MCR 07D	E250/S1620	UNIT 3	972	0.16	0.17
MCR 08E	W176/S1900	UNIT 3	201	0.15	0.18
MCR 09D	W176/S1880	UNIT 3	201	0.23	0.27
MCR 10E	W176/S1875	UNIT 3	202	0.20	0.22
MCR 11D	E922/S1600	UNIT 3	561	0.33	0.36
MCR 12E	E790/S1600	UNIT 3	596	0.24	0.26
MCR 13D	E656/S1600	UNIT 3	615	0.51	0.57
MCR 14E	E790/S1620	UNIT 3	207	0.30	0.32
MCR 15D	E790/S1720	UNIT 3	215	0.22	0.24
MCR 16D	E790/S1820	UNIT 3	225	0.54	0.57
MCR 16E	E790/S1820	UNIT 3	225	0.11	0.12
MCR 17E	E790/S1920	UNIT 3	231	0.22	0.25
MCR 18E	E790/S1960	UNIT 3	427	0.21	0.24
MCR 21D	E712/S1960	UNIT 3	429	0.16	0.17
MCR 21E	E712/S1960	UNIT 3	429	0.26	0.27
MCR 24E	E972/S1590	UNIT 3	569	0.12	0.12
MCR 26E	E729/S1590	UNIT 3	622	0.19	0.19
MCR 27D	E800/S1670	UNIT 3	232	0.39	0.39
MCR 27E	E800/S1670	UNIT 3	232	0.30	0.31
MCR 29E	E800/S1870	UNIT 3	247	0.27	0.29
MCR 34E	E650/S1770	UNIT 3	265	0.23	0.24
MCR 39E	E650/S1870	UNIT 3	268	0.15	0.16
MCR 43E	E165/N974	UNIT 3	56	0.22	0.25
MCR 46D	E165/N944	UNIT 3	56	0.30	0.33
MCR 47E	E163/N942	UNIT 3	56	0.11	0.12
MCR 51D	E160/N865	UNIT 3	1744	0.20	0.23
MCR 51E	E160/N865	UNIT 3	1744	0.30	0.34
MCR 52E	E160/N855	UNIT 3	1744	0.26	0.29

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT	
				95°C	150°C
MCR 53E	E160/N845	UNIT 3	1744	0.20	0.23
MCR 55D	E145/N959	UNIT 3	56	0.77	0.78
MCR 57E	E145/N979	UNIT 3	56	0.46	0.46
MCR 58E	E144/N984	UNIT 3	56	0.28	0.29
MCR 59E	E143/N988	UNIT 3	56	0.31	0.32
MCR 60E	E142/N992	UNIT 3	56	0.21	0.21
MCR 61E	E140/N996	UNIT 3	57	0.35	0.35
MCR 62E	E140/N1030	UNIT 3	1744	0.63	0.67
MCR 63E	E140/N1040	UNIT 3	1744	0.13	0.14
MCR 64E	E140/N1050	UNIT 3	1744	0.21	0.23
MCR 65E	W610/S72	UNIT 3	34	0.24	0.26
MCR 68E	W615/S2	UNIT 3	1	0.13	0.16
MCR 69E	W615/N17	UNIT 3	1	0.13	0.15
MCR 72E	W630/S115	UNIT 3	34	0.84	0.85
MCR 74D	W570/S80	UNIT 3	43	0.17	0.18
MCR 74E	W570/S80	UNIT 3	43	0.24	0.26
MCR 75E	W560/S80	UNIT 3	43	0.21	0.23
MCR 76E	W550/S80	UNIT 3	43	0.30	0.32
MCR 78E	W208/N305	UNIT 3	1	0.11	0.14
MCR 79E	W333/N305	UNIT 3	1	0.09	0.11
MCR 83E	W632/S115	UNIT 3	3	0.23	0.26
MCR 84E	W600/N150	UNIT 3	1	0.13	0.17
MCR 85E	E586/N1410	UNIT 3	1451	0.12	0.17
MCR 86F	E626/N1410	UNIT 3	1449	0.23	0.30
MCR 86E	E626/N1410	UNIT 3	1449	0.15	0.21
MCR 01F	W170/S1957	UNIT 4	37	0.25	0.29
MCR 02F	W176/S1900	UNIT 4	96	0.56	0.66
MCR 03F	E310/S2065	UNIT 4	287	1.60	1.70
MCR 04E	E310/S2140	UNIT 4	287	0.04	0.06
MCR 04F	E310/S2140	UNIT 4	287	0.42	0.49
MCR 05F	E630/S1920	UNIT 4	395	2.00	2.10
MCR 06F	E1180/S1940	UNIT 4	223	0.54	0.55

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 07E	E250/S1620	UNIT 4	972	0.39	0.42
MCR 07F	E250/S1620	UNIT 4	972	1.70	1.70
MCR 08F	W176/S1900	UNIT 4	201	0.36	0.39
MCR 09E	W176/S1880	UNIT 4	201	0.34	0.40
MCR 09F	W176/S1880	UNIT 4	201	0.35	0.41
MCR 10F	W176/S1875	UNIT 4	202	1.21	1.30
MCR 11E	E922/S1600	UNIT 4	561	0.36	0.39
MCR 11F	E922/S1600	UNIT 4	561	2.30	2.48
MCR 12F	E790/S1600	UNIT 4	596	0.72	0.78
MCR 13E	E656/S1600	UNIT 4	615	0.91	0.98
MCR 14F	E790/S1620	UNIT 4	207	3.75	4.01
MCR 15E	E790/S1720	UNIT 4	215	0.78	0.84
MCR 15F	E790/S1720	UNIT 4	215	0.85	0.90
MCR 16F	E790/S1820	UNIT 4	225	3.12	3.35
MCR 17F	E790/S1920	UNIT 4	231	0.42	0.47
MCR 18F	E790/S1960	UNIT 4	427	0.59	0.65
MCR 19E	E922/S1960	UNIT 4	426	0.47	0.49
MCR 20E	E656/S1960	UNIT 4	430	0.24	0.25
MCR 20F	E656/S1960	UNIT 4	430	0.96	1.01
MCR 21F	E712/S1960	UNIT 4	429	0.61	0.64
MCR 22D	E852/S1960	UNIT 4	427	0.64	0.68
MCR 22E	E852/S1960	UNIT 4	427	0.38	0.40
MCR 22F	E852/S1960	UNIT 4	427	2.33	2.47
MCR 23E	E1022/S1590	UNIT 4	567	0.45	0.47
MCR 23F	E1022/S1590	UNIT 4	567	1.41	1.47
MCR 24F	E972/S1590	UNIT 4	569	3.47	3.60
MCR 25E	E860/S1590	UNIT 4	589	0.45	0.48
MCR 25F	E860/S1590	UNIT 4	589	2.49	2.65
MCR 26F	E729/S1590	UNIT 4	622	1.67	1.73
MCR 27F	E800/S1670	UNIT 4	232	1.18	1.22
MCR 28E	E800/S1770	UNIT 4	235	0.32	0.33
MCR 28F	E800/S1770	UNIT 4	235	1.60	1.65
MCR 29F	E800/S1870	UNIT 4	247	0.62	0.66

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT	
				95°C	150°C
MCR 30E	W225/S92	UNIT 4	0	0.20	0.24
MCR 30F	W225/S92	UNIT 4	0	0.21	0.23
MCR 31E	E650/S1620	UNIT 4	260	0.60	0.63
MCR 31F	E650/S1620	UNIT 4	260	0.76	0.78
MCR 32E	E650/S1670	UNIT 4	261	0.30	0.30
MCR 32F	E650/S1670	UNIT 4	261	1.61	1.66
MCR 33E	E650/S1720	UNIT 4	262	0.43	0.44
MCR 33F	E650/S1720	UNIT 4	262	3.40	3.51
MCR 34F	E650/S1770	UNIT 4	265	1.07	1.11
MCR 35E	W225/S88	UNIT 4	0	0.23	0.27
MCR 35F	W225/S88	UNIT 4	0	0.26	0.27
MCR 36E	W268/S88	UNIT 4	0	0.35	0.37
MCR 36F	W268/S88	UNIT 4	0	0.41	0.43
MCR 37E	W268/S92	UNIT 4	0	0.34	0.39
MCR 37F	W268/S92	UNIT 4	0	0.43	0.47
MCR 38E	E650/S1820	UNIT 4	268	0.60	0.62
MCR 38F	E650/S1820	UNIT 4	268	1.40	1.44
MCR 39F	E650/S1870	UNIT 4	268	3.51	3.66
MCR 40E	E650/S1920	UNIT 4	270	0.29	0.31
MCR 40F	E650/S1920	UNIT 4	270	2.06	2.13
MCR 41E	W295/S88	UNIT 4	0	0.24	0.29
MCR 41F	W295/S88	UNIT 4	0	0.63	0.67
MCR 42E	W295/S92	UNIT 4	0	0.22	0.25
MCR 42F	W295/S92	UNIT 4	0	0.58	0.62
MCR 43F	E165/N974	UNIT 4	56	1.22	1.27
MCR 44E	E165/N964	UNIT 4	56	0.26	0.29
MCR 44F	E165/N964	UNIT 4	56	0.53	0.56
MCR 45E	E165/M954	UNIT 4	56	0.36	0.39
MCR 46E	E165/N944	UNIT 4	56	0.27	0.31
MCR 46F	E165/N944	UNIT 4	56	1.05	1.12
MCR 48E	E162/N940	UNIT 4	56	0.35	0.38
MCR 49E	E161/N938	UNIT 4	56	0.23	0.26
MCR 50E	E160/N936	UNIT 4	56	0.35	0.39

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES (CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 50F	E160/N936	UNIT 4	56	0.40	0.44
MCR 52F	E160/N855	UNIT 4	1744	0.57	0.62
MCR 53F	E160/N845	UNIT 4	1744	1.16	1.22
MCR 54E	E143/N949	UNIT 4	56	0.66	0.71
MCR 55E	E145/N959	UNIT 4	56	0.37	0.38
MCR 55F	E145/N959	UNIT 4	56	0.46	0.46
MCR 56E	E145/N969	UNIT 4	56	0.48	0.49
MCR 56F	E145/N969	UNIT 4	56	1.12	1.14
MCR 57F	E145/N979	UNIT 4	56	2.23	2.27
MCR 61F	E140/N996	UNIT 4	57	2.79	2.82
MCR 62F	E140/N1030	UNIT 4	1744	1.37	1.42
MCR 63F	E140/N1040	UNIT 4	1744	0.31	0.34
MCR 64F	E140/N1050	UNIT 4	1744	0.58	0.62
MCR 65F	W610/S72	UNIT 4	34	0.69	0.72
MCR 66F	W615/S25	UNIT 4	24	1.23	1.29
MCR 68F	W615/S2	UNIT 4	1	0.39	0.42
MCR 69F	W615/N1	UNIT 4	1	0.44	0.47
MCR 72F	W630/S115	UNIT 4	34	0.43	0.44
MCR 73E	W620/S125	UNIT 4	34	0.12	0.13
MCR 73F	W620/S125	UNIT 4	34	0.32	0.34
MCR 74F	W570/S80	UNIT 4	43	0.88	0.92
MCR 75F	W560/S80	UNIT 4	43	0.59	0.60
MCR 76F	W550/S80	UNIT 4	43	0.70	0.76
MCR 77E	W198/N310	UNIT 4	2	0.41	0.46
MCR 77F	W198/N310	UNIT 4	2	0.37	0.41
MCR 78F	W208/N305	UNIT 4	1	0.25	0.26
MCR 79F	W333/N305	UNIT 4	1	0.46	0.50
MCR 83F	W635/SS115	UNIT 4	3	1.28	1.34
MCR 84F	W600/N150	UNIT 4	1	1.25	1.35
MCR 85F	E586/N1410	UNIT 4	1451	0.75	0.87
MCR 86X	E626/N1410	UNIT 4	1449	0.78	0.86
MCR 19F	E922/S1960	UNIT 5	426	2.76	2.92

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 45F	E165/N954	UNIT 5	56	0.86	0.91
MCR 66G	W615/S25	UNIT 6	24	0.12	0.13
MCR 67G	W615/S2	UNIT 6	24	0.09	0.10
MCR 67H	W615/S2	UNIT 6	24	0.09	0.10
MCR 67I	W615/S2	UNIT 6	24	0.10	0.11
MCR 68G	W615/N9	UNIT 6	24	0.20	0.22
MCR 68H	W615/N9	UNIT 6	24	0.02	0.02
MCR 68I	W615/N9	UNIT 6	24	0.05	0.06
MCR 68J	W615/N9	UNIT 6	24	0.27	0.28
MCR 69G	W615/N17	UNIT 6	1	0.32	0.36
MCR 69H	W615/N17	UNIT 6	24	0.07	0.08
MCR 69I	W615/N17	UNIT 6	24	0.13	0.13
MCR 70I	W620/N38	UNIT 6	23	0.05	0.08
MCR 86G	E626/N1410	UNIT 6	1449	0.24	0.30
MCR 86H	E626/N1410	UNIT 6	1449	0.07	0.11
MCR 86I	E626/N1410	UNIT 6	1449	0.07	0.11
MCR 87G	E669/N1410	UNIT 6	1445	0.45	0.53
MCR 87H	E699/N1410	UNIT 6	1445	0.08	0.12
MCR 87I	E699/N1410	UNIT 6	1445	0.11	0.15
MCR 87J	E699/N1410	UNIT 6	1445	0.59	0.65
MCR 88H	E732/N1410	UNIT 6	1444	0.16	0.21
MCR 88I	E732/N1410	UNIT 6	1444	0.19	0.23
MCR 88J	E732/N1410	UNIT 6	1444	0.14	0.18
MCR 67J	W615/S2	UNIT 7	24	0.14	0.15
MCR 67K	W615/S2	UNIT 7	24	0.66	0.69
MCR 68K	W615/N9	UNIT 7	24	0.42	0.43
MCR 68L	W615/N9	UNIT 7	24	0.38	0.39
MCR 69J	W615/N17	UNIT 7	24	0.30	0.30
MCR 69K	W615/N17	UNIT 7	24	0.33	0.34
MCR 69L	W615/N17	UNIT 7	24	0.27	0.29
MCR 70J	W620/N38	UNIT 7	23	1.64	1.65

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 70K	W620/N38	UNIT 7	23	0.13	0.15
MCR 70L	W620/N38	UNIT 7	23	0.27	0.27
MCR 80L	E1490/N1530	UNIT 7	1395	0.46	0.51
MCR 81L	E1480/N1525	UNIT 7	1395	0.27	0.29
MCR 82L	E1480/N1515	UNIT 7	1395	0.31	0.34
MCR 86J	E626/N1410	UNIT 7	1449	0.25	0.31
MCR 86K	E626/N1410	UNIT 7	1170	0.27	0.33
MCR 87K	E699/N1410	UNIT 7	1445	0.39	0.45
MCR 88K	E732/N1410	UNIT 7	1444	0.33	0.38
MCR 88L	E732/N1410	UNIT 7	1443	0.40	0.47
MCR 89K	E777/N1410	UNIT 7	1442	0.21	0.27
MCR 89L	E777/N1410	UNIT 7	1442	0.92	0.97
MCR 80O	E1490/N1530	UNIT 9	1395	0.09	0.12
MCR 80P	E1490/N1530	UNIT 9	1395	0.07	0.09
MCR 80Q	E1490/N1530	UNIT 9	1395	0.06	0.09
MCR 80R	E1490/N1530	UNIT 9	1395	0.11	0.14
MCR 81Q	E1480/N1525	UNIT 9	1395	0.08	0.11
MCR 81R	E1480/N1525	UNIT 9	1395	0.06	0.08
MCR 81O	E1480/N1525	UNIT 9	1395	0.08	0.11
MCR 81P	E1480/N1525	UNIT 9	1395	0.08	0.10
MCR 82Q	E1480/N1515	UNIT 9	1395	0.05	0.07
MCR 82R	E1480/N1515	UNIT 9	1395	0.06	0.08
MCR 82O	E1480/N1515	UNIT 9	1395	0.05	0.06
MCR 82P	E1480/N1515	UNIT 9	1395	0.05	0.07
MCR 88O	E732/N1410	UNIT 9	1443	0.06	0.10
MCR 88P	E732/N1410	UNIT 9	1443	0.07	0.09
MCR 88Q	E732/N1410	UNIT 9	1443	0.06	0.09
MCR 88R	E732/N1410	UNIT 9	1170	0.10	0.14
MCR 89O	E777/N1410	UNIT 9	1442	0.08	0.11
MCR 89P	E777/N1410	UNIT 9	1442	0.08	0.11
MCR 89Q	E777/N1410	UNIT 9	1442	0.08	0.10
MCR 89R	E777/N1410	UNIT 9	1442	0.09	0.12

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 90O	E827/N1410	UNIT 9	1440	0.07	0.09
MCR 90P	E827/N1410	UNIT 9	1440	0.08	0.10
MCR 90Q	E827/N1410	UNIT 9	1440	0.07	0.86
MCR 90R	E827/N1410	UNIT 9	1440	0.10	0.14
MCR 91O	E875/N1410	UNIT 9	1438	0.09	0.11
MCR 91P	E875/N1410	UNIT 9	1438	0.10	0.19
MCR 91Q	E875/N1410	UNIT 9	1438	0.09	0.11
MCR 91R	E875/N1410	UNIT 9	1438	0.08	0.11
MCR 80S	E1490/N1530	UNIT 11	1395	0.98	1.07
MCR 81S	E1480/N1525	UNIT 11	1395	0.23	0.26
MCR 82S	E1480/N1515	UNIT 11	1395	0.16	0.18
MCR 89S	E777/N1410	UNIT 11	1442	0.76	0.83
MCR 90S	E827/N1410	UNIT 11	1440	0.42	0.48
MCR 91S	E875/N1410	UNIT 11	1438	0.94	1.03
MCR 80T	E1490/N1530	UNIT 12	1395	0.14	0.18
MCR 80U	E1490/N1530	UNIT 12	1395	0.10	0.14
MCR 81T	E1480/N1525	UNIT 12	1395	0.14	0.16
MCR 81U	E1480/N1525	UNIT 12	1395	0.07	0.08
MCR 82T	E1480/N1515	UNIT 12	1395	0.17	0.20
MCR 82U	E1480/N1515	UNIT 12	1395	0.16	0.18
MCR 89T	E777/N1410	UNIT 12	1442	0.11	0.14
MCR 90T	E827/N1410	UNIT 12	1440	0.05	0.06
MCR 90U	E827/N1410	UNIT 12	1440	0.16	0.19
MCR 91T	E875/N1410	UNIT 12	1438	0.17	0.21
MCR 91U	E875/N1410	UNIT 12	1438	0.11	0.14
MCR 80V	E1490/N1530	UNIT 13	1395	0.10	0.13
MCR 81V	E1480/N1525	UNIT 13	1395	0.05	0.07
MCR 82V	E1480/N1515	UNIT 13	1395	0.21	0.24
MCR 80W	E1490/N1530	UNIT 14	1395	0.31	0.34

TABLE G-1

SUMMARY OF CURRENT MOISTURE CONTENT ANALYSES
(CONTINUED)

SAMPLE NO.	LOCATION	GEOLOGICAL UNIT	SAMPLED DAYS AFTER EXCAVATION	CUMULATIVE PERCENT WEIGHT LOSS AT 95°C	150°C
MCR 80W	E1490/N1530	UNIT 14	1395	0.31	0.34
MCR 81W	E1480/N1525	UNIT 14	1395	0.15	0.18
MCR 82W	E1480/N1515	UNIT 14	1395	0.23	0.27
MCR 68N	W615/N9	ANHYD "b"	24	0.07	0.09
MCR 69N	W615/N17	ANHYD "b"	24	0.15	0.18
MCR 88N	E732/N1410	ANHYD "b"	1443	1.44	1.54
MCR 70N	W620/N38	ANHYD "b"	23	0.53	0.58
MCR 71N	W630/N17	ANHYD "b"	24	0.14	0.16
MCR 68M	W615/N9	CLAY G	24	1.56	1.81
MCR 69M	W615/N17	CLAY G	24	2.44	2.64
MCR 70M	W620/N38	CLAY G	23	1.56	1.70
MCR 71M	W630/N17	CLAY G	24	1.42	1.52
MCR 80M	E1490/N1530	CLAY G	1395	1.34	1.43
MCR 81M	E1480/N1525	CLAY G	1395	2.06	2.20
MCR 82M	E1480/N1515	CLAY G	1395	1.82	1.92
MCR 89M	E777/N1410	CLAY G	1442	1.74	1.81
MCR 13F	E656/S1600	CLAY F	615	3.94	4.29
MCR 51F	E160/N865	CLAY F	1744	1.89	2.05
MCR 54F	E143/N949	CLAY F	56	0.87	0.92
MCR 02D	W176/S1900	SOL PIT	96	0.24	0.28
MCR 09C	W176/S1880	SOL PIT	201	0.11	0.13
MCR 26D	E729/S1590	SOL PIT	622	0.40	0.42
MCR 38B	E650/S1820	SOL PIT	268	0.59	0.61
MCR 50C	E160/N936	SOL PIT	56	0.52	0.55
MCR 50D	E160/N936	SOL PIT	56	0.71	0.76
MCR 52C	E160/N855	SOL PIT	1744	0.29	0.33
MCR 56D	E145/N969	SOL PIT	56	0.65	0.65
MCR 64C	E140/N1050	SOL PIT	1744	0.12	0.14
MCR 64D	E140/N1050	SOL PIT	1744	0.29	0.31

APPENDIX H

STRATIGRAPHY, INDUCTION LOGS, CONDUCTIVITIES AND MOISTURE CONTENT OF SELECTED BOREHOLES AT WIPP

TAB[illegible] H-1

DESCRIPTION OF GENERALIZED STRATIGRAPHY

APPROXIMATE DISTANCE FROM CLAY G m (ft)	STRATIGRAPHIC UNIT	DESCRIPTION
20.12 to 21.21 (66.0 to 69.6)	Polyhalitic Halite (PH-7)	Clear to moderate reddish orange/brown, fine to coarsely crystalline, <1-3% polyhalite.
19.29 to 20.12 (63.3 to 66.0)	Halite (H-9)	Clear to light moderate reddish orange, medium to coarsely crystalline, ≤1% polyhalite. May contain ≤1% brown and gray clay.
17.47 to 19.29 (57.3 to 63.3)	Polyhalitic Halite (PH-6)	Clear to moderate reddish orange/brown, medium to coarsely crystalline, <1-3% polyhalite. May contain traces of gray clay and/or scattered anhydrite.
16.82 to 17.47 (55.2 to 57.3)	Argillaceous Halite (AH-4)	Clear to moderate brown, medium to coarsely crystalline. <1-3% brown clay. Intercrystalline and discontinuous breaks. In one core hole, consists of a one-inch thick clay seam. Unit can vary up to four feet in thickness. Contact with lower unit is gradational.
14.17 to 16.82 (46.5 to 55.2)	Halite (H-8)	Clear to moderate reddish orange and moderate brown, coarsely crystalline, some medium. F1% brown clay, locally argillaceous (clays M-1 and M-2). Scattered anhydrite stringers locally.
13.05 to 14.17 (42.8 to 46.5)	Polyhalitic Halite (PH-5)	Clear to moderate reddish orange, some moderate brown, coarsely crystalline. <1-3% polyhalite. 0-1% brown and some gray clay. Scattered anhydrite locally. Contact with unit below is fairly sharp.
11.58 to 13.05 (38.0 to 42.8)	Argillaceous Halite (AH-3)	Clear to moderate brown, medium to coarsely crystalline, some fine. <1-5% brown clay. Locally contains 10% clay. Intercrystalline and scattered breaks. Locally contains partings and seams. Contact with lower unit is gradational based on increased clay content. Average range of unit is 38.0 to 42.8 feet above Clay G, but does vary from 33.8 to 46 feet.

TABLE H-1

DESCRIPTION OF GENERALIZED STRATIGRAPHY
(CONTINUED)

APPROXIMATE DISTANCE FROM CLAY G m (ft)	STRATIGRAPHIC UNIT	DESCRIPTION
10.36 to 11.58 (34.0 to 38.0)	Halite (H-7)	Clear to moderate brown, some moderate reddish brown, coarsely crystalline, some fine and medium. $\leq$1% brown clay; trace gray clay locally. Scattered breaks. Locally argillaceous. $\leq$1% polyhalite. Contact with unit below is gradational based on clay and polyhalite content.
9.17 to 10.36 (30.1 to 34.0)	Halite (H-6)	Clear to moderate reddish orange, coarsely crystalline. <1-3% polyhalite. Commonly polyhalitic. Scattered anhydrite stringers with anhydrite layers up to one-half inch thick locally. Scattered brown clay locally. Contact with MB-138 below is sharp.
8.96 to 9.17 (29.4 to 30.1)	Anhydrite (MB-138)	Light to medium gray, microcrystalline. Partly laminated. Scattered halite growths. Clay seam K found at base of unit.
7.62 to 8.96 (25.0 to 29.4)	Argillaceous Halite (AH-2)	Clear to moderate brown, some light moderate reddish orange. Medium to coarsely crystalline. <1-3% brown clay, some gray. Locally up to 5% clay. Clay is intercrystalline with scattered breaks and partings present. <1/2% dispersed polyhalite. Contact with lower unit is gradational based on clay content. Upper contact with clay K is sharp.
7.01 to 7.62 (23.0 to 25.0)	Halite (H-5)	Clear, some light moderate brown, coarsely crystalline. <1/2% brown clay. Contact with clay J below varies from sharp to gradational depending if clay J is a distinct seam or merely an argillaceous zone.
6.40 to 7.01 (21.0 to 23.0)	Argillaceous Halite (AH-1) (clay J)	Usually consists of scattered breaks or argillaceous zone containing <1-3% brown clay. In C&SH shaft, it is a one-half inch thick brown clay seam.
5.09 to 6.40 (16.7 to 21.0)	Halite (map unit 15)	Clear, coarsely crystalline, scattered medium. Up to 1% dispersed polyhalite and brown clay. Scattered anhydrite. Lower contact is sharp with clay I.

TAB H-1

DESCRIPTION OF GENERALIZED STRATIGRAPHY
(CONTINUED)

APPROXIMATE DISTANCE FROM CLAY G m (ft)	STRATIGRAPHIC UNIT	DESCRIPTION
4.82 to 5.09 (15.8 to 16.7)	Halite (map unit 14)	Clear to grayish orange/pink, coarsely crystalline, some medium. <1/2% dispersed polyhalite. Scattered discontinuous gray clay stringers. Clay I is along upper contact. Contact with lower unit is diffuse.
3.51 to 4.82 (11.5 to 15.8)	Halite (map unit 13)	Clear to moderate reddish orange and moderate brown, medium to coarsely crystalline, some fine. ≤1% brown clay, locally up to 3%. Trace of gray clay. Scattered discontinuous breaks. <1% dispersed polyhalite and polyhalite and polyhalite blebs. Contact with unit below is gradational based on clay and polyhalite content.
2.29 to 3.51 (7.5 to 11.5)	Polyhalitic Halite (map unit 12)	Clear to moderate reddish orange, coarsely crystalline. ≤-3% dispersed polyhalite and polyhalite blebs. Scattered anhydrite stringers. Contact is sharp with unit below.
2.07 to 2.29 (6.8 to 7.5)	Anhydrite ("a"-map unit 11)	Light to medium gray, light brownish gray and sometimes light moderate reddish orange. Microcrystalline. Halite growths within. Partly laminated. Clear, coarsely crystalline halite layer up to two inches wide, found within exposures in waste experimental area. Thin gray clay seam H at base of unit.
1.68 to 2.07 (5.5 to 6.8)	Halite (map unit 10)	Clear to moderate reddish orange/brown, fine to coarsely crystalline. ≤1% brown and/or gray clay and dispersed polyhalite. Discontinuous clay stringers locally. Contact with lower unit is diffuse based on crystal size and varying amounts of clay and polyhalite.
0.06 to 1.68 (0.2 to 5.5)	Halite (map unit 9)	Clear to light moderately reddish orange, coarsely crystalline, some medium. 0-<1% polyhalite. Trace of gray clay locally. Scattered anhydrite stringers. Contact with unit below is sharp.

TABLE H-1

DESCRIPTION OF GENERALIZED STRATIGRAPHY
(CONTINUED)

APPROXIMATE DISTANCE FROM CLAY G m (ft)	STRATIGRAPHIC UNIT	DESCRIPTION
0.00 to 0.06 (0.0 to 0.2)	Anhydrite ("b"-map unit 8)	Light to medium gray, microcrystalline anhydrite. Scattered halite growths. Thin gray clay seam G at base of unit.
0.00 to -0.67 (0.0 to -2.2)	Halite (map unit 7)	Clean to light/medium gray, some moderate reddish orange/brown. Coarsely crystalline, some fine and medium. ≤1% brown and gray clay. Locally up to 2% clay. <1% dispersed polyhalite. Upper contact is sharp with clay G. Contact with lower unit is gradational.
-0.67 to -2.13 (-2.2 to -7.0)	Halite (map unit 6)	Clear, some moderate reddish orange, coarsely crystalline, some fine to medium locally. <1/2% gray clay and polyhalite. Contact with lower unit gradational and/or diffuse.
-2.13 to -2.74 (-7.0 to -9.0)	Halite (map unit 5)	Clear coarsely crystalline. <1/2% gray clay. Contact with lower unit usually sharp with clay F.
-2.74 to -3.47 (-9.0 to -11.4)	Argillaceous Halite (map unit 4)	Clear to moderate brown and moderate reddish brown, coarsely crystalline. <1% polyhalite. <1-5% argillaceous material; predominantly brown, some gray, locally. Intercrystalline and discontinuous breaks and partings common in upper part of unit. Decreasing argillaceous content downward. Contact with lower unit is gradational.
-3.47 to -4.18 (-11.4 to -13.7)	Halite (map unit 3)	Clear to moderate reddish orange, coarsely crystalline. ≤1% dispersed polyhalite and polyhalite blebs. Locally polyhalitic. Scattered gray clay locally. Contact with lower unit is sharp.
-4.18 to -4.27 (-13.7 to -14.0)	Argillaceous Halite (map unit 2)	Moderate reddish brown to medium gray, medium to coarsely crystalline. <1-3% argillaceous material. Contact with lower unit is usually sharp.
-4.27 to -4.42 (-14.0 to -14.5)	Halite (map unit 1)	Light to reddish orange to moderate reddish orange, medium to coarsely crystalline. ≤1% dispersed polyhalite. Contact with lower unit is sharp.

TAB H-1

DESCRIPTION OF GENERALIZED STRATIGRAPHY
(CONTINUED)

APPROXIMATE DISTANCE FROM CLAY G m (ft)	STRATIGRAPHIC UNIT	DESCRIPTION
-4.42 to -6.71 (-14.5 to -22.0)	Halite (map unit 0)	Clear to moderate reddish orange/brown, moderate brown and grayish brown. Medium to coarsely crystalline. <1-5% argillaceous material. Predominantly brown, some gray, intercrystalline argillaceous material and discontinuous breaks and partings. Upper two feet of unit is argillaceous halite decreasing in argillaceous material content downward. 0-<1% polyhalite. Contact with lower unit is gradational based on polyhalite content.
-6.71 to -7.71 (-22.0 to -25.3)	Polyhalitic Halite (PH-4)	Clear to moderate reddish orange. Coarsely crystalline, some medium to locally. <1-3% polyhalite. Scattered anhydrite. Scattered gray clay locally. Contact with lower unit (MB-139) is sharp, but commonly irregular and undulating. Trace of gray locally present along this contact.
-7.71 to -8.60 (-25.3 to -28.2)	Anhydrite (MB-139)	Moderate reddish orange/brown to light and medium gray, microcrystalline anhydrite. "Swallow tail" pattern, consisting of halite growths within anhydrite, common in upper part of unit. Locally, hairline, clay-filled, low-angle fractures found in lower part of unit. Thin halite layer common close to lower contact. Clay seam E found at base of unit. Upper contact is irregular, undulating and sometimes contains <1/16-inch gray clay.
-8.60 to -9.51 (-28.2 to -31.2)	Halite (H-4)	Clear to moderate reddish orange, and light gray. Coarsely crystalline, some fine and medium. ≤1% polyhalite and intercrystalline gray clay. Contact with lower unit is gradational based on increased polyhalite content.
-9.51 to -10.97 (-31.2 to -36.0)	Polyhalitic Halite (PH-3)	Clear to moderate reddish orange, coarsely crystalline. <1-3% polyhalite. Contact with lower unit is usually sharp along clay D.

TABLE H-1

DESCRIPTION OF GENERALIZED STRATIGRAPHY
(CONTINUED)

APPROXIMATE DISTANCE FROM CLAY G m (ft)	STRATIGRAPHIC UNIT	DESCRIPTION
-10.97 to -11.52 (-36.0 to -37.8)	Halite (H-3)	Clear to moderate reddish orange, some light gray. Medium to coarsely crystalline. ≤1% polyhalite and gray clay. Contact with lower unit is gradational based on increased polyhalite content.
-11.52 to -13.01 (-37.8 to -42.7)	Polyhalitic Halite (PH-2)	Clear to moderate reddish orange/brown, coarsely crystalline. <1-3% polyhalite. Trace of clay locally. Scattered anhydrite locally. Contact with lower unit is gradational, based on decreased polyhalite content.
-13.01 to -14.42 (-42.7 to -47.3)	Halite (H-2)	Clear to moderate reddish orange, medium to coarsely crystalline. <1% dispersed polyhalite. <1% brown and/or gray clay. Contact with lower unit is gradational and/or diffuse.
-14.42 to -16.25 (-47.3 to -53.3)	Polyhalitic Halite (PH-1)	Clear to moderate reddish orange. Coarsely crystalline with some medium sometimes present close to lower contact. <1-3% polyhalite. Scattered anhydrite especially common close to anhydrite "c." Lower contact is sharp with anhydrite "c."
-16.25 to -16.31 (-53.3 to -53.5)	Anhydrite ("c")	Light to medium gray, microcrystalline anhydrite. Scattered halite growths. Faintly laminated locally. Clay seam B found at base of unit.
-16.31 to -20.03 (-53.5 to -65.7)	Halite (H-1)	Clear to medium gray and moderate brown. Medium to coarsely crystalline, some fine locally. ≤1% polyhalite, locally polyhalitic. <1-3% clay, both brown and gray. Intercrystalline clay with discontinuous breaks and partings. Zones of argillaceous halite found within unit. Seams of clay mixed with halite crystals present locally. Upper contact of this unit is sharp with clay B.

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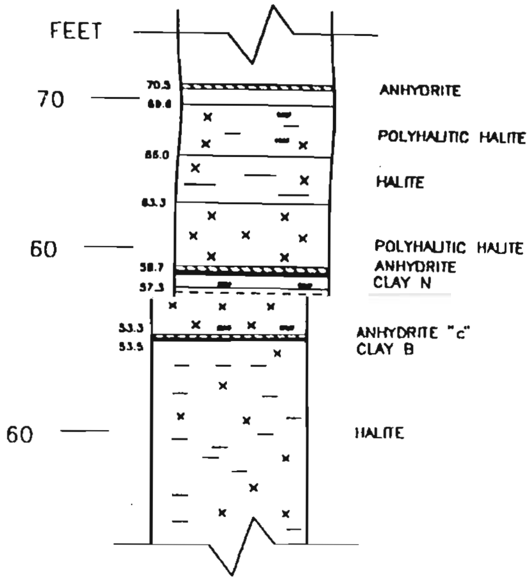

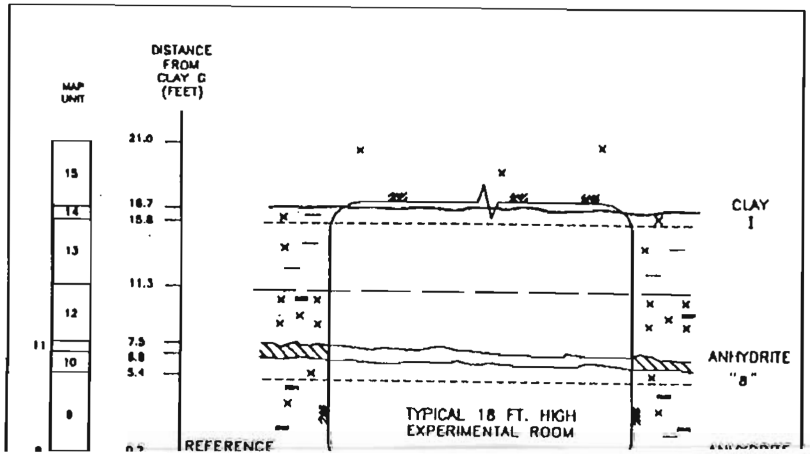

NOTES:

1. DISTANCES ARE MEASURED FROM THE BASE OF ANHYDRITE "b" (CLAY G) AND ARE AVERAGED FROM REPRESENTATIVE CORE HOLE LOGS, SHAFT AND TEST ROOM MAPPING. ACTUAL DISTANCES AND UNIT THICKNESS MAY VARY LOCALLY FROM THOSE SHOWN.

2. DESCIPTIONS OF UNITS ARE BASED ON CORE HOLE DATA, SHAFT MAPPING AND VISUAL INSPECTION OF EXPOSURES IN UNDERGROUND DRIFTS AND ROOMS.

GENERALIZED STRATIGRAPHIC COLUMN

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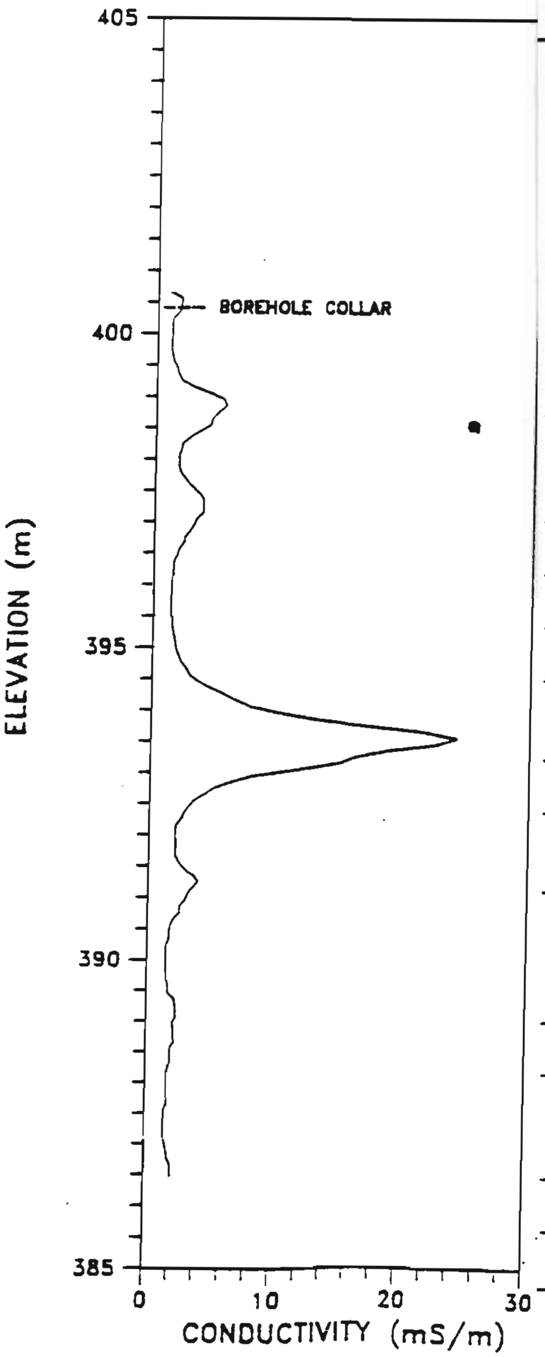
INDUCTION LOG DATA



RAPHY

	DESCRIPTION
- 398.88 m	HALITE (Map Unit 7)
- 397.53 m	HALITE (Map Unit 6) - Break at 398.71 m
- 396.85 m	HALITE (Map Unit 5)
- 396.79 m	ARGILLACEOUS HALITE (Map Unit 4) - Irregular break at 396.85 m
- 396.68 m	HALITE (Map Unit 3)
- 396.48 m	HALITE - Clear/medium bluish gray, coarsely X-talline, 1% gray clay, <½% polyhalite
- 395.92 m	ARGILLACEOUS HALITE (Map Unit 2)
- 394.09 m	HALITE (Map Units 1 and 0)
- 393.50 m	POLYHALITIC HALITE (PH-4)
- 392.72 m	ANHYDRITE (MB-139) - Trace of gray clay at 392.72 m (Clay "E")
- 391.80 m	HALITE (H-4)
- 390.51 m	POLYHALITIC HALITE (PH-3) - Break at 391.44 m
- 390.42 m	Mixture of mostly anhydrite and some polyhalitic halite (part of PH-3) - Discontinuous gray clay seam at 390.42 m (Clay "D")
- 389.79 m	HALITE (H-3)
- 388.30 m	POLYHALITIC HALITE (PH-2) - Irregular gray clay break at 388.30 m
- 386.90 m	HALITE (H-2)
- 385.34 m	POLYHALITIC HALITE (PH-1)

NDUCTION LOG, CONDUCTIVITIES, MOISTURE
ONTENT, AND STRATIGRAPHY FOR
OREHOLE A1X01

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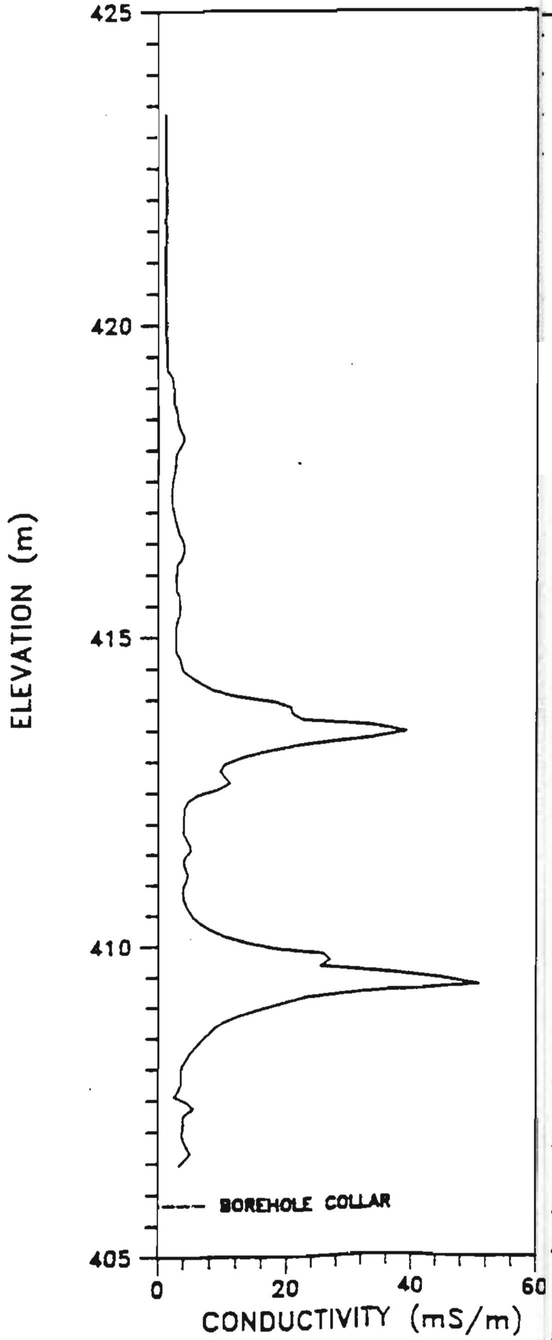
INDUCTION LOG DATA



	DESCRIPTION
421.80 m	POLYHALITIC HALITE (PH-7)
420.77 m	HALITE (H-9)
418.94 m	HALITE (Corresponds to PH-6)
417.35 m	ARGILLACEOUS HALITE (AH-4) - Scattered irregular brown breaks and partings; <1/8" very irregular gray/brown clay seam at 418.88 m (Clay "M-2")
416.47 m	HALITE (Part of H-8)
415.95 m	ARGILLACEOUS HALITE (Corresponds to part of H-8) - 1/4" very irregular brown clay at 416.44 m (Clay "M-1")
414.82 m	HALITE (Part of H-8)
413.41 m	POLYHALITIC HALITE (PH-5)
413.05 m	ARGILLACEOUS HALITE (Part of AH-3) - 3/4" brown clay seam at 413.05 m
412.11 m	HALITE (Corresponds to part of AH-3) - Irregular breaks at 412.29 and 412.63 m
411.68 m	POLYHALITIC HALITE (Corresponds to part of H-7)
410.86 m	HALITE (Part of H-7) - Break at 411.53 m, discontinuous argillaceous zone from 411.07 to 411.13 m
409.67 m	POLYHALITIC HALITE (Corresponds to H-6)
409.35 m	ANHYDRITE (MB-138) - 1" brown clay seam at 409.35 m, wet, brine weeping from this unit during drilling (Clay "K")
408.36 m	HALITE (Corresponds to part of AH-2)
407.86 m	HALITE (Corresponds to part of AH-2)
407.29 m	HALITE (H-5)
407.08 m	ARGILLACEOUS HALITE (AH-1) - 1/16" gray clay at 407.29 m, low angle (Clay "J")
406.84 m	HALITE (Map Unit 15)
405.80 m	HALITE (Map Unit 14)

UCTION LOG, CONDUCTIVITIES, MOISTURE
NTENT, AND STRATIGRAPHY FOR
REHOLE A1X02

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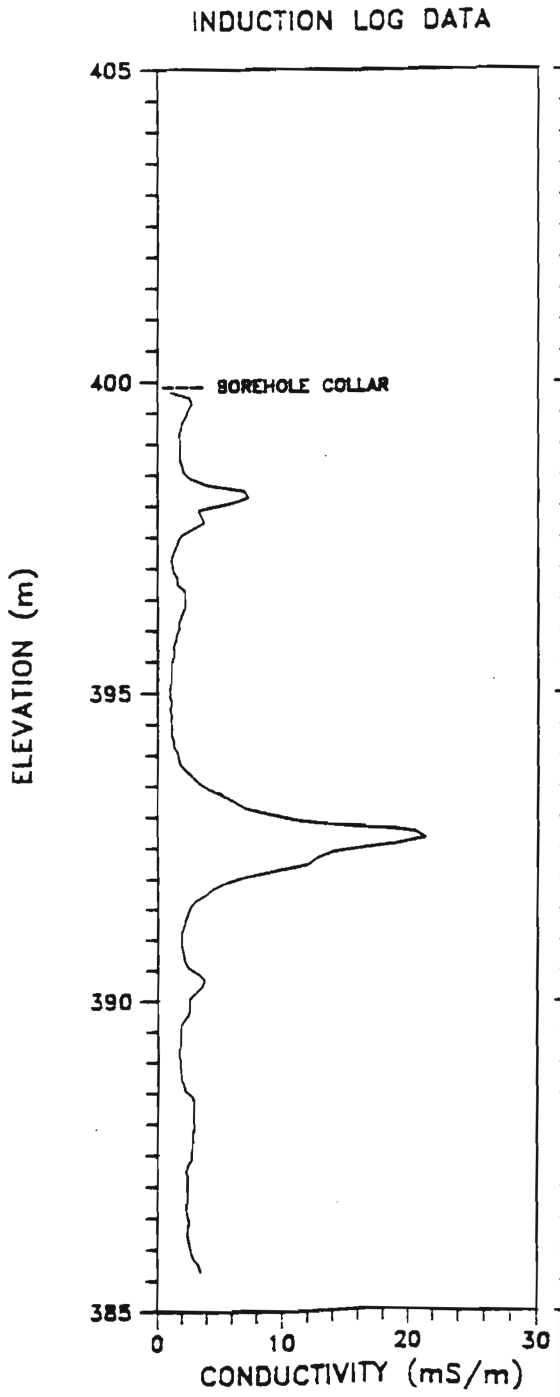

	DESCRIPTION
399.53 m	HALITE (Map Unit 7)
398.50 m	HALITE (Map Unit 6)
397.07 m	HALITE (Map Units 4 and 5)
396.30 m	HALITE (Map Units 2 and 3)
394.93 m	HALITE (Map Unit 1)
393.65 m	HALITE (Map Unit 0)
393.13 m	POLYHALITIC HALITE (PH-4)
392.27 m	ANHYDRITE (MB-139) - No clay noted at lower contact
391.21 m	HALITE (H-4)
389.98 m	POLYHALITIC HALITE (PH-3)
389.90 m	Mixture of anhydrite and halite (part of PH-3) - Irregular hard, dry gray clay seam at 389.90 m (Clay "D")
389.23 m	HALITE (H-3)
388.01 m	POLYHALITIC HALITE (PH-2)
386.31 m	HALITE (H-2) - Irregular gray break at 387.89 m
384.31 m	POLYHALITIC HALITE (PH-1)

UCTION LOG, CONDUCTIVITIES, MOISTURE
NTENT, AND STRATIGRAPHY FOR
REHOLE A2X01

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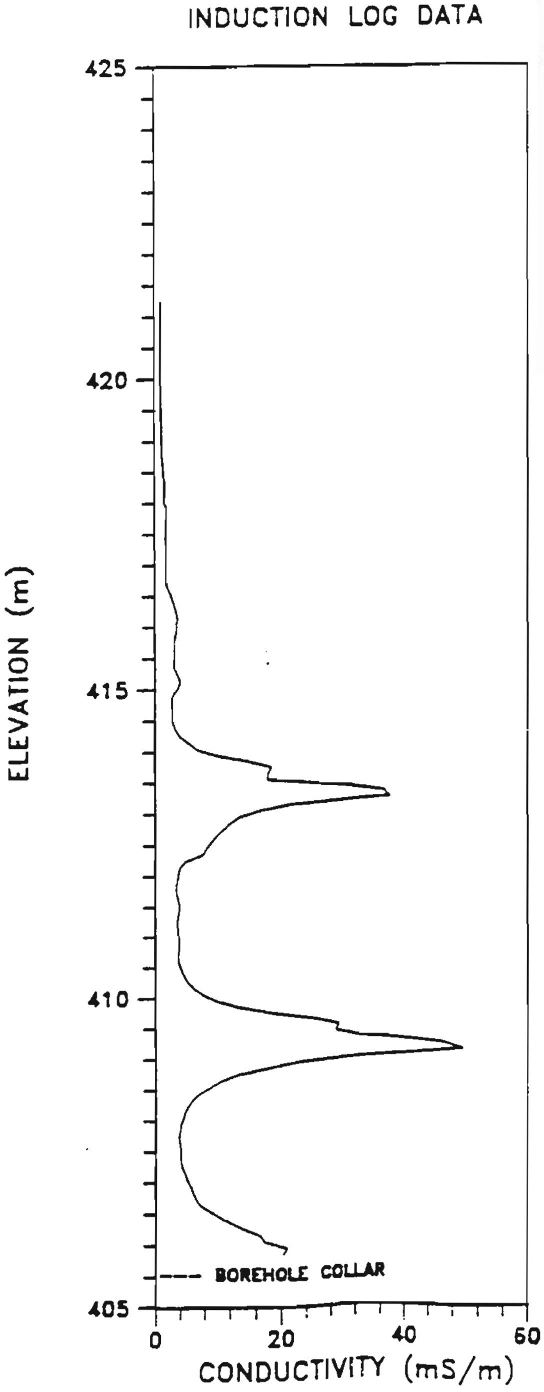

RAPHY

	DESCRIPTION
419.01 m	HALITE (H-9)
418.61 m	POLYHALITIC HALITE (PH-6)
416.57 m	HALITE (Corresponds to part of AH-4) - Scattered discontinuous brown breaks
415.93 m	POLYHALITIC HALITE (Corresponds to part of H-8) - 3/4" discontinuous anhydrite layer at 415.99 m
414.65 m	HALITE (Part of H-8) - Clay parting at 414.97 m, scattered brown clay breaks
413.31 m	POLYHALITIC HALITE (PH-5)
411.78 m	ARGILLACEOUS HALITE (AH-3) - 1/4" pure clay seam at 413.18 m, wet; parting at 412.74 m
411.17 m	POLYHALITIC HALITE (Corresponds to part of H-7)
410.53 m	HALITE (Part of H-7)
409.25 m	HALITE (H-6)
408.99 m	ANHYDRITE (MB-138) - Up to 1" brown clay seam at 408.99 m, wet when drilling (Clay "K")
408.03 m	HALITE (Corresponds to AH-2) - Parting at 408.82 m
407.18 m	HALITE (H-5)
406.63 m	HALITE (Corresponds to AH-1)
405.50 m	HALITE (Map Unit 15)

IDUCTION LOG, CONDUCTIVITIES, MOISTURE
ONTENT, AND STRATIGRAPHY FOR
OREHOLE A2X02

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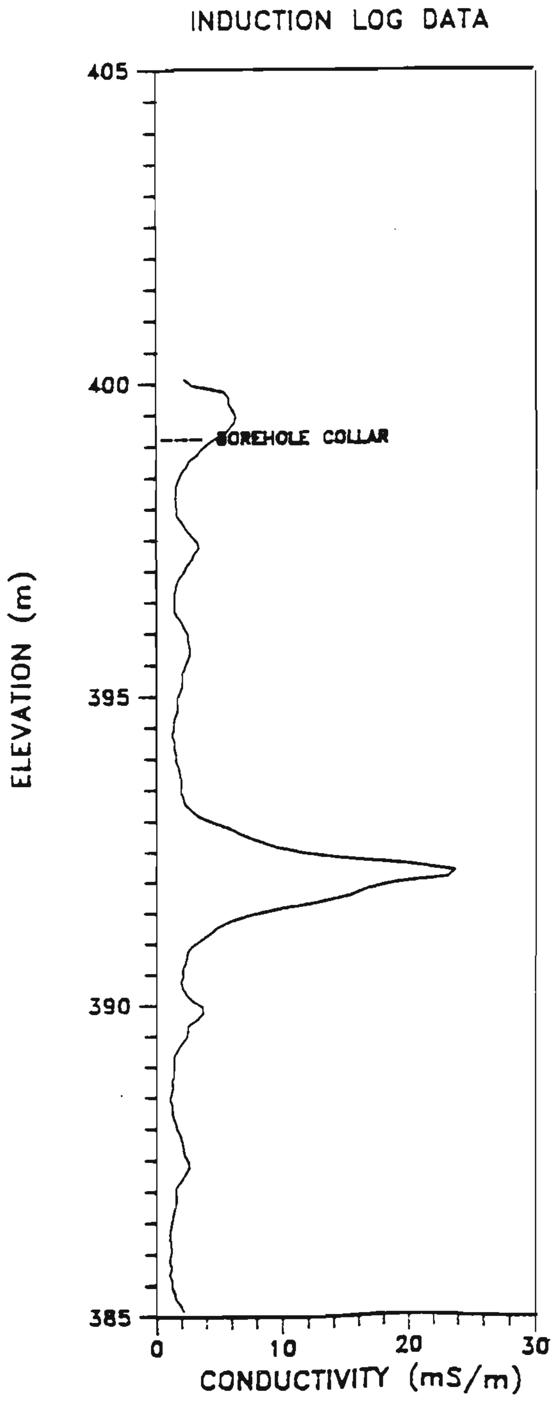
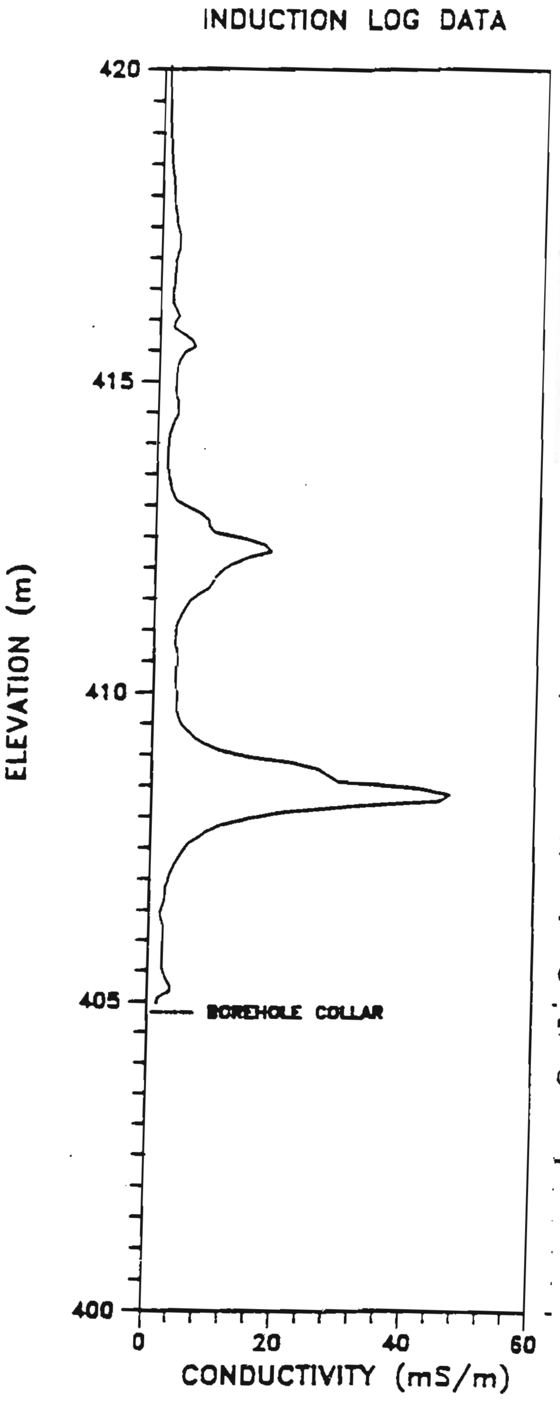


GRAPHY

	DESCRIPTION
397.12 m	HALITE (Map Units 6 and 7)
395.90 m	HALITE (Map Units 4 and 5)
394.50 m	HALITE (Corresponds to Map Units 1, 2, and 3)
392.94 m	HALITE (Map Unit 0)
392.46 m	HALITE (Corresponds to PH-4)
391.66 m	ANHYDRITE (MB-139) - Trace of gray clay at 391.66 m (Clay "E")
390.87 m	HALITE (H-4)
389.47 m	POLYHALITIC HALITE (PH-3) - Discontinuous breaks at 390.38 m
389.35 m	Mixture of mostly anhydrite and some halite (Part of PH-3)
388.77 m	HALITE (H-3)
387.50 m	POLYHALITIC HALITE (PH-2)
85.87 m	HALITE (H-2)
84.23 m	POLYHALITIC HALITE (PH-1) - 1½" anhydrite at 384.35 m

TION LOG, CONDUCTIVITIES, MOISTURE
ENT, AND STRATIGRAPHY FOR
HOLE A3X01

2



GRAPHY	DESCRIPTION
7 - 418.39 m	POLYHALITIC HALITE (PH-6)
9 - 416.41 m	HALITE (Corresponds to AH-4)
1 - 415.42 m	HALITE (Part of H-8)
2 - 415.19 m	ARGILLACEOUS HALITE (Corresponds to part of H-8) - 3/4" clay/ halite seam at 415.42 m (Clay "M-2")
9 - 414.43 m	POLYHALITIC HALITE (Corresponds to part of H-8)
3 - 414.16 m	HALITE (Part of H-8) - Parting at 414.16 m (Clay "M-1")
5 - 412.33 m	POLYHALITIC HALITE (PH-5)
3 - 411.96 m	ARGILLACEOUS HALITE (AH-3) - ½" clay at 412.27 m; clay along break at 412.01 m
6 - 409.22 m	HALITE (H-7)
2 - 408.53 m	POLYHALITIC HALITE (Corresponds to H-6)
3 - 408.37 m	ANHYDRITE (MB-138) - 1/4" brown clay at 408.37 m (Clay "K")
7 - 407.06 m	HALITE (Corresponds to AH-2)
6 - 406.45 m	HALITE (H-5)
5 - 405.90 m	HALITE (Corresponds to AH-1)
0 - 404.80 m	HALITE (Map Unit 15)

INDUCTION LOG, CONDUCTIVITIES, MOISTURE CONTENT, AND STRATIGRAPHY FOR BOREHOLE A3X02

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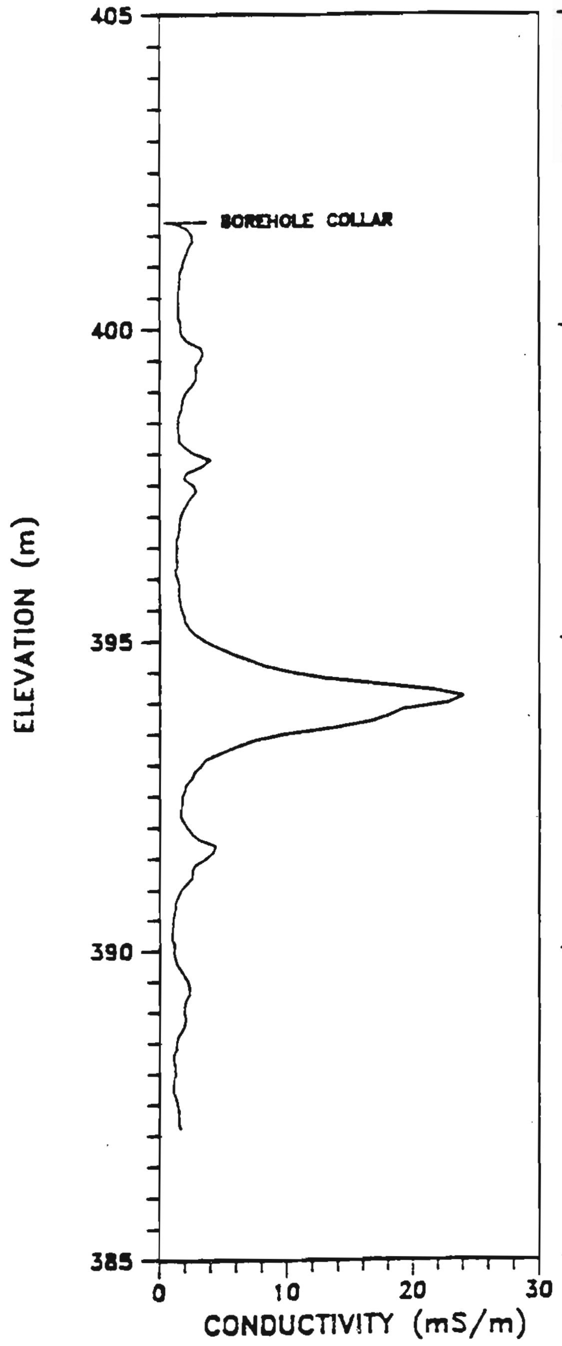
INDUCTION LOG DATA



APHY

	DESCRIPTION
400.12 m	HALITE (Map Unit 6)
398.59 m	HALITE (Map Units 4 and 5) - Break at 399.12 m, gray clay along break (Clay "F")
398.26 m	POLYHALITIC HALITE (Map Unit 3)
397.65 m	HALITE (Map Unit 2)
397.45 m	HALITE (Map Unit 1) - Irregular gray clay parting at 397.45 m
395.60 m	HALITE (Map Unit 0)
394.61 m	POLYHALITIC HALITE (PH-4)
393.79 m	ANHYDRITE (MB-139) - Mixture of anhydrite and polyhalitic halite to 394.26 m; 1/4" hard dry gray clay at 393.79 m (Clay "E")
392.77 m	HALITE (H-4)
391.37 m	POLYHALITIC HALITE (PH-3)
391.31 m	Discontinuous clay/anhydrite (Part of PH-3)
390.79 m	HALITE (H-3) - Gray clay parting at 391.26 m (Clay "D")
389.08 m	POLYHALITIC HALITE (PH-2)
388.06 m	HALITE (H-2)
386.51 m	POLYHALITIC HALITE (PH-1) - Scattered anhydrite

UCTION LOG, CONDUCTIVITIES, MOISTURE
NTENT, AND STRATIGRAPHY FOR
REHOLE BX01

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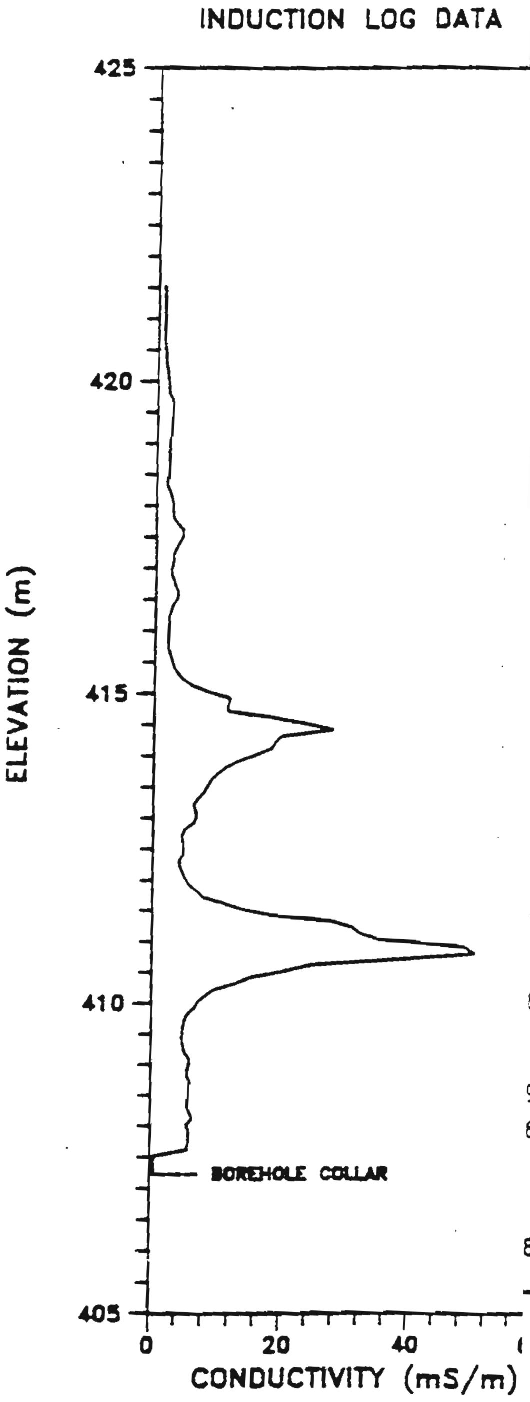


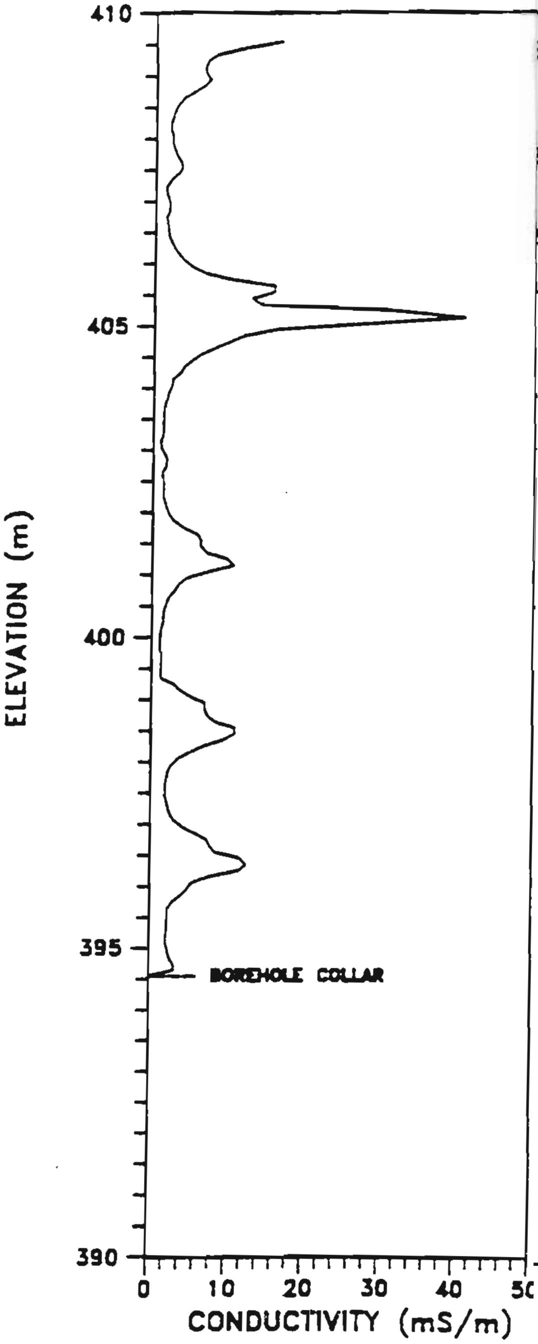
RAPHY

	DESCRIPTION
- 420.15 m	POLYHALITIC HALITE (PH-6)
- 418.48 m	HALITE (Corresponds to AH-4) - Clay parting at 419.13 m; 1" hard, dry, brown clay at 419.76 m; clay and halite mix from 419.76 to 419.85 m
- 417.69 m	POLYHALITIC HALITE (Corresponds to part of H-8)
- 417.32 m	ARGILLACEOUS HALITE (Corresponds to part of H-8)
- 416.83 m	POLYHALITIC HALITE (Corresponds to part of H-8)
- 416.22 m	HALITE (Part of H-8) - Break at 416.50 m
- 414.58 m	POLYHALITIC HALITE (PH-5)
- 413.81 m	ARGILLACEOUS HALITE (AH-3) - Hard, dry, brown clay mixed with halite X-tals from 414.52 to 414.58 m
- 413.17 m	POLYHALITIC HALITE (Corresponds to part of H-7)
7 - 412.23 m	HALITE (Part of H-7) - Brown parting/seam at 412.99 m
3 - 411.48 m	HALITE (Part of H-6)
3 - 411.12 m	POLYHALITIC HALITE (Corresponds to part of H-6)
2 - 410.96 m	ANHYDRITE (MB-138) - 1" hard gray clay seam at 410.96 m (Clay "K")
6 - 409.79 m	HALITE (Corresponds to AH-2) - Argillaceous halite in part from 410.48 to 410.96 m
9 - 409.26 m	HALITE (H-5)
6 - 408.88 m	HALITE (Corresponds to AH-1) - 1/4" discontinuous gray clay at 408.91 m; parting at 409.17 m (Clay "J")
8 - 407.20 m	HALITE (Map Unit 15)

INDUCTION LOG, CONDUCTIVITIES, MOISTURE CONTENT, AND STRATIGRAPHY FOR BOREHOLE BX02

2

INDUCTION LOG DATA



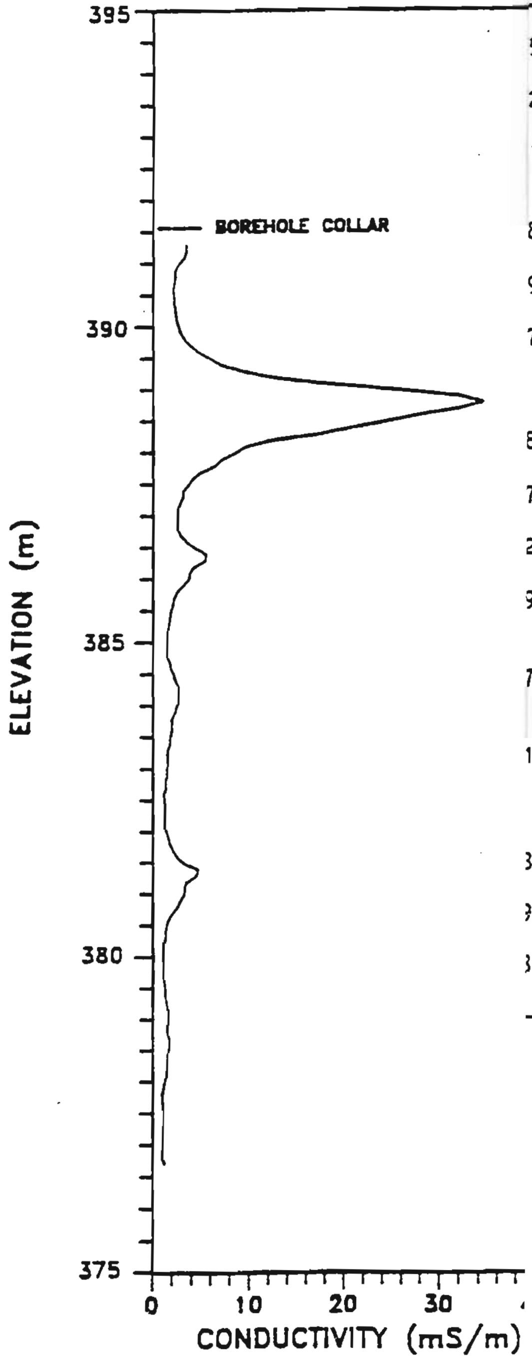
RAPHY

	DESCRIPTION
- 408.58 m	ARGILLACEOUS HALITE (AH-3) - Seam of clay mixed with halite X-tals from 409.89 to 409.96 m
- 407.52 m	HALITE (H-7) - Irregular break at 408.11 m
- 405.84 m	HALITE (H-6)
- 405.66 m	ANHYDRITE (MB-138) - 1/2" hard brown clay at 405.66 m (Clay "K")
- 404.44 m	ARGILLACEOUS HALITE (AH-2)
- 403.28 m	HALITE (H-5)
- 403.01 m	HALITE (Corresponds to AH-1)
- 401.86 m	HALITE (Map Unit 15)
- 401.21 m	HALITE (Map Unit 14) - Up to 3/8" hard brown clay at 401.85 m (Clay "I")
- 400.02 m	HALITE (Map Unit 13)
- 398.75 m	POLYHALITIC HALITE (Map Unit 12)
- 398.56 m	ANHYDRITE "a" (Map Unit 11) - Up to 1/4" hard gray clay at 398.56 m (Clay "H")
- 398.22 m	HALITE (Map Unit 10) - Brown break at 398.30 m
- 396.48 m	HALITE (Map Unit 9)
- 396.42 m	ANHYDRITE "b" (Map Unit 8) - Trace of hard gray clay at 396.42 m (Clay "G")
- 395.87 m	HALITE (Map Unit 7)
- 394.53 m	HALITE (Map Unit 6)

IDUCTION LOG, CONDUCTIVITIES, MOISTURE
ONTENT, AND STRATIGRAPHY FOR
OREHOLE DH-35

2

INDUCTION LOG DATA

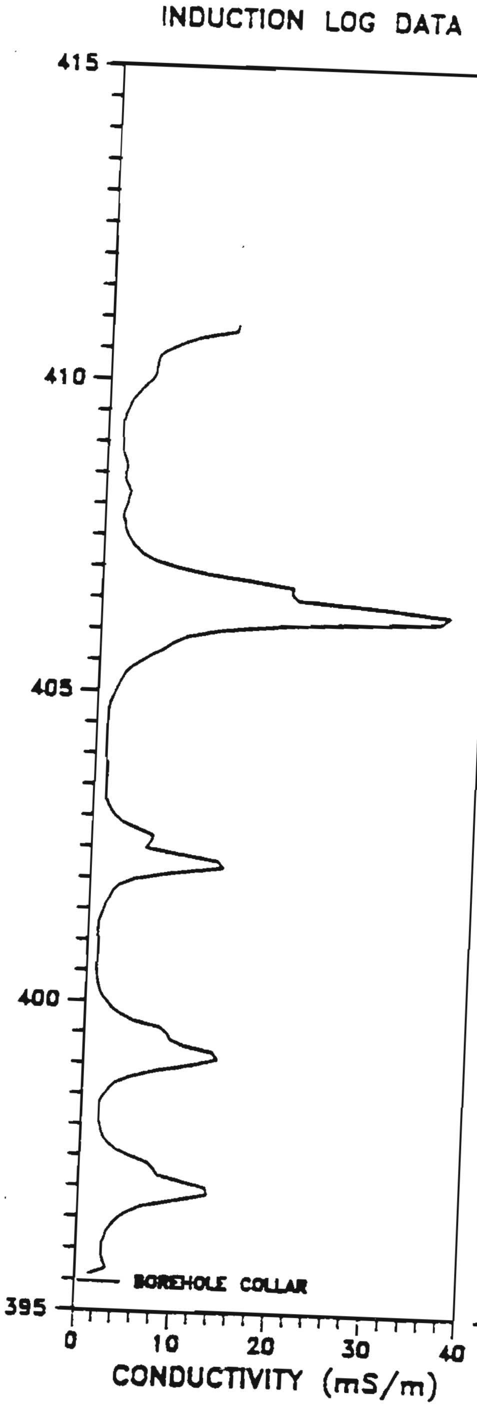


GRAPHY

	DESCRIPTION
5 - 390.72 m	HALITE (Map Unit 0)
2 - 389.41 m	POLYHALITIC HALITE (PH-4)
1 - 388.38 m	ANHYDRITE (MB-139) - Gray clay up to ½" at 388.38 m (Clay "E")
8 - 387.19 m	HALITE (H-4)
9 - 385.97 m	POLYHALITIC HALITE (PH-3)
7 - 385.88 m	Gray clay with some anhydrite (part of PH-3) - Irregular gray seam at 385.88 (Clay "D")
8 - 385.27 m	HALITE (H-3)
7 - 384.02 m	POLYHALITIC HALITE (PH-2)
2 - 382.59 m	HALITE (H-2)
9 - 381.37 m	POLYHALITIC HALITE (Part of PH-1)
7 - 380.91 m	HALITE (Corresponds to part of PH-1)
1 - 380.73 m	ANHYDRITE (ANHYDRITE "c") - 1/2" hard gray clay at 380.73 m (Clay "B")
3 - 378.99 m	HALITE (Part of H-1)
9 - 378.53 m	HALITE (Part of H-1)
3 - 377.86 m	HALITE (Part of H-1)

INDUCTION LOG, CONDUCTIVITIES, MOISTURE CONTENT, AND STRATIGRAPHY FOR BOREHOLE DH-36

2



RAPHY

	DESCRIPTION
- 409.85 m	ARGILLACEOUS HALITE (AH-3)
- 409.13 m	HALITE (Part of H-7)
- 408.43 m	HALITE (Part of H-7)
- 407.55 m	HALITE (Part of H-7) - Irregular break at 408.16 m
- 406.37 m	HALITE (H-6)
- 406.16 m	ANHYDRITE (MB-138) - 1" hard brown clay at 406.16 m (Clay "K")
- 404.65 m	ARGILLACEOUS HALITE (AH-2)
- 403.52 m	HALITE (H-5)
- 402.92 m	HALITE (Corresponds to AH-1)
- 402.03 m	HALITE (Map Unit 15)
- 401.95 m	HALITE (Map Unit 15) - Up to 1/2" hard brown clay at 401.95 m (Clay "I")
- 400.48 m	HALITE (Map Units 13 and 14)
- 399.32 m	POLYHALITIC HALITE (Map Unit 12)
- 399.17 m	ANHYDRITE "a" (Map Unit 11) - Up to 1/8" brown clay at 399.17 m (Clay "H")
- 398.89 m	HALITE (Map Unit 10)
- 397.12 m	HALITE (Map Unit 9)
- 397.06 m	ANHYDRITE "b" (Map Unit 8) - Trace of gray clay at 397.06 m (Clay "G")
- 396.00 m	HALITE (Map Unit 7)
- 395.45 m	HALITE (Map Unit 6)

NDUCTION LOG, CONDUCTIVITIES, MOISTURE
ONTENT, AND STRATIGRAPHY FOR
OREHOLE DH-37

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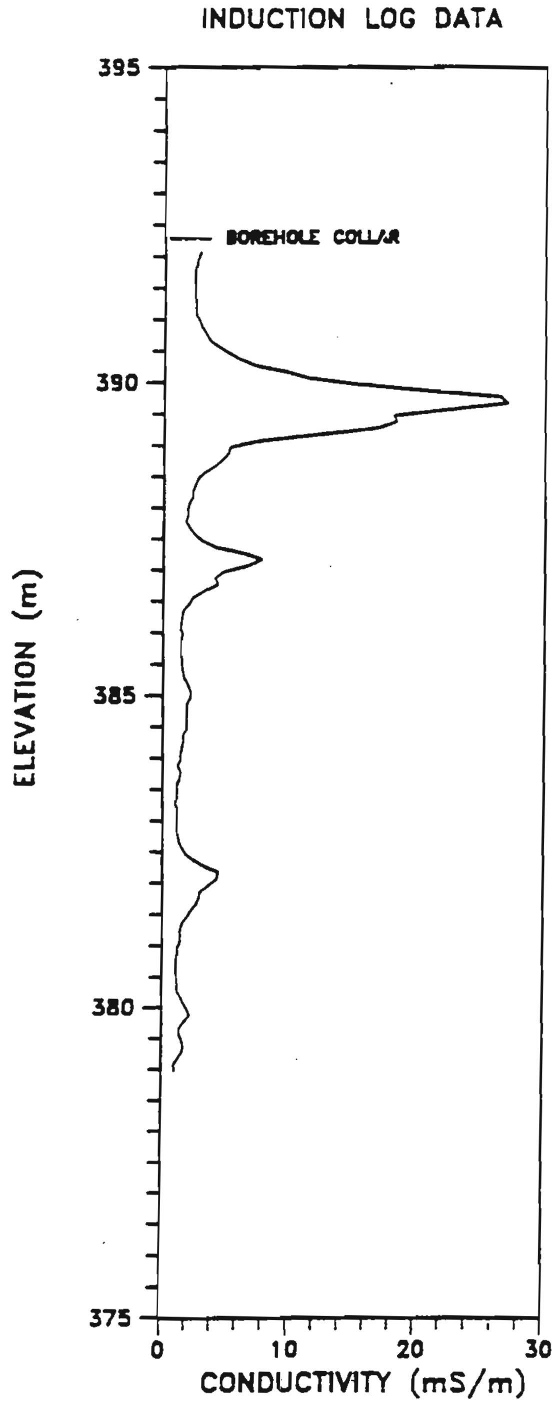

RAPHY

	DESCRIPTION
391.33 m	HALITE (Map Unit 0)
390.02 m	POLYHALITIC HALITE (PH-4)
389.40 m	ANHYDRITE (MB-139) - Gray clay at 389.40 m (Clay "E")
388.25 m	HALITE (H-4)
387.08 m	POLYHALITIC HALITE (PH-3)
386.99 m	Mixture of some anhydrite and gray clay (part of PH-3) (Clay "D")
386.55 m	HALITE (H-3)
385.48 m	POLYHALITIC HALITE (PH-2) - Trace of clay at 385.72 m
383.53 m	HALITE (H-2)
381.91 m	POLYHALITIC HALITE (Part of PH-1)
381.82 m	HALITE (Corresponds to part of PH-1)
381.73 m	ANHYDRITE (ANHYDRITE "c") - 1/4" hard, dry, gray clay at 381.73 m (Clay "B")
379.72 m	HALITE (Part of H-1)
379.61 m	POLYHALITIC HALITE (Corresponds to part of H-1)
378.84 m	HALITE (Part of H-1)

UCTION LOG, CONDUCTIVITIES, MOISTURE
NTENT, AND STRATIGRAPHY FOR
REHOLE DH-38

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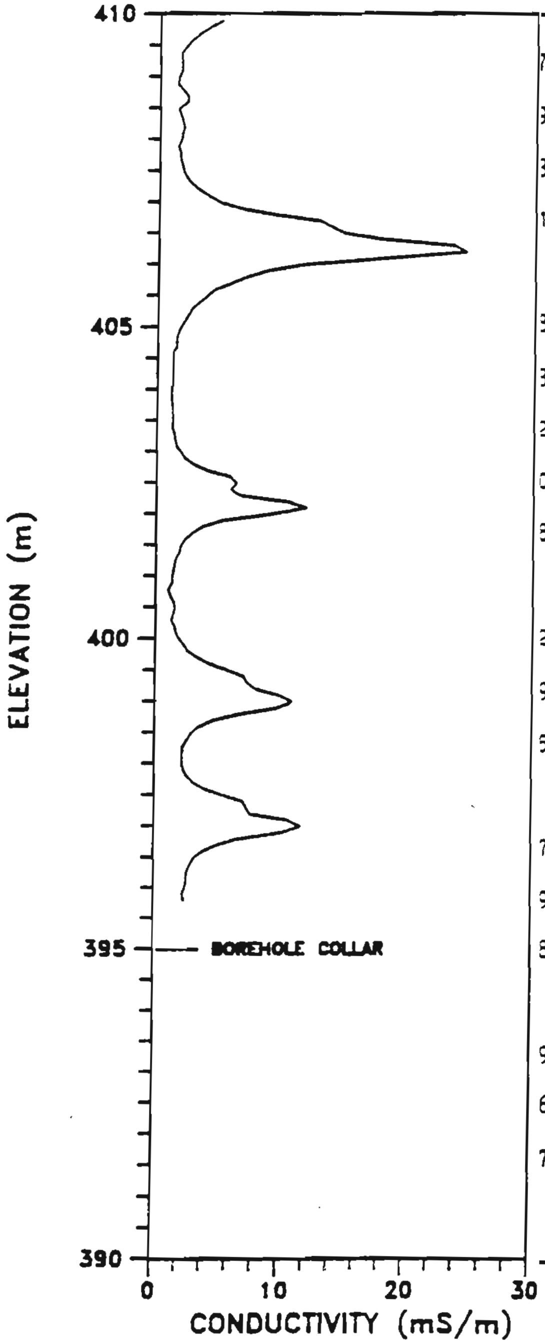
RAPHY

INDUCTION LOG DATA



DESCRIPTION

7 - 409.29 m ARGILLACEOUS HALITE (AH-3)

9 - 407.93 m HALITE (H-7)

3 - 406.31 m HALITE (H-6)

1 - 406.08 m ANHYDRITE (MB-138) - Up to 1/4" brown clay at 406.08 m (Clay "K")

3 - 404.53 m ARGILLACEOUS HALITE (AH-2)

3 - 403.92 m HALITE (H-5)

2 - 403.40 m HALITE (Corresponds to AH-1)

0 - 402.58 m HALITE (Map Unit 15)

3 - 402.52 m HALITE (Map Unit 15) - Irregular low-angle brown clay seam at 402.52 m (Clay "I")

2 - 400.69 m HALITE (Map Units 13 and 14)

9 - 399.35 m POLYHALITIC HALITE (Map Unit 12)

5 - 399.17 m ANHYDRITE "a" (Map Unit 11) - Trace of brown clay at 399.17 m (Clay "H")

7 - 398.89 m HALITE (Map Unit 10)

9 - 397.18 m HALITE (Map Unit 9)

3 - 397.09 m ANHYDRITE "b" (Map Unit 8) - ½" gray clay at 397.09 m (Clay "G")

9 - 396.76 m HALITE (Map Unit 7)

6 - 395.87 m HALITE (Map Unit 6)

7 - 394.96 m HALITE (Map Unit 5)

NDUCTION LOG, CONDUCTIVITIES, MOISTURE
ONTENT, AND STRATIGRAPHY FOR
OREHOLE DH-41

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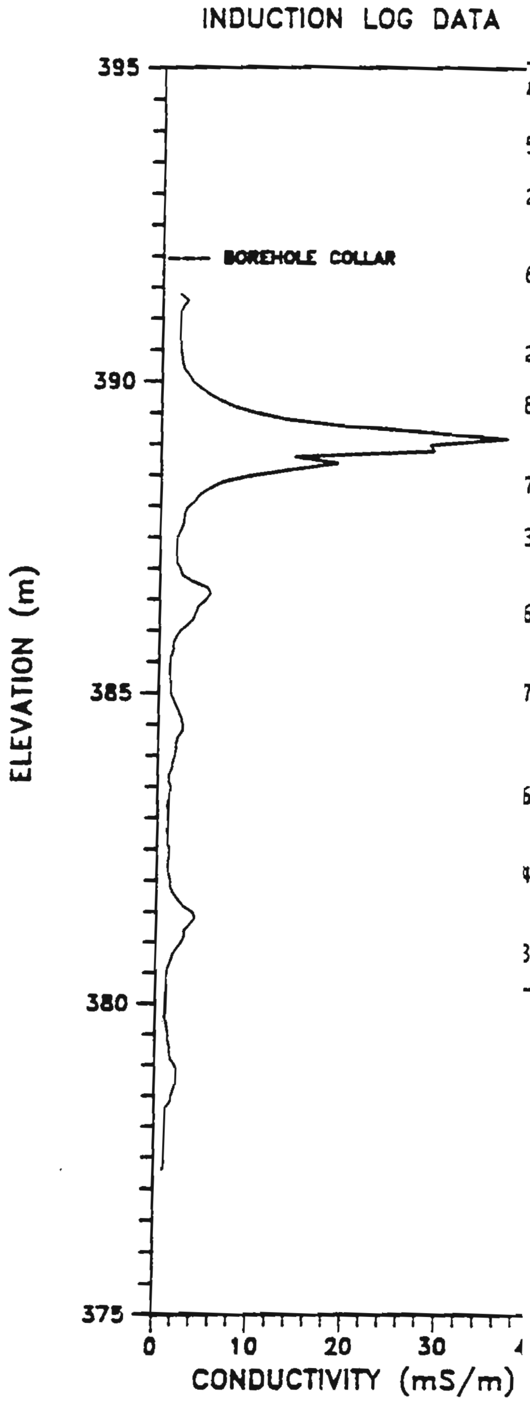
2



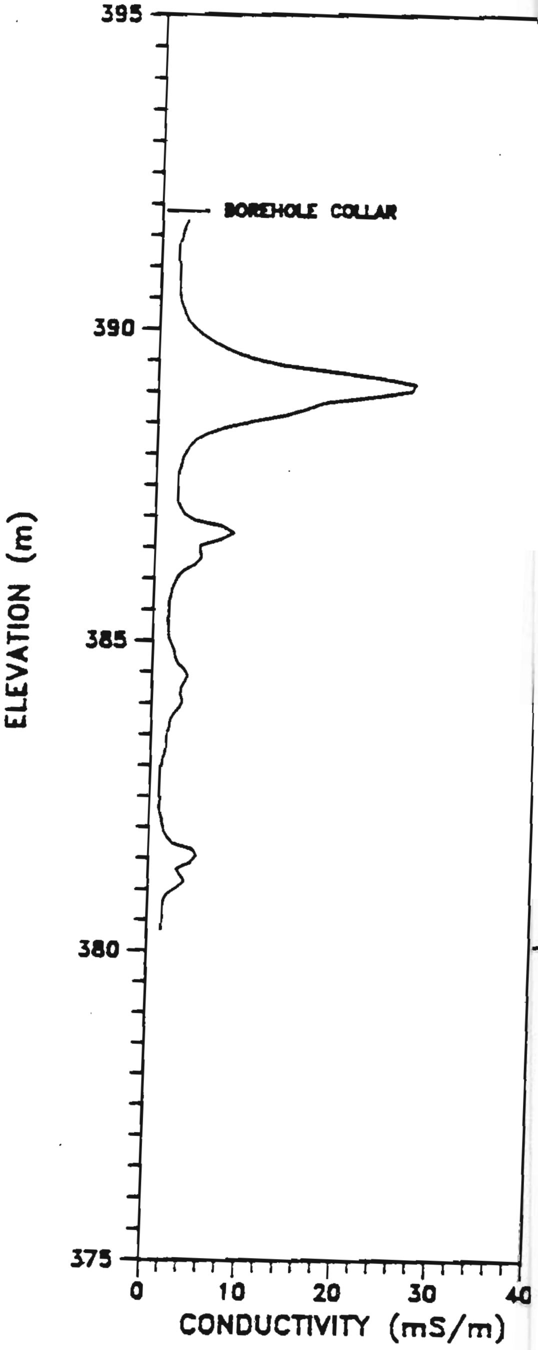
IGRAPHY

	DESCRIPTION
4 - 390.05 m	HALITE (Map Unit 0)
5 - 389.72 m	POLYHALITIC HALITE (PH-4)
2 - 388.86 m	ANHYDRITE (MB-139) - Up to ½" gray clay at 388.86 m (Clay "E")
6 - 387.52 m	HALITE (H-4) - Brown clay at 388.01 to 387.89 m
2 - 386.58 m	POLYHALITIC HALITE (PH-3)
8 - 384.47 m	POLYHALITIC HALITE (PH-2 and H-3)
7 - 383.13 m	HALITE (H-2)
3 - 381.76 m	POLYHALITIC HALITE (Part of PH-1)
6 - 381.27 m	HALITE (Corresponds to part of PH-1)
7 - 381.06 m	ANHYDRITE (ANHYDRITE "c") - Up to 3/4" gray clay at 381.06 m (Clay "B")
6 - 378.74 m	HALITE (H-1) - Breaks at 380.60, 380.50, and 378.74 m
4 - 378.33 m	ARGILLACEOUS HALITE (Corresponds to part of H-1)
3 - 377.55 m	HALITE (Part of H-1)

INDUCTION LOG, CONDUCTIVITIES, MOISTURE CONTENT, AND STRATIGRAPHY FOR BOREHOLE DH-42

2

INDUCTION LOG DATA



GRAPHY

	DESCRIPTION
- 390.05 m	HALITE (Map Unit 0)
- 389.72 m	POLYHALITIC HALITE (PH-4)
- 388.86 m	ANHYDRITE (MB-139) - Up to ½" gray clay at 388.86 m (Clay "E")
- 387.52 m	HALITE (H-4) - Brown clay at 388.01 to 387.89 m
- 386.58 m	POLYHALITIC HALITE (PH-3)
- 384.47 m	POLYHALITIC HALITE (PH-2 and H-3)
- 383.13 m	HALITE (H-2)
- 381.76 m	POLYHALITIC HALITE (Part of PH-1)
- 381.27 m	HALITE (Corresponds to part of PH-1)
- 381.06 m	ANHYDRITE (ANHYDRITE "c") - Up to 3/4" gray clay at 381.06 m (Clay "B")
- 378.74 m	HALITE (H-1) - Breaks at 380.60, 380.50, and 378.74 m
- 378.33 m	ARGILLACEOUS HALITE (Corresponds to part of H-1)
- 377.55 m	HALITE (Part of H-1)

NDUCTION LOG, CONDUCTIVITIES, MOISTURE
ONTENT, AND STRATIGRAPHY FOR
OREHOLE DH-42A

APPENDIX I

FEATURES OBSERVED WITH VIDEO CAMERA CORRELATED WITH THE LITHOLOGIC DRILL LOG

TABLE I-1

FEATURES OBSERVED WITH THE VIDEO CAMERA CORRELATED WITH THE LITHOLOGIC DRILL LOG

Distances are in meters

HOLE NO. DIRECTION LOCATION	VIDEO LOG (THIS REPORT)		DRILL LOG (FROM GALLERANI, 1985)	
L1X00	1.70	Salt buildup starts	1.70	Top of anhydrite- MB-139
Down	2.00	Looks wet	2.30	Bottom of anhydrite- MB-139
Room L1	3.50	End of hole - Salt crust extends to bottom	3.70	End of hole
BX01	2.65	Salt crust begins	2.57	Break in the core
Down	6.71	Top of anhydrite- MB-139	7.09	Top of anhydrite- MB-139
Room B	7.92	Bottom of anhydrite- MB-139	7.91	Bottom of anhydrite- MB-139
	12.89	End of survey	15.28	End of hole
BX02	0.00	Start salt crust	1.71	Small gray clay
Up	1.34	End salt crust	1.96	Small fracture
Room B	3.87	Bottom of anhydrite- MB-138	3.76	Bottom of anhydrite- MB-138
	4.05	Top of anhydrite- MB-138		Gray clay - <25 mm
	4.30	Clay/anhydrite - <3 mm	3.92	Top of anhydrite -MB-138
	10.64	Clay/anhydrite - <13 mm	5.79	Brown clay stringer
	11.22	Salt knobs	10.49	Bottom of anhydrite
			10.55	Top of anhydrite
			12.56	Brown clay - <25 mm
	11.52	End of survey	15.01	End of hole
A1X01	2.16	Small salt knobs	1.69	Break in the core
Down	6.89	Top of anhydrite -MB-139	3.55	Break in the core
Room A1	7.01	Bottom of anhydrite	6.90	Top of MB-139
	7.74	Bottom of anhydrite -MB-139	7.68	Bottom of MB-139
		Upper contact gradational	9.97	Small clay stringer
	12.86	End of survey	15.16	End of hole
A1X02	0.46	Anhydrite/clay - <3 mm	1.49	Clay - <2 mm
Up	3.51	Bottom of anhydrite - MB-138	3.55	Bottom of anhydrite- MB-138
Room A1		-clay seam - <19 mm	3.87	Top of anhydrite- MB-138
	3.81	Top of anhydrite -MB-138	5.27-	Discontinuous clay
	4.02	Clay/anhydrite - <6 mm	5.33	
	4.21	Clay/anhydrite - <2 mm	7.25	Brown clay - 19 mm
	7.56	Clay squeezing into hole		
	10.64	Clay/anhydrite - <19 mm	10.64	Brown clay - 6 mm
	13.66	End of survey	14.97	End of hole
A2X01	1.60	Salt knobs on west and northwest sides		
Down				
Room A2	2.00	Slat knobs, Appears wet, crust not continuous on all sides	2.00	Fracture

TABLE I-1

FEATURES OBSERVED WITH THE VIDEO CAMERA CORRELATED WITH THE LITHOLOGIC DRILL LOG
(CONTINUED)

HOLE NO. DIRECTION LOCATION	VIDEO LOG (THIS REPORT)		DRILL LOG (FROM GALLERANI, 1985)	
	6.70	Salt crust starts - No abrupt end, just fades out by 8.0m	6.80	Top of anhydrite- MB-139
			7.60	Bottom of anhydrite- MB-139
	13.40	End of survey	15.30	End of hole
A2X02 Up Room A2	0.00	Start salt crust		
	0.79	Clay/anhydrite - <2 mm		
	1.58	End salt crust		
	3.60	Bottom of anhydrite- MB-138 - Clay at contact	3.49	Bottom of anhydrite- MB-138
	3.72	Top of anhydrite - MB-138	3.75	Top of anhydrite- MB-138
	4.08	Clay/anhydrite - <10 mm		
	4.24	Clay/anhydrite - <6 mm		
	7.71	Clay squeezing into hole	7.68	Gray clay - 6 mm
	7.77	Clay/anhydrite - <3 mm	10.49	Anhydrite - 19 mm
	13.62	End of survey	16.08	End of hole
A3X01 Down Room A3	2.38	Salt knobs/crust		
	6.10	Top of anhydrite- MB-139-Bottom gradational		
	6.80	Top of anhydrite	6.64	Top of anhydrite- MB-139
	7.53	Bottom of anhydrite- MB-139 -gradational	7.44	Bottom of anhydrite- MB-139
	12.28	End of survey	15.36	End of hole
A3X02 Up Room A3	0.00	Start salt crust	0.00-	Scattered anhydrite
	0.30	Anhydrite - <3 mm	1.10	Stringers
	0.52	End salt crust		
	3.54	Bottom of anhydrite- MB-138	3.57	Bottom of anhydrite- MB-138
	3.69	Top of anhydrite- MB-138	3.73	Top of anhydrite- MB-138
	3.99	Anhydrite- <10 mm	7.21	Clay - <2 mm
			7.47	Brown clay - 13 mm
			10.62	Clay - 19 mm
	13.75	End of survey	15.47	End of hole
DH-15 Up Room D	0.00	Slat crust starts		
	0.49	Salt crust ends		
	0.79	Visible fracture		
	2.80	Offset at Clay I-small anhydrite just above the offset	2.77	Clay - 3 mm
			2.79	Anhydrite - 25 mm
	3.08	Clay/anhydrite - <13 mm		
	5.82	Clay K squeezing into the hole on all sides- Bottom of anhydrite- MB-139	5.97	Clay - 13 mm
	5.94	Top of anhydrite- MB-138	6.36	Clay layer - Bottom of

TABLE I-1

FEATURES OBSERVED WITH THE VIDEO CAMERA CORRELATED WITH THE LITHOLOGIC DRILL LOG (CONTINUED)

HOLE NO. DIRECTION LOCATION	VIDEO LOG (THIS REPORT)		DRILL LOG (FROM GALLERANI, 1985)	
	6.19	Anhydrite/clay - <13 mm		anhydrite- MB-138
	6.46	Anhydrite/clay - <3 mm	6.51	Top of anhydrite- MB-138
	9.97	Clay L squeezing into the hole		
	10.73	Light orange band- anhydrite (?) - <25 mm	11.35	Anhydrite - 25 mm
	13.53	End of survey	15.54	End of hole
DH-35 Up Room G	0.00	Begin salt crust		
	0.21	End salt crust		
	1.77	Begin salt crust		
	1.98	End salt crust		
	2.16	Bottom on anhydrite "b" definitely wet	1.89	Bottom of anhydrite "b"
	2.35	Top of anhydrite "b"	1.95	Top of anhydrite "b"
	2.41	Anhydrite - <2 mm		
	2.59	Anhydrite - 2 mm - 3 mm	1.95-	Anhydrite stringers
	2.87	Anhydrite - <3 mm		
	3.02	Anhydrite - <3 mm		
	3.17	Anhydrite/clay - <2 mm		
	3.26	Anhydrite/clay - <3 mm		
	4.15	Begin salt crust		
	4.33	End salt crust- bottom of anhydrite "a"	4.02	Bottom of anhydrite "a"
	4.51	Top of anhydrite "a"	4.22	Top of anhydrite "a"
	4.85	Anhydrite - <13 mm		
	4.94	Anhydrite - <25 mm		
	5.97	Begin salt crust		
	6.40	End salt crust		
	7.50	Anhydrite/clay I- <50 mm	7.32	Clay layer- < 10 mm
	7.53	Anhydrite- <3 mm		
	7.86	Anhydrite- <6 mm		
	11.40	Bottom of anhydrite- MB-138	11.13	Bottom of anhydrite- MB-138
	11.58	Top of anhydrite- MB-138	11.31	Top of anhydrite- MB-138
	11.64	Anhydrite/clay - <13 mm		
	11.86	Anhydrite/clay- <13 mm	15.39	Clay layer - <50 mm
	14.63	End of survey	15.85	End of hole
DH-36 Down Room G	2.13	Top of anhydrite- MB-139	2.13	Top of anhydrite- MB-139
	3.05	Bottom of anhydrite- MB-139	3.17	Bottom of anhydrite- MB-139
			5.58	Top clay/anhydrite
			5.67	Bottom clay/anhydrite
	9.85	Top of anhydrite "c"- visible fracture at top of unit- <3 mm wide and 50 mm long	10.64	Top of anhydrite "c"

TABLE I-1

FEATURES OBSERVED WITH THE VIDEO CAMERA CORRELATED WITH THE LITHOLOGIC DRILL LOG
(CONTINUED)

HOLE NO. DIRECTION LOCATION	VIDEO LOG (THIS REPORT)		DRILL LOG (FROM GALLERANI, 1985)	
	9.94	Bottom of anhydrite "c"	10.82	Bottom of anhydrite "c"
	12.34	End of survey	15.70	End of hole
DH-37 Up Room G	0.67	Bottom of salt crust		
	1.46	Top of salt		
	1.77	Salt knobs		
	1.92	Bottom of anhydrite "b"	1.62	Bottom of anhydrite "b"
	1.98	Top of anhydrite "b"	1.68	Top of anhydrite "b"
	1.99	Clay - < 2 mm		
	2.10	Clay - <3 mm	1.68-3.44	Scattered white anhydrite stringers
	2.23	Clay - <3 mm		
	2.62	2 clay layers <25 mm apart both <2 mm thick		
	2.96	Clay layer - <2 mm		
	4.02	Bottom of anhydrite "a"	3.72	Bottom of anhydrite "a"
	4.15	Top of anhydrite "a"	3.87	Top of anhydrite "a"
	4.42	Bottom of anhydrite bed		
	4.51	Top of anhydrite bed		
	7.10	Anhydrite - <25 mm	6.51	Clay - <13 mm
	7.50	Clay - <6 mm		
	8.72	Bottom of salt crust		
	8.90	Top of salt crust		
	11.00	Bottom of anhydrite- MB-138	10.71	Bottom of anhydrite- MB-138
	11.22	Top of anhydrite MB-138	10.93	Top of anhydrite - MB 138
	11.49	Anhydrite/clay - <3 mm		
	11.64	Anhydrite/clay - <3 mm	10.93-12.10	Scattered white anhydrite with anhydrite stringers
	11.70	Clay - <2 mm		
	11.86	Clay - <2 mm		
	12.04	Anhydrite/clay - <2 mm		
	14.20	End of survey	15.70	End of hole
DH-38 Down Room G			2.30	Top of anhydrite- MB-139
			2.90	Bottom of anhydrite- MB-139
	10.48	Top of anhydrite "c"	10.45	Top of anhydrite "c"
	10.55	Bottom of anhydrite "c"	10.55	Bottom of anhydrite "c"
	13.40	End of survey	14.48	End of hole
DH-39 Up Room G	0.67	Salt knobs		
	0.98	Start of salt crust		
	1.25	End of salt crust		
	2.10	Bottom on anhydrite "b"	2.01	Bottom of anhydrite "b"
	2.16	Top of anhydrite "b"	2.07	Top of anhydrite "b"
	2.65	Clay - <3 mm		
	2.93	Clay - <3 mm		

TABLE I-1

FEATURES OBSERVED WITH THE VIDEO CAMERA CORRELATED WITH THE LITHOLOGIC DRILL LOG
(CONTINUED)

HOLE NO. DIRECTION LOCATION	VIDEO LOG (THIS REPORT)		DRILL LOG (FROM GALLERANI, 1985)	
	2.99	Clay - <2 mm		
	3.08	Clay - <2 mm		
	4.11	Bottom of anhydrite "a"	4.24	Bottom of anhydrite "a"
	4.30	Top of anhydrite "a"	4.31	Top of anhydrite "a"
	4.57	Anhydrite/clay - <25 mm	4.82	Anhydrite - <3 mm
	4.63	Anhydrite/clay - <25 mm		
	6.40	Clay <2 mm		
	7.18	Bottom of anhydrite/clay I		
	7.25	Top of anhydrite/clay I		
	7.32	Clay - <3 mm		
	7.47	Clay - <3 mm		
	7.65	2 clay layers <25 mm apart both <6 mm thick	7.65	Clay - <6 mm-bottom of anhydrite
	8.66	Bottom possible salt crust	7.67	Top of anhydrite
	8.93	Top of possible salt crust		
	11.25	Bottom on anhydrite- MB-138 clay K squeezing into hole	10.94	Bottom of anhydrite- MB-138
	11.49	Top of anhydrite- MB-138	11.13	Top of anhydrite- MB-138
	11.70	Clay anhydrite - <25 mm		
	11.77	Clay/anhydrite - 50 mm		
	14.63	End of survey	15.45	End of hole
DH-40 Down Room G	1.90	Small salt knobs		
	2.70	Salt crust begins	2.10	Top of anhydrite- MB-139
	3.10	End of salt crust		
	3.30	Begin salt crust	3.30	Bottom of anhydrite- MB-139
	3.70	End salt crust		
	4.30	Salt knobs		
	10.40	Top of anhydrite "c"	10.70	Top of anhydrite "c"
	10.50	Bottom of anhydrite "c"	10.80	Bottom of anhydrite "c"
	13.40	End of survey	15.54	End of hole
DH-41 Up Room G	0.34	Bottom of salt crust		
	0.94	Top of salt crust		
	2.16	Bottom of anhydrite "b"	2.13	Bottom of anhydrite "b"
	2.59	Top of anhydrite "b"	2.23	Top of anhydrite "b"
	4.05	Bottom of anhydrite "a"	4.21	Bottom of anhydrite "a"
	4.24	Top of anhydrite "a"	4.39	Top of anhydrite "a"
	4.57	Bottom of anhydrite		
	4.63	Top of anhydrite		
	7.16	Anhydrite/clay (?)	7.56	Clay - <6 mm, Bottom of anhydrite
	7.80	Clay I/anhydrite - <2 mm		
	11.22	Bottom of anhydrite- MB-138	7.62	Top of anhydrite- MB-138
	11.37	Top of anhydrite	11.13	Bottom of anhydrite

TABLE I-1

FEATURES OBSERVED WITH THE VIDEO CAMERA CORRELATED WITH THE LITHOLOGIC DRILL LOG
(CONTINUED)

HOLE NO. DIRECTION LOCATION	VIDEO LOG (THIS REPORT)		DRILL LOG (FROM GALLERANI, 1985)	
	11.58	Clay/anhydrite - 25 mm		
	11.77	Clay/anhydrite - 25 mm		
	14.20	End of survey	14.93	End of hole
DH-42 Down Room G	2.70	Solid salt crust starts	2.20	Top of anhydrite- MB-139
	3.00	Solid salt crust ends	3.10	Bottom of anhydrite- MB-139
	10.70	Top of anhydrite "c"	8.60-12.10	Unable to log - see log for DH-42A
	10.80	Bottom of anhydrite "c"		
	11.30	End of survey	15.60	End of hole
DH-42A Down Room G	0.90	Small salt crust ends by 1.1m	0.00-6.60	Not logged - see log for DH-42
	2.40	Salt crust starts		
	2.70	Salt crust ends		
			10.70	Top of Anhydrite "c"
			10.90	Bottom of Anhydrite "c"
	11.90	End of Survey	12.34	End of hole
DHP-401 Up Panel 1	1.80	Bottom of anhydrite "b"	2.53	Bottom of anhydrite "b"
	1.89	Top of anhydrite "b"	2.65	Top of anhydrite "b"
	4.60	Bottom of anhydrite "a"	4.39	Bottom of anhydrite "a"
	4.78	Top of anhydrite "a"	4.60	Top of anhydrite "a"
	4.94	Clay/anhydrite - <2 mm	4.75	Anhydrite - 13 mm
	5.03	Clay/anhydrite - <25 mm		
	7.16	Clay - <2 mm		
	7.53	Clay/anhydrite - <13 mm		
	11.61	Bottom of anhydrite- MB-138 clay squeezing into hole at contact	11.37	Bottom of anhydrite- MB-138
	11.67	Top of anhydrite- MB-138	11.64	Top of anhydrite- MB-138
	11.76	Clay/anhydrite - <3 mm		
	11.86	Clay/anhydrite - <51 mm		
	12.07	Clay/anhydrite - <6 mm		
	12.13	End of survey	15.03	End of hole
DHP-402A Down Panel 1	1.13	Top of anhydrite- MB-139	1.37	Top of - MB-139
	1.80	Fracture in MB-139- <13 mm	1.83	Top of anhydrite
	1.89	Bottom of anhydrite- MB-139	2.13	Bottom of anhydrite- MB-139
			4.54	Clay - 27 mm
			9.45	Polyhalite - <27 mm
			9.63	Top of anhydrite "c"
			9.69	Bottom of anhydrite "c"
	8.53	End of survey	15.21	End of hole

APPENDIX J

MATHEMATICAL FORMULATION OF THE COUPLED SALT CREEP/BRINE FLOW PHENOMENA

APPENDIX J:

MATHEMATICAL FORMULATION OF THE COUPLED SALT-CREEP/BRINE FLOW PHENOMENA

This appendix provides background information on mathematical formulations, solution methods, and verification results to support the brine modeling work. Sections J.1 through J.6 present the comprehensive formulations for rock deformation and brine flow. This background information supports Section 5.3 in the text. To describe the flow system, three equations are required: conservation of mass, conservation of momentum, and conservation of energy. The governing equations derived in Sections J.1 through J.3 are the mass conservation equations. The general time dependent relations for rock salt are discussed in Section J.4. Section J.5 discusses heat transfer equations. Section J.6 discusses proposed solution methods. To assist the reader in interpreting these relations, Table J-1 presents the nomenclature used in this appendix and Chapter 5.0.

Section J.7 provides background information for the implementation of a preliminary analysis by utilizing modifications to two existing codes that model rock mechanics and fluid flow. These modifications provide an initial estimate of the effects of salt deformation on the flow of brine to a 1.8-meter-radius shaft at a depth of 655 meters, as described in Sections 5.4 through 5.11 of the text.

J.1 SINGLE PHASE FLOW THROUGH DEFORMABLE ROCKS

Considering a control volume saturated with a fluid, the continuity equation (derived from Freeze and Cherry, 1979) may be written as:

$$(\rho_f u_i),i - \frac{D(\rho_f \theta)}{Dt} = 0 \qquad \text{(J.1)}$$

where

ρ_f = fluid density,
u_i = fluid flux rate in the "i" direction,
θ = rock porosity, and
t = time.

TABLE J-1
NOMENCLATURE

A' = Constant

A = Activation Energy

$B_1 = \dfrac{V_\iota \text{ at reservoir condition}}{V_\iota \text{ at standard condition}} = \dfrac{P_\iota \text{ at standard condition}}{P_\iota \text{ at reservoir condition}}$

C_f = Fluid compressibility

C_1, C_2 = Shear strength constants

C_3, C_4 = Viscous constants

C_E = Effective solubility of salt in water

D_E = Effective diffusivity of salt in brine

E = Heat dispensivity of fluid or Young's modulus $[M/LT^2]$

E_1, E_2 = Young's moduli

F = Body force

G = Shear modulus

G_1, G_2 = Shear moduli

$H(\tau_o - \tau_s)$ = Step function = 0 when $\tau_o \leq \tau_s$
= 1 when $\tau_o > \tau_s$

I_h = Heat generation rate

J_b = Conductive heat flux of fluid per unit area

J_r = Conductive heat flux of rock per unit area

M_a = Molecular weight of gas

P = Pressure

P_a = Air pressure

P_b = Brine pressure

P_c = Capillary pressure

P_o = Farfield hydrostatic stress

P_0 = Initial pressure

Q = Constant pumping rate

Q_d = Source term

Q = Activation energy

TABLE J-1
NOMENCLATURE

(continued)

Qp = Fluid mass source

R = Universal gas constant

S_a = Air saturation

S_b = Brine saturation

S' = Storage coefficient

S_1 = Saturation ratio of phase 1

S_w = Water saturation

T = Temperature

T' = Fluid tramsmissivity

T_o = Initial temperature

T_a = Air temperature

T_b = Brine temperature

T_r = Rock temperature

U_b = Internal energy of fluid per unit mass

U_r = Internal energy of rock per unit mass

V = Viscous factor

V_1 = Volume of phase 1

V_b = Volume of brine

V_2, V_3, V_p = Viscous factors

V_r = Volume of rock element

V_s = Volume of solids in rock element

V_v = Void volume of rock element

$W (u)$ = Well function

Z = Compressibility factor

a = Area fraction of grain boundaries that is dry or radius of circular opening or gas phase identifier

b = Brine phase identifier

b_0 = Boltzmann's constant

d = Grain size

g = Gravitational constant

TABLE J-1
NOMENCLATURE

(continued)

h = Specific heat capacity

k = Rock permeability

k_{r1} = Relative permeability

n = Stress exponent

o = Initial state

q_1 = Fluid production (or injection)

r = Rock phase identifier or radius

s = Drawdown

t = Time

th = Thermal identifier

u = Displacement matrix or fluid flow data

u_i = Fluid flux rate in the "i" direction

u_r = Relative radial displacement

$\underline{v}$ = Average fluid velocity vector

v_b = Velocity of fluid with respect to a fixed coordinate

v_i = Velocity of a moving coordinate system

ve = Viscoelastic identifier

vp = Viscoelastic identifier

x = Direction identifier

y = Direction identifier

z = Elevation from reference plane

ι = Phase ι

ΔT = Change in temperature

Φ = Fluid potential = $P + pgz$

Ω = Atomic volume of salt

α = Compressibility of porous matrix or thermal expansion coefficient

β_b = Brine thermal expansion coefficient

β_f = Volumetric thermal expansion coefficient

γ = Shear strain

γ_o = Octahedral shear strain

TABLE J-1
NOMENCLATURE

(continued)

γ_{xy} = Engineering shear strain

ε = Strain

ε_m = Dilational strain

ε_D = Diffusional creep rate

ε_r = Strain coefficient in the radial direction

ε_x = Strain in the x direction

ε_y = Strain in the y direction

${}^{\varepsilon}1, {}^{\varepsilon}2, {}^{\varepsilon}3$ = Principal strains

ζ = Heat transfer coefficient

θ = Rock porosity

λ_ι = $\frac{{}^{k}n}{\mu_\iota B_\iota}$ or coefficient of heat conduction

μ = Fluid viscosity

μ_a = Air viscosity

μ_b = Brine viscosity

μ_f = Fluid viscosity

ν = Velocity

ρ = Density

ρ_b = Brine density

ρ_f = Fluid density

ρ_g = Gas density

ρ_0 = Density at $T=T_0$ and $P=P_0$

ρ_o^T = Initial density at T=constant temperature and $P=P_o$

σ = Stress

σ_h = Farfield hydrostatic stress

σ_l = Normal stress

σ_m = Mean stress = $1/3\ (\sigma_x + \sigma_y + \sigma_z)$

σ_r = Radial stress

σ_x = Normal stress

σ_y = Normal stress

σ_z = Normal stress

TABLE J-1
NOMENCLATURE

(concluded)

σ_θ = Tangential stress

τ = Shear stress

τ_c = Reference shear stress

τ_o = Octahedral shear stress

τ_s = Shear strength

υ = Poisson's ratio

$\underline{\nabla}$ = Del operator

Note that tensor notations are adopted in Equation (J.1).

$D(\rho_f \theta)/Dt$ is called the material derivative that accounts for the motion of the reference coordinate, and

$$(\rho_f u_i)_{,i} = \frac{\partial(\rho_f \theta)}{\partial t} + (\rho_f \theta)_{,i} v_i \qquad \text{(J.2)}$$

where

v_i = velocity of moving coordinate (rock element).

To express u_i in terms of pressure, Darcy's Law is introduced.

$$u_i = \frac{-k_{ij}}{\mu} \phi_{,j} \qquad \text{(J.3)}$$

where

ϕ = fluid potential = $P + \rho_f gz$,
k_{ij} = component of intrinsic permeability tensor for rock,
μ = fluid viscosity,
g = gravitational constant,
z = elevation above reference plane, and
P = fluid pressure.

The assumptions behind this law are:

- Hydraulic gradient is the driving force for fluid flow.
- Fluid acceleration is negligible.
- Both the fluid and the flow media are homogeneous.

Darcy's Law is assumed to apply at the very low fluid velocities encountered in salt. For slightly compressible materials, the variation of density as a function of confining pressure under isothermal conditions (Bear, 1972) is:

$$\rho = \rho_0^T \exp\left[C_f(P - P_0)\right] \qquad (J.4)$$

where

C_f = compressibility,
ρ_0^T = initial density at T = constant temperature and $P = P_0$, and
P_0 = initial pressure.

Thermal expansion under isobaric conditions (Bear, 1972) is given by:

$$\rho_0^T = \frac{\rho_0}{\left[1 - \beta_f(T - T_0)\right]} \qquad (J.5)$$

where

β = volumetric thermal expansion coefficient,
T = temperature,
T_0 = initial temperature, and
ρ_0 = density at $T = T_0$ and $P = P_0$.

Both β and C are functions of confining pressure and temperature. Both are assumed to be constant in this study for simplification. A literature review did not find any state relationship for liquids and White (1986) indicates that he does not know of a "perfect-liquid law" comparable to that for gases. Therefore, to consider changes in density as pressure and temperature are varied simultaneously, based on Equations J.4 and J.5, the following relationship is proposed:

$$\rho = \rho_0 \frac{\exp\left[C_f(P - P_0)\right]}{\left[1 + \beta_f(T - T_0)\right]} \qquad (J.6)$$

Knowing

$$\frac{\partial \rho_f}{\partial P} = C_f \, \rho_f \qquad \text{and} \qquad \frac{\partial \rho_f}{\partial T} = - \frac{\rho_f \, \beta}{1 + \beta_f (T - T_0)} ,$$

the partial differential of ρ_f with respect to any arbitrary variable can be defined as:

$$\begin{aligned} \frac{\partial \rho_f}{\partial .} &= \frac{\partial \rho_f}{\partial P} \frac{\partial P}{\partial .} + \frac{\partial \rho_f}{\partial T} \frac{\partial T}{\partial .} \\ &= \rho_f \, \{ C_f \frac{\partial P}{\partial .} - \frac{\beta}{[1 + \beta_f \, (T - T_0)]} \frac{\partial T}{\partial .} \} \end{aligned} \tag{J.7}$$

Changes in rock porosity are generally expressed as a function of total stress, pore pressure, and temperature. (Detailed expansions of $\partial\theta/\partial t$ and $\theta_{,i}$ are shown in the following sections rather than here because of the complexity involved in rock stress-strain constitutive relationships.) These two terms are left intact throughout this appendix.

Fluid viscosity is a function of pressure, temperature, and brine concentration. Among these factors, brine concentration and temperature have much more influence on fluid viscosity than pressure has. If the concentration of the saturated brine remains constant, it is assumed that:

$$\mu = \mu(T)$$

and

$$\frac{\partial \mu}{\partial .} = \frac{\partial \mu}{\partial T} \frac{\partial T}{\partial .} \tag{J.8}$$

Combining Equations (J.2) through (J.8), yields:

$$\frac{k_{ij}}{\mu} \phi_{,j} \left(C_f P_{,i} - \frac{\beta_f}{1 + \beta_f (T - T_0)} T_{,i}\right) + \frac{1}{\mu} k_{ij,i} \phi_{,j} - \frac{1}{\mu^2} k_{ij} \frac{\partial \mu}{\partial T} T_{,i} \phi_{,j} + \frac{k_{ij}}{\mu} \phi_{,ji}$$

$$= \theta\left[C_f \frac{\partial P}{\partial t} - \frac{\beta_f}{1 + \beta_f (T - T_0)} \frac{\partial T}{\partial t}\right] \qquad \text{(J.9)}$$

$$+ \frac{\partial \theta}{\partial t} + \left\{ \theta \left[C_f P_{,i} - \frac{\beta_f}{1 + \beta_f (T - T_0)} T_{,i}\right] + \theta_{,i} \right\} v_i$$

Note that $\phi = P + \rho g z$, therefore:

$$\phi_{,i} = P_{,i} + \rho_{,i} g z + \rho g z_{,i} \qquad \text{(J.10)}$$

and

$$\phi_{,ji} = P_{,ji} + \rho_{,ji} g z + \rho_{,j} g z_{,i} + \rho_{,i} g z_{,j} + \rho g z_{,ji}$$

As variations in ρ_f and z are much smaller than pressure variations, $\rho_{,ji}$ and $z_{,ji}$ are both negligible. Thus:

$$\phi_{,ji} = P_{,ji} + g(\rho_{,j} z_{,i} + \rho_{,i} z_{,j}) \qquad \text{(J.11)}$$

Substituting Equations (J.10) and (J.11) into Equation (J.9), the governing equation for single-phase fluid flow through a heterogeneous, nonisothermal, and compressible porous media is:

$$\begin{aligned}
&\frac{1}{\mu}\left[P_{,j}(1 + \rho_f C_f gz) - \frac{\beta_f T_{,j} gz}{[1 + \beta_f (T - T_0)]} + \rho_f gz_{,j}\right] \cdot \\
&\quad \left[k_{ij}\left(C_f P_{,i} - \frac{\beta_f}{1 + \beta_f (T - T_0)} T_{,i}\right) + k_{ij,i} - \frac{1}{\mu} k_{ij} \frac{\partial \mu}{\partial T} T_{,i}\right] \\
&\quad + \frac{k_{ij}}{\mu}\left[P_{,ji} + g C_f \rho_f (P_{,i} z_{,j} + P_{,j} z_{,i}) - g\rho_f \frac{\beta_f (T_{,j} Z_{,i} + T_{,i} Z_{,j})}{[1 + \beta_f (T - T_0)]}\right] \qquad \text{(J.12)} \\
&= \theta\left[C_f \frac{\partial P}{\partial t} - \frac{\beta_f}{1 + \beta_f (T - T_0)} \frac{\partial T}{\partial t}\right] + \frac{\partial \theta}{\partial t} + \left\{\theta\left[C_f P_{,i} - \frac{\beta_f}{1 + \beta_f (T - T_0)} T_{,i}\right] + \theta_{,i}\right\} v_i
\end{aligned}$$

J.2 TWO-PHASE FLUID FLOW THROUGH DEFORMABLE ROCKS

A typical set of two-phase flow equations (Aziz and Settari, 1979) is:

$$(\lambda_b \phi_{b,i})_{,j} = \frac{D}{Dt}\left(\theta \frac{S_b}{B_b}\right) + q_b \qquad \text{(J.13)}$$

$$(\lambda_a \phi_{a,i})_{,j} = \frac{D}{Dt}\left(\theta \frac{S_a}{B_a}\right) + q_a \qquad \text{(J.14)}$$

$$P_c = P_a - P_b = f(S_b) \qquad \text{(J.15)}$$

$$S_b + S_a = 1 \qquad \text{(J.16)}$$

where

S_a = air saturation,
S_b = brine saturation,
$\lambda_1 = \dfrac{k_{r1}}{\mu_1 B_1} k_{ij}$, fix for either air or brine,
k_{r1} = relative permeability of phase 1 as a function of S_1,
S_1 = saturation ratio of phase 1 $= \dfrac{V_1}{V_v}$,

$$B_1 = \frac{V_1 \text{ reservoir}}{V_1 \text{ at standard condition}} = \frac{\rho_1 \text{ at standard condition}}{\rho_1 \text{ of reservoir fluid}}$$

q_1 = fluid production rate (or injection) of phase 1,
P_c = capillary pressure,
V_1 = volume of phase 1 in a fixed volume rock element,
V_v = void volume of a rock element,
V_r = volume of a rock element,
ρ_g = gas density 1.25 kg/m^3 at 15°C and 1 atm (for nitrogen), and
ρ_b = brine density 1,200 kg/m^3 at 15°C and 1 atm.

The equation of state for the gas is:

$$\frac{P_a}{\rho_a} = \frac{ZRT}{M_a} \tag{J.17}$$

where

P_a = air pressure
Z = compressibility factor
R = universal gas constant
M_a = molecular weight of gas.

Taking a derivative of gas density and utilizing Equation (J.17) produces:

$$\frac{\partial \rho_a}{\partial .} = \frac{\partial \rho_a}{\partial P_a}\frac{\partial P_a}{\partial .} + \frac{\partial \rho_a}{\partial T_a}\frac{\partial T_a}{\partial .} = \rho_a\left(\frac{1}{P_a}\frac{\partial P_a}{\partial .} - \frac{1}{T_a}\frac{\partial T_a}{\partial .}\right) \tag{J.18}$$

The fluid potential is defined previously. When density is small, as for air, the equation used is:

$$\phi_a = P_a + \rho_a gz \approx P_a \tag{J.19}$$

In flow problems with solution gas, free gas is released from the liquid phase when pressure is reduced. (Isothermal conditions are assumed for contact handled transuranic (CH-TRU) waste environments.) Mobilized gas may occupy space in rock pores, keeping pore pressure higher than expected. To account for this effect, it is proposed to approximate gas solubility data explicitly and estimate the amount of exsolved gas as a function of pressure and the pressure history. The term q_n is used to quantify the rate of gas exsolution. However, no liquid production or injection is expected in nuclear repository environments and consequently q_w is zero. Combining Equations (J.6), (J.7), (J.8), and (J.13) through (J.19), the flow equation for the brine is obtained:

$$\begin{aligned}
&\frac{k_{rb}}{\mu_b}\left[C_b P_{b,i} - \frac{\beta_b}{1 + \beta_b (T - T_0)} T_{,j}\right] k_{ij}\, \phi_{b,i} - \frac{k_{rb}}{\mu_b^2}\frac{\partial \mu_b}{\partial T} T_{,j}\, k_{ij}\, \phi_{b,i} \\
&+ \frac{(k_{rb}\, k_{ij,j})}{\mu_b}\phi_{b,i} + \frac{k_{rb}}{\mu_b} k_{ij}\, \phi_{b,ij} \\
&= \frac{V_b}{1200V_r}\left[C_b \frac{\partial P_b}{\partial t} - \frac{\beta_b}{1 + \beta_b(T - T_0)}\frac{\partial T}{\partial t}\right] + \frac{1}{V_r}\frac{\partial V_b}{\partial t} - \frac{V_b}{V_r^{2}}\frac{\partial V_r}{\partial t} \\
&+ \frac{v_l}{1200V_r}\left\{V_b\left[C_b P_{b,i} - \frac{\beta_b}{1 + \beta_b(T - T_0)} T_{,i}\right] + V_{b,i} - \frac{V_b}{V_r} V_{r,i}\right\}
\end{aligned} \tag{J.20}$$

where subscript b stands for brine. The flow equation of gas is:

$$\begin{aligned} & \frac{k_{ra}}{\mu_a}\left(\frac{1}{P_a} P_{a,j} - \frac{1}{T} T_{,j}\right) k_{ij} P_{a,i} - \frac{k_{ra}}{\mu_a}\frac{\partial \mu_a}{\partial T} k_{ij} T_{,j} P_{a,i} \\ & + \frac{(k_{ra} k_{ij})_{,j}}{\mu_a} P_{a,i} + \frac{k_{ra}}{\mu_a} k_{ij} P_{a,ij} \\ & = \frac{V_a}{V_r}\left(\frac{1}{P_a}\frac{\partial P_a}{\partial t} - \frac{1}{T}\frac{\partial T}{\partial t}\right) + \frac{1}{V_r}\frac{\partial V_a}{\partial t} - \frac{V_a}{V_r^2}\frac{\partial V_r}{\partial t} \\ & + \frac{1}{V_r}\left[V_a\left(\frac{1}{P_a} P_{a,i} - \frac{1}{T} T_{,i}\right) + V_{a,i} - \frac{V_a}{V_r} V_{r,i}\right] + \frac{q_a}{\rho_a}\rho_{gas} \end{aligned} \qquad (J.21)$$

In deriving these equations, it is assumed that gas temperature, brine temperature, and rock temperature are all equal at any given point in the rock.

$$T_a = T_b = T_r = T$$

Local thermal equilibrium is assumed. The governing equations for two-phase fluid flow through porous media are Equations (J.15), (J.16), (J.20), and (J.21).

J.3 SIMPLIFICATIONS OF THE GOVERNING EQUATIONS

At the Waste Isolation Pilot Plant (WIPP) site, it is assumed that (CH-TRU) nuclear wastes (rather than RH wastes) will be stored underground. The heat that may be generated by the nuclear waste may then be ignored and the temperature is assumed to be constant.

Thus, Equation (J.12) is simplified as:

$$\begin{aligned} & \frac{1}{\mu_f}\{[P_{,j}(1 + g\rho_f C_f z) + g\rho_f z_{,j}](C_f k_{ij} P_{,i} + k_{ij,i}) \\ & \qquad + k_{ij}[P_{,ji} + g\rho_f C_f (P_{,j} z_{,i} + P_{,i} z_{,j})]\} \\ & = \theta C_f \frac{\partial P}{\partial t} + \frac{\partial \theta}{\partial t} + (\theta C_f P_{,i} + \theta_{,i}) v_i \end{aligned} \qquad (J.22)$$

Further simplification can be made to other relationships by eliminating the temperature terms.

J.4 TIME-DEPENDENT DEFORMATION OF ROCK SALT AROUND EXCAVATION ROOMS

Rock salt is a rheologic material. Deformation of rock salt around underground excavations is dependent on time, stress, and temperature. Part of the roof-floor convergence of the excavations at the WIPP can be attributed to fracture development. Induced fractures in the vicinity of excavated rooms complicate the stress-deformation analysis. Deformation of fractured salt is attributed to the propagation of fractures as well as the plastic flow of salt grains. Unfortunately, it is nearly impossible to predict the initiation and propagation of fractures in the field. As a simplification, salt is analyzed as a continuum that follows the stress equilibrium states and displacement continuity conditions. This approach tends to underestimate the induced porosity of salt in the fractured zone and overestimates the same porosity away from the fractured zone.

Three sets of equations describe the deformation process: the equations of equilibrium, the displacement-compatibility equations, and the stress-strain constitutive equations. The effects of time and temperature on salt deformation will be discussed in detail when the stress-strain equations are derived.

J.4.1 The Equations of Equilibrium and Displacement Compatibility

The equation of equilibrium states that in the absence of external forces and in the case of very slow deformation, such as creep in salt, the equation of equilibrium can be stated as:

$$\sigma_{ij,j} + F_j = 0 \qquad \text{(J.23)}$$

or

$$\dot{\sigma}_{ij,j} = 0 \qquad \text{(J.24)}$$

where σ_{ij} is the stress tensor and F_j is the body force (which acts only in the z direction for this study).

The equation of displacement compatibility (Fung, 1965) is:

$$\varepsilon_{ij,kl} + \varepsilon_{kl,ij} = \varepsilon_{ik,jl} + \varepsilon_{jl,ik} \tag{J.25}$$

For two-dimensional problems (x, y plane), Equation (J.25) reduces to:

$$\frac{\partial^2 \varepsilon_x}{\partial y^2} + \frac{\partial^2 \varepsilon_y}{\partial x^2} = \frac{\partial^2 \gamma_{xy}}{\partial x \partial y} \tag{J.26}$$

where

$\varepsilon_{ij,kl}$ = strain in tensor notation,
ε_x = strain in the x direction,
ε_y = strain in the y direction,
γ_{xy} = engineering shear strain.

J.4.2 Constitutive Equations for Deformation of Salt

Typical room convergence curves are illustrated in Figure J-1. In the figure, the room first shows a relatively rapid initial displacement, followed by transient movements as displacement rates decrease until the rates become constant. Thus it is assumed that:

$$\text{total strain} = \text{elastic strain} + \text{viscoelastic strain} + \text{viscoplastic strain}$$

and

$$\text{total strain rate} = \text{elastic strain rate} + \text{viscoelastic strain rate} + \text{viscoplastic strain rate}$$

The viscoplastic strain is used here to approximate the steady-state creep of salt and the viscoelastic strain is used to model the transient creep. There are many constitutive relationships proposed for modeling the creep of salt; this model was chosen for its simplicity and reasonable accuracy. Modification of this model may be required.

Figure J-2 illustrates the model.

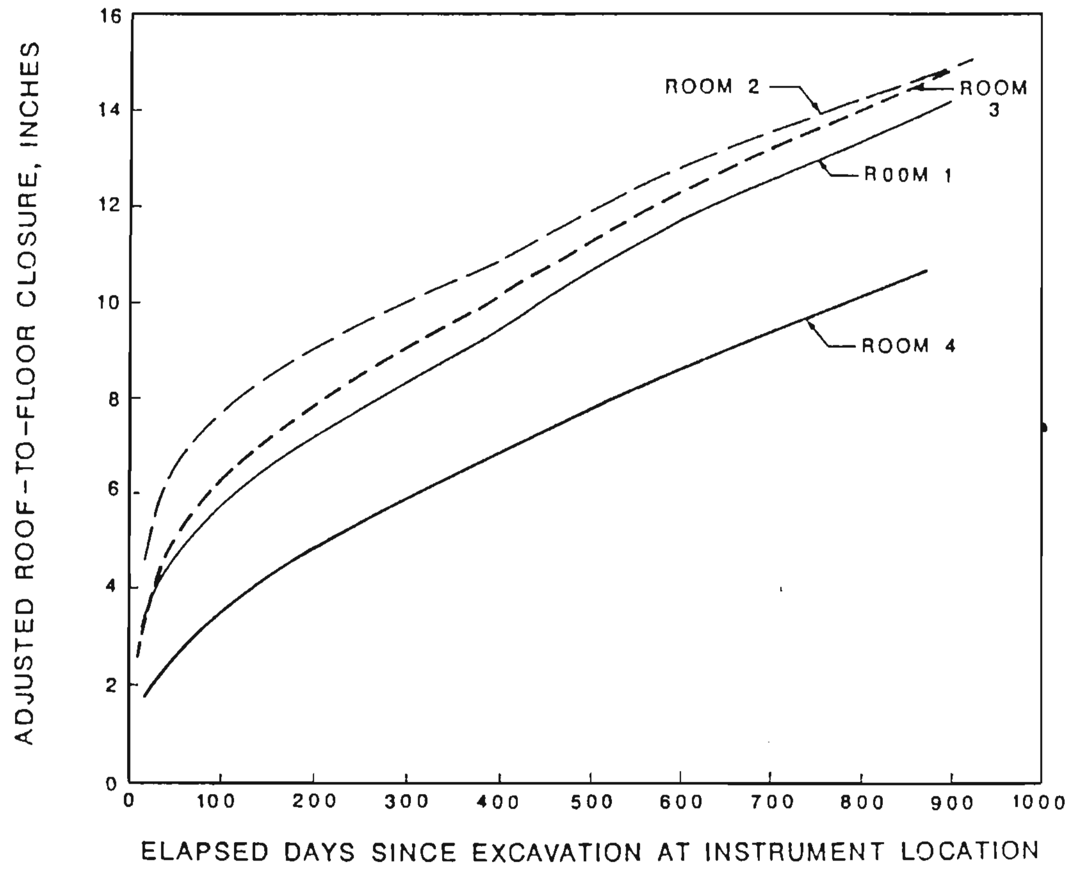


FIGURE J-1 TYPICAL ROOM CLOSURE MEASURED RATES
(MODIFIED FROM BETCHEL NATIONAL, INC., 1986)

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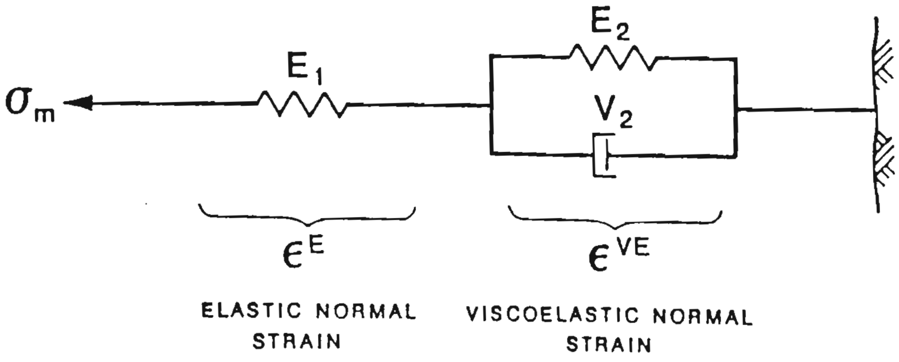
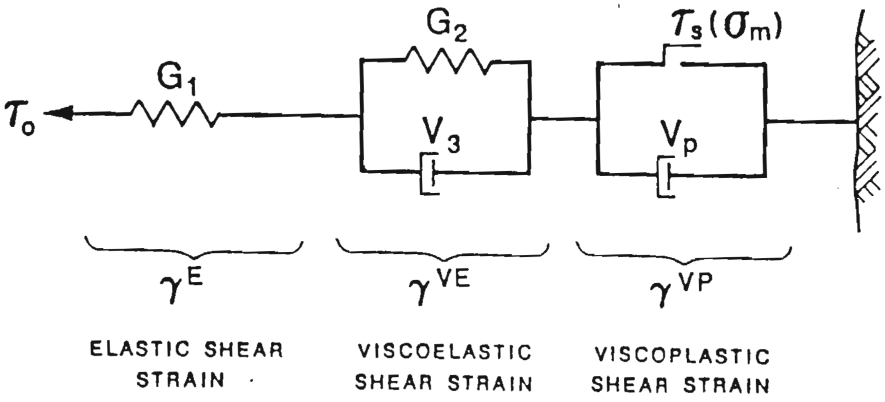
DILATATIONAL MODEL



DISTORTIONAL MODEL



where

E_1, E_2 = Young's moduli
G_1, G_2 = Shear moduli
V_2, V_3, V_p = Viscous factors
τ_s = Shear strength of rock = $C_1\sigma_m + C_2$
σ_i = Normal stresses
τ = Shear stress
σ_m = Octahedral normal stress = $1/3\ (\sigma_x + \sigma_y + \sigma_z)$

FIGURE J-2 PROPOSED CONSTITUTIVE MODELS FOR DEFORMATION OF ROCK SALT *(MODIFIED FROM SERATA AND OTHERS, 1985)*

The models are mathematically expressed as (modified from Serata and others, 1985):

$$\varepsilon_m = \sigma_m \{\frac{1}{E_1} + \frac{1}{E_2} [1 - \exp(\frac{-E_2}{V_2}t)] \} \qquad (J.27)$$

$$\gamma_0 = \tau_0 \{\frac{1}{G_1} + \frac{1}{G_2}[1 - \exp(-\frac{G_2}{V_3} t)] + \frac{1}{V_p} t\, H(\tau_0 - \tau_s) \} \qquad (J.28)$$

where

E_1, E_2 = Young's modulus,
G_1, G_2 = shear modulus,
V_2, V_3, V_p = viscous factor,
τ_s = shear strength of rock = $C_1\sigma_m + C_2$,
σ_m = mean stress = $1/3\ (\sigma_x + \sigma_y + \sigma_z)$,
C_1, C_2 = shear strength constants,
$H(\tau_0 - \tau_s)$ = step function $\{ \begin{matrix} = 0 \text{ when } \tau_0 \leq \tau_s \\ = 1 \text{ when } \tau_0 > \tau_s \end{matrix}$
τ_0 = octahedral shear stress,
t = time,
γ_o = octahedral strain,
ε_m = dilational strain, and
V_p = viscous factor of viscoplasticity.

The strain rates are:

$$\dot{\varepsilon}_m = \dot{\varepsilon}_{m_o} + \frac{\sigma_m}{V_2} \exp(-\frac{E_2}{V_2}t) \qquad (J.29)$$

$$\begin{aligned} \dot{\gamma}_0 = {} & \dot{\tau}_0 [\frac{1}{G_1} + \frac{1}{G_2} (1 - \exp(-\frac{G_2}{V_3}t)) + \frac{1}{V_p}tH(\tau_0 - \tau_s)] \\ & + \tau_0 [\frac{1}{V_3}\exp(-\frac{G_2}{V_3}t) + \frac{1}{V_p}H(\tau_0 - \tau_s)] \end{aligned} \qquad (J.30)$$

where

$$\dot{\varepsilon}_{m_o} = \dot{\sigma}_m \{\frac{1}{E_1} + \frac{1}{E_2}[1 - \exp(-\frac{E_2}{V_2}t)]\}$$

Equations (J.27) through (J.30) are generalized constitutive equations and can be modified for all stress and strain components.

J.4.3 Thermal Effects on Deformation of Salt

The steady-state creep of salt has previously been expressed (Herrman and others, 1980) as:

$$\dot{\gamma}_0^{vp} = A\left(\frac{\tau_0}{\tau_c}\right)^n \exp\left(-\frac{Q}{RT}\right) \qquad (J.31)$$

where

A = a constant,
τ_c = a constant for normalizing shear stress,
n = stress exponent,
Q = activation energy,
R = universal gas constant,
T = temperature, and
$\dot{\gamma}_0^{vp}$ = viscoplastic shear strain rate.

An examination of Equation (J.31) suggests the following modifications for the viscoelastic strains:

$$\varepsilon_m^{ve} = \frac{\sigma_m}{E_2}\left[1 - \exp\left(-\frac{E_2}{C_3 T} t\right)\right] \qquad (J.32)$$

$$\gamma_0^{ve} = \frac{\tau_0}{G_2}\left[1 - \exp\left(-\frac{G_2}{C_4 T} t\right)\right] \qquad (J.33)$$

where

C_3, C_4 = constants

$\varepsilon_m{}^{ve}$ = equivalent "viscoelastic" strain, and

$\gamma_0{}^{ve}$ = equivalent "viscoelastic" shear strain.

Heat will accelerate the deformation of salt in Equations (J.32) and (J.33). Because heat also causes instantaneous volumetric changes in rocks, it is further assumed that thermal deformation is elastic and has only dilatational effects:

$$\varepsilon_m^{TH} = -\alpha(T)\,\Delta T \tag{J.34}$$

$$\gamma_0^{TH} = 0 \tag{J.35}$$

where

α = thermal expansion coefficient,
$\varepsilon_m{}^{TH}$ = thermal dilational strain, and
$\gamma_0{}^{TH}$ = thermal shear strain.

Combining the above equations, it can be shown that:

$$\dot{\varepsilon}_m = \dot{\varepsilon}_{m_0} + \frac{\sigma_m}{V_2} \exp\left(-\frac{E_2}{C_3 T} t\right) \tag{J.36}$$

for $\tau_0 > \tau_s$:

$$\begin{aligned}\dot{\gamma}_0 = {} & A\left(\frac{\tau_0}{\tau_c}\right)^n \exp\left(\frac{-Q_p}{RT}\right) + \dot{\tau}_0\left[\frac{1}{G_1} + \frac{1}{G_2}\left(1 - \exp\left(-\frac{G_2}{C_4 T} t\right)\right)\right] \\ & + \frac{\tau_0}{C_4 T} \exp\left(-\frac{G_2}{C_4 T} t\right)\end{aligned} \tag{J.37}$$

for $\tau_0 \leq \tau_s$:

(J.38)

$$\dot{\gamma}_o = \dot{\tau}_0\left[\frac{1}{G_1} + \frac{1}{G_2}\left(1 - \exp\left(-\frac{G_2}{C_4 T} t\right)\right)\right] + \frac{\tau_0}{C_4 T} \exp\left(-\frac{G_2}{C_4 T} t\right)$$

These are the complete stress-strain-temperature constitutive equations.

J.4.4 Effects of Moisture on Rock Deformation

Water or brine is known to have a weakening effect on rock salt (Spiers and others, 1986). Water-salt interactions may fall into the following categories:

- Interaction between brine and crack surfaces.
- Intracrystalline effects.
- Interaction between brine and grain boundaries.

Fluids in solids reduce the internal frictional coefficient of solids. As a result, a wet creeping material, such as salt in a mine, may have a higher creep rate under deviatoric stresses than dry salts. Very little experimental work has been done on either the interaction between brine and crack surfaces or intracrystalline effects, but theories exist for predicting the effects of water or brine between grain boundaries. A typical equation to describe the fluid-assisted diffusional creep (Spiers and others, 1986) is:

$$\dot{\varepsilon}_D = \frac{A' C_E D_E \Omega (1 - a)}{a b_0 T d^3} \sigma \tag{J.39}$$

where

$\dot{\varepsilon}_D$ = diffusional creep rate,
A' = a constant,
C_E = effective solubility of salt in water,
D_E = effective diffusivity of salt in brine,
Ω = atomic volume of salt,
a = area fraction that is dry of grain boundaries,
d = grain size,
σ = stress,
b_0 = Boltzmann's constant, and
T = temperature.

Among these parameters, A', C_E, D_E, Ω, d, and b_0 are properties of the material and may be viewed as constants for a specific rock. The ratio (1 - a) / a is a function of saturation. The modification of Equations (J.37) and (J.38) through the application of Equation (J.39) presents a problem, because of the ratio (1 - a) / a. Comparing the case in which the area of grain boundaries is covered completely by brine to the case which grain boundaries are completely dry, (1 - a) / a changes from infinity to zero. Thus, according to Equation (J.39), the diffusional creep rate $\dot{\varepsilon}_D$ should also vary from infinity to zero, which is not reasonable. It is thus proposed that:

$$\begin{aligned} \dot{\varepsilon} &= (aS_b + b)\,\dot{\varepsilon}_{wet} \\ \dot{\gamma} &= (aS_b + b)\dot{\gamma}_{wet} \end{aligned} \qquad \text{(J.40)}$$

where

a,b = constants and
S_b = saturation of brine in salt.

The modified stress-strain constitutive equations are thus:

$$\dot{\varepsilon}_m = (aS_b + b)\ \{\dot{\varepsilon}_{m_0} + \frac{\sigma_m}{V_2}\exp(-\frac{E_2}{C_3T}t\ )\} \qquad \text{(J.41)}$$

for $\tau_0 \le \tau_s$:

$$\dot{\gamma}_0 = (aS_b + b)\ \{\dot{\tau}_0(\frac{1}{G_1} + \frac{1}{G_2}\ [1 - \exp(-\frac{G_2 t}{C_4 T})] + \frac{\tau_0}{C_4 T}\exp(-\frac{G_2 t}{C_4 T})\}$$

and for $\tau_0 > \tau_s$:

$$\begin{aligned} \dot{\gamma}_o = {} & (aS_b + b)\ \{A\ (\frac{\tau_0}{\tau_c})^n \exp(\frac{Q_p}{RT}) + \dot{\tau}_0 \frac{1}{G_1} + \frac{1}{G_2}[1 - \exp(-\frac{G_2 t}{C_4 T})\ ] \\ & + \frac{\tau_0}{C_4 T}\exp(\frac{G_2 t}{C_4 T}))\} \end{aligned} \qquad \text{(J.42)}$$

J.5 HEAT TRANSFER THROUGH THE SYSTEM

Unsaturated brine flow involves three different materials: salt, brine, and gas. Heat generated from nuclear wastes may propagate out via conduction through rocks and convection through brine and air. By assuming that heat transfer through radiation and convection through air is negligible, the energy balance equation is obtained as:

change of energy per unit mass	=	energy change caused by heat conduction through rocks	+	energy change caused by heat convection through brine	+	changes in strain energy of rock	+	energy exchange between brine and rock	+	internal heat generation

Mathematically expressed, the energy balance equation for the rock is:

$$\frac{D(\rho_r U_r)}{Dt} = (\sigma_{ij} v_{rj})_{,i} - J_{r_{i,i}} + \zeta_r (T_b - T_r) \qquad \text{(J.43)}$$

where

r = rock,
U_r = internal energy of rock per unit mass = $h_r T_r$,
h = specific heat capacity,
J_r = conductive heat flux of rock per unit area = $-(\lambda_{rij} T_r)_{,j}$
ζ = heat transfer coefficient,
$\lambda_{r_{ij}}$ = coefficient of heat conduction of rock, and
v_r = velocity of the rock element with respect to a fixed coordinate.

The energy balance equation for the brine is:

$$\frac{D(\rho_b U_b)}{Dt} = -J_{b_{ii}} - (E_{ij} T_b)_{,ji} + (\phi v_b)_{,i} + \zeta_b (T_r - T_b) + I_h \qquad \text{(J.44)}$$

where

U_b = internal energy of fluid = $h_b T_b$,
I_h = heat generation rate,
E_{ij} = heat dispersivity of fluid,
J_b = conductive heat flux of fluid per unit area
= $-(\lambda_f T_b)$,i
λ_f = coefficient of heat conduction of fluid, and
v_b = velocity of the fluid with respect to a fixed coordinate.

To combine Equations (J.43) and (J.44), the volumetric fractions of rock solids and brine in a rock element are required. Volume of rock solids in a rock element of volume V_r is

$$V_s = V_r(1 - \theta) \tag{J.45}$$

where

V_s = volume of solids.

In the same rock element, volume of brine (V_b) is:

$$V_b = V_r \theta S_b \tag{J.46}$$

The overall energy balance equation is:

$$\begin{aligned}(1 - \theta)\,[\frac{\partial(\rho_r U_r)}{\partial t} + (\rho_r U_r)_{,j} v_{rj}] + S_b\theta[\frac{\partial(\rho_b U_b)}{\partial t} + (\rho_b U_b)_{,i} v_{bi}] \\ = (1 - \theta)(\lambda_{rij} T_r)_{,ji} + S_b\theta(\lambda_b T_b)_{,ji} + (1 - \theta)(\sigma_{ij} v_{rj})_{,i} - (E_{ij} T_b)_{,ji} \\ + S_b\theta(\phi u_i)_{,i} + (1 - \theta)\zeta_r (T_b - T_r) + S_b\theta\zeta_b(T_r - T_b) + I_h\end{aligned} \tag{J.47a}$$

Because the permeability of salt is low, local thermal equilibrium is assumed:

$$T_r = T_b = T$$

and Equation (J.47a) becomes:

$$\begin{aligned}(1 - \theta)[\frac{\partial(\rho_r U_r)}{\partial t} + (\rho_r U_r)_{,j} v_{rj}] + S_b\theta[\frac{\partial(\rho_b U_b)}{\partial t} + (\rho_b U_b)_{,i} v_{bi}] \\ = (1 - \theta)(\lambda_{r_{ij}} T)_{,ji} + S_b\theta(\lambda_b T)_{,ji} + (1 - \theta)(\sigma_{ij} v_{rj})_{,i} - (E_{ij} T)_{,ji} \\ + S_b\theta(\phi u_i)_{,i} + I_h\end{aligned} \tag{J.47b}$$

J.6 DISCUSSION OF EQUATIONS AND SUGGESTIONS ON SOLUTION METHODS

Consider a small volume of low permeability rock with fluid included in its pores. Changes in rock stress will change the shape and volume of the rock pores and thus change the pressure of fluid stored in the rock pores. The two processes, fluid flow and rock deformation, are coupled through pore pressure and rock porosity. The combined effects of stress and pore pressure determine the deformation of rock pores. The sizes and shapes of rock pores thus control rock permeability, which in turn describes fluid flow paths and the flow rates.

In this section, the derived equations are regrouped and coupling is discussed. Suggestions on solution methods are provided as guidelines for future development.

J.6.1 Discussion of the Fluid-Flow Equations

This study formulates the mechanism of brine inflow and suggests a method of solution to estimate the brine inflow rate into excavated rooms at the WIPP repository level. The equations for mass conservation are the main equations for pressure distribution in the salt.

In deriving the relations Darcy's Law is applied, although the applicability of Darcy's Law for rocks of very low permeability is questionable. The use of piece-wise linear relationships between the pressure gradient and fluid flow rate would avoid this problem. Figure J-3 illustrates this concept. At very low pressure gradients, fluid cannot flow because of the static resistance. At higher pressure gradients, a line with a low slope appears to account for the surface adsorption effects. At even higher pressure gradients, the regular slope representing Darcy's flow exists; at very high pressure gradients, turbulent effects come into play and the slope flattens.

The equations require relations for permeability, fluid, density, fluid solutions, and rock porosity as a function of pressure to solve the equations in space and time. Through consideration of two-phase flow conditions, the apparent rock permeability is lowered because of the factor k (relative permeability), which is a function of fluid saturation. As a result, the actual brine flow rate estimated by these equations is lower than that estimated by assuming saturated flow conditions. Equation (J.15) defines capillary pressure (P_c) as the difference between gas and brine pressures. The capillary pressure is a function of saturation of the wetting fluid (brine) and is sometimes referred to as suction or tension. When the nonwetting fluid (gas) pressure stays at 1 atm, brine pressure is negative (gage pressure) while P_c is still positive.

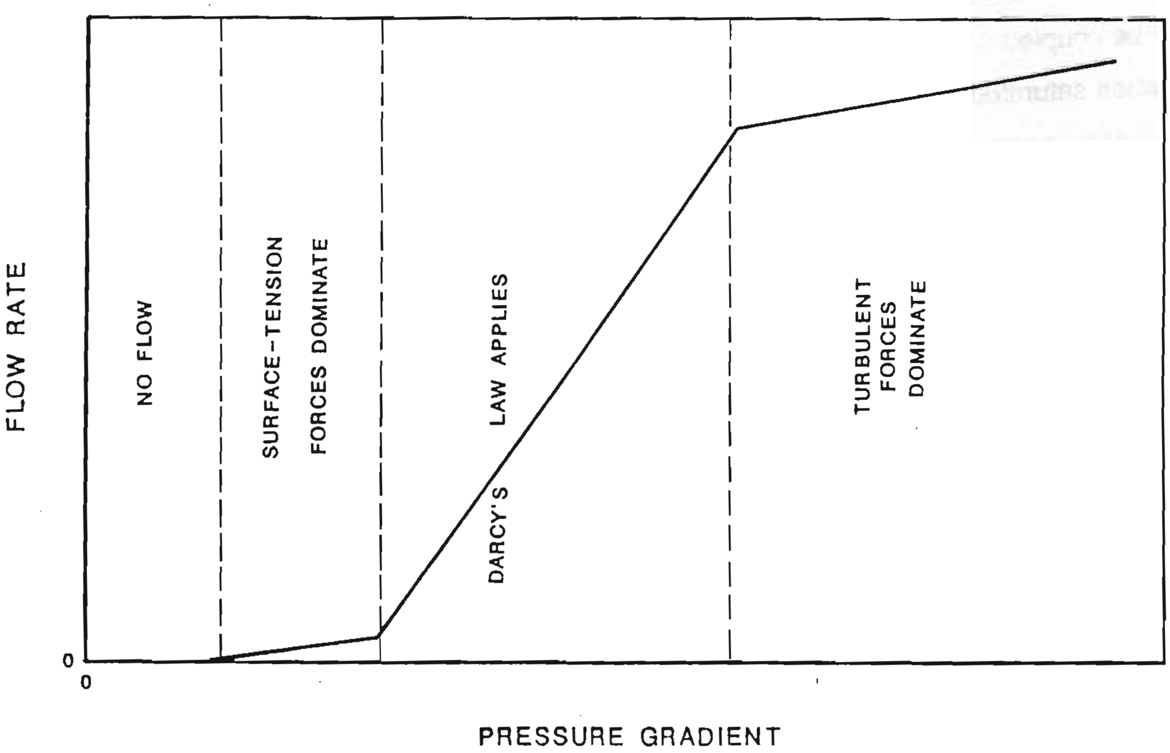


FIGURE J-3 PIECE-WISE APPLICATION OF LINEAR RELATIONSHIPS BETWEEN PRESSURE GRADIENT AND THE RATE OF FLUID FLOW.

$$P_c = -P_w \tag{J.48}$$

Equation (J.48) states that rock pores are filled with mixtures of gas and brine. Through application of Equations (J.15) and (J.16), the governing equations of brine and gas flow can then be coupled to solve the two-phase problem. As discussed previously, the analysis assumes saturated fluid flow due to the absence of the constitutive properties required for evaluating unsaturated fluid flow.

J.6.2 Concluding Remarks

A set of equations was derived to describe the flow of brine and gas through creeping salt under the influence of stress and temperature changes. The equations include:

- Mass conservation equations for two-phase flow of fluids through a porous media
- Stress equilibrium and displacement compatibility equations
- Stress-strain constitutive relations
- Energy balance equation.

Derivations are carried out based on:

- Darcy's Law and a piece-wise application of linear relationships between pressure gradient and fluid flow rate

- The concept of mass and energy balance

- A proposed constitutive model for salt deformation.

J.7 COMPUTER CODE DESCRIPTIONS

A broad description of the coupled computer code is presented in Figure J-4. The computer code VISCOT (Intera, 1983) is capable of solving salt creep by either implicit or explicit techniques. The explicit method (initial stiffness method or the modified Newton-Raphson method) was used in this analysis.

The Saturated-Unsaturated TRAnsport (SUTRA) model (Voss, 1984) is capable of simulating variable density, variable saturation, ground-water flow. It solves either steady-state or transient problem formulations in one or two dimensions. Flow fields can be either areal or cross-sectional. Both direct or iterative solution schemes are available.

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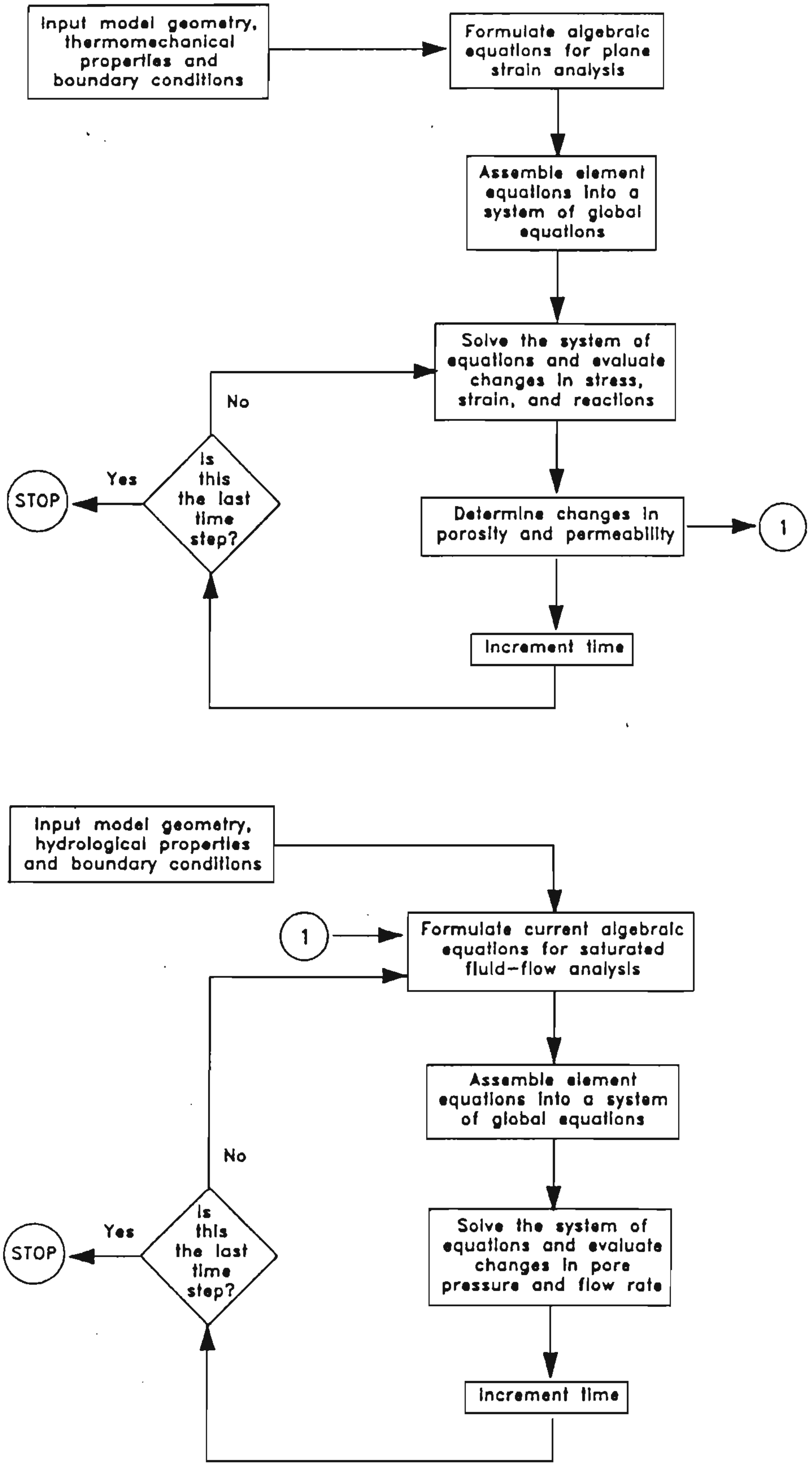

FIGURE J-4 FLOWCHARTS FOR THE SALT CREEP AND FLUID FLOW MODELS

The governing ground-water flow equation (Voss, 1984 Eqn. 2.22) is:

$$\frac{\partial(\theta S_w \rho)}{\partial t} = \underline{\nabla} \cdot (\theta S_w \rho \underline{v}) + Q_p + T \qquad \text{(J.49)}$$

where

$\underline{v}(x,y,t)$ = average fluid velocity vector.

The time derivative term on the left-hand side of the equation can be expressed as:

$$\frac{\partial(\theta S_w \rho)}{\partial t} = (S_w \rho S_{op} + \theta\rho\frac{\partial S_w}{\partial t})\ \frac{\partial P}{\partial t} \qquad \text{(J.50)}$$

where

$S_{op} = \theta\beta + (1 - \theta)\,\alpha$, and

α = compressibility of porous matrix.

Substituting Darcy's Law into the velocity vector (v) term, the equation becomes:

$$(S_w \rho S_{op} + \theta\rho\frac{\partial S_w}{\partial p})\ \frac{\partial P}{\partial t} = \underline{\nabla} \cdot [\frac{k\rho}{\mu} \cdot (\underline{\nabla} p - \rho \underline{g})] + Q_p \qquad \text{(J.51)}$$

The output from the modified version of VISCOT, consisting of regularly updated permeabilities, strain rates, and porosities, is generated on an element-by-element basis. For SUTRA to incorporate this data, it must function as a fully developed finite element program with all parameters appropriately discretized. The governing algorithms were thus rewritten to implement these changes.

The code was manipulated to discretize all parameters except pressure on an element-wise basis. Only the terms pertinent to this analysis were utilized. Also, the strain term was substituted as an equivalent Q_p term.

J.7.1 Salt-Creep Module Verification

The salt-creep module was verified against calculations for several closed-form solutions or problems. These include:

- Elastic Kirsch solution under external hydrostatic loading,
- Elastic Kirsch solution under external hydrostatic loading with stress relief at the circular boundary,
- A cylindrical laboratory specimen of salt with viscoplastic constitutive relations (Sandia Creep Law) subject to triaxial compression.

J.7.1.1 Elastic Kirsch Solution Under External Hydrostatic Loading

This problem was developed to verify the correct assemblage of the structural stiffness matrix for structures subject to external load and displacement boundary conditions. This problem verifies certain aspects of the finite-element formulation against closed-form solutions presented below.

Under a uniform hydrostatic loading, the radial and tangential stresses distributions (Goodman, 1980 - p. 215) are given by:

$$\sigma_r = P_0(1 - \frac{a^2}{r^2}) \qquad \text{(J.52)}$$

$$\sigma_\theta = P_0(1 + \frac{a^2}{r^2}) \qquad \text{(J.53)}$$

The relative displacement is given by:

$$u_r = P_0(\frac{1 + \nu}{E})\frac{a^2}{r} \qquad \text{(J.54)}$$

where

σ_r = radial stress at radius r,
σ_θ = tangential stress at radius r,
P_0 = far-field hydrostaic stress (15 MPa),
a = radius of the circular opening (1.8 m),
r = radius,
u_r = relative radial displacement,
E = Young's modulus for the material (31,000 MPa), and
ν = Poisson's ratio (0.25).

The Equation (J.54) solution for relative radial displacement corresponds to the displacement induced due to excavation, whereas the problem described above considers an additional component of hydrostatic compression. Along the x-x axis, the radial strains and displacement may be compared:

$$\varepsilon_{rr} \approx \varepsilon_{xx} = \frac{1}{E}[\sigma_{xx} - \nu(\sigma_{yy} + \sigma_{zz})] \qquad \text{(J.55)}$$

Under hydrostatic loading and plane strain conditions, the strain ε_{xx} is given by:

$$\varepsilon_{xx} = \frac{(1 - \nu - \nu^2)}{E}P_0 \qquad \text{(J.56)}$$

and the displacement, δ_x is given by:

$$\delta_x = \frac{x}{E}(1 - \nu - \nu^2)P_0 \qquad \text{(J.57)}$$

The approximate closed-form solution is given by:

$$u_r \approx [\frac{(1 + \nu)a^2}{r} + (1 - \nu - \nu^2)\, r]\, \frac{P_o}{E} \qquad \text{(J.58)}$$

The results of these calculations are presented in Figures J-5 and J-6. There is good agreement in the stress solutions with the predicted boundary stress concentration factor of

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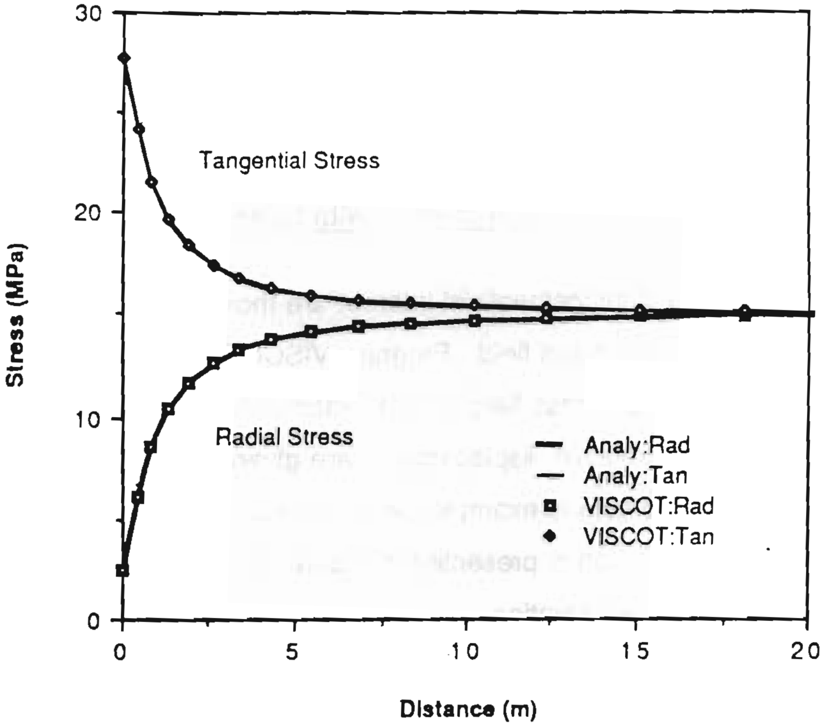

FIGURE J-5 KIRSCH SOLUTION FOR A CIRCULAR EXCAVATION AND VISCOT SOLUTION

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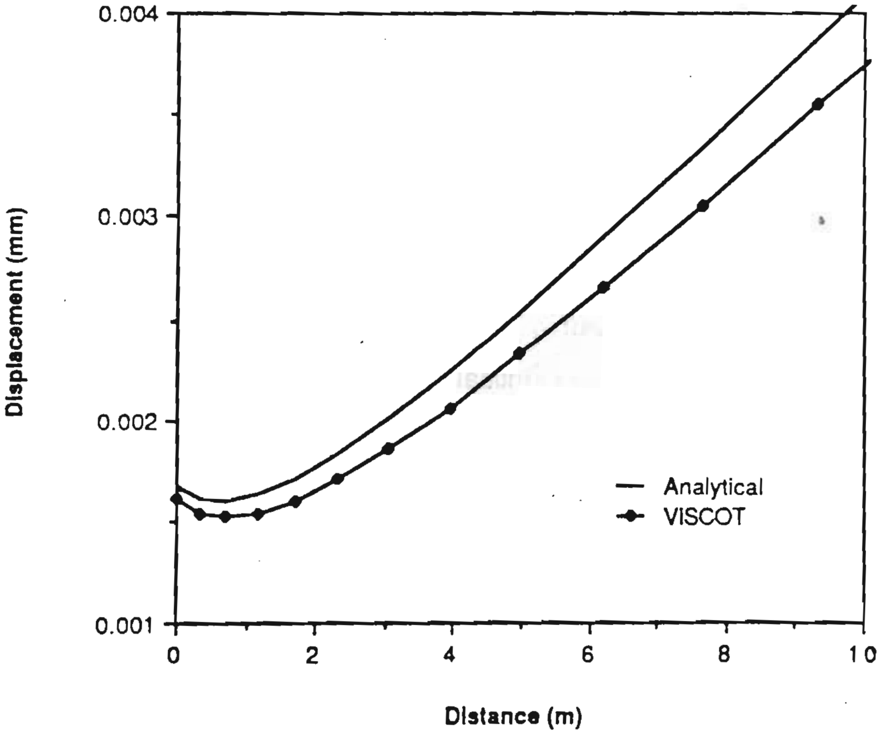


FIGURE J-6 COMPARISON OF RADIAL DISPLACEMENT FOR A CIRCULAR OPENING UNDER EXTERNAL LOADING.

2.0 at the radius of the opening. The predicted radial displacement reaches a minimum at 2.4 meters, which can be calculated by differentiating Equation (J.58) and setting the differential to zero.

J.7.1.2 Kirsch Solution Under an Initial Stress Field With Stress Relief at the Excavation Boundary

In underground excavations, the displacements of interest are those developed from excavation with an existing or initial stress field. Program VISCOT models displacements due to excavation by specifying an initial stress field and relaxation of the stresses along the boundary of the excavation. The relative displacements are given by Equation (J.54), which the stress field is identical to the previous example. A comparison of this solution for radial displacement with the VISCOT solution is presented in Figure J-7. Good agreement is indicated near the boundary of the excavation.

J.7.1.3 Cylindrical Salt Specimen Subject to Triaxial Compression

In order to test the incorporation of the Sandia Creep Law into the viscoplastic constitutive relations for rock salt, a simple problem for creep deformation of a cylindrical specimen of salt was evaluated under various loadings as shown in Figure J-8. The figure shows the assumed secondary creep parameters. This problem verifies the incorporation of the viscoplastic creep law. For each of the loading conditions evaluated, the imposed loading state of stress is known; the deviatoric stress components can be calculated and substituted directly into the creep law to determine strain rates.

The results of the calculations are presented in Figures J-9 through J-12. For a problem in which loadings are specified, the results are identical between the closed-form solution or hand calculations and the VISCOT analysis.

J.7.2 Fluid-Flow Module Verification

The SUTRA finite element code was modified to solve the governing equation for fluid flow for a deformable medium. The modifications included changing the discretization scheme for the time derivative term from a cell-wise (node-centered) to an element-wise basis, so that changes in porosity obtained from the salt-creep analysis could be incorporated. An additional

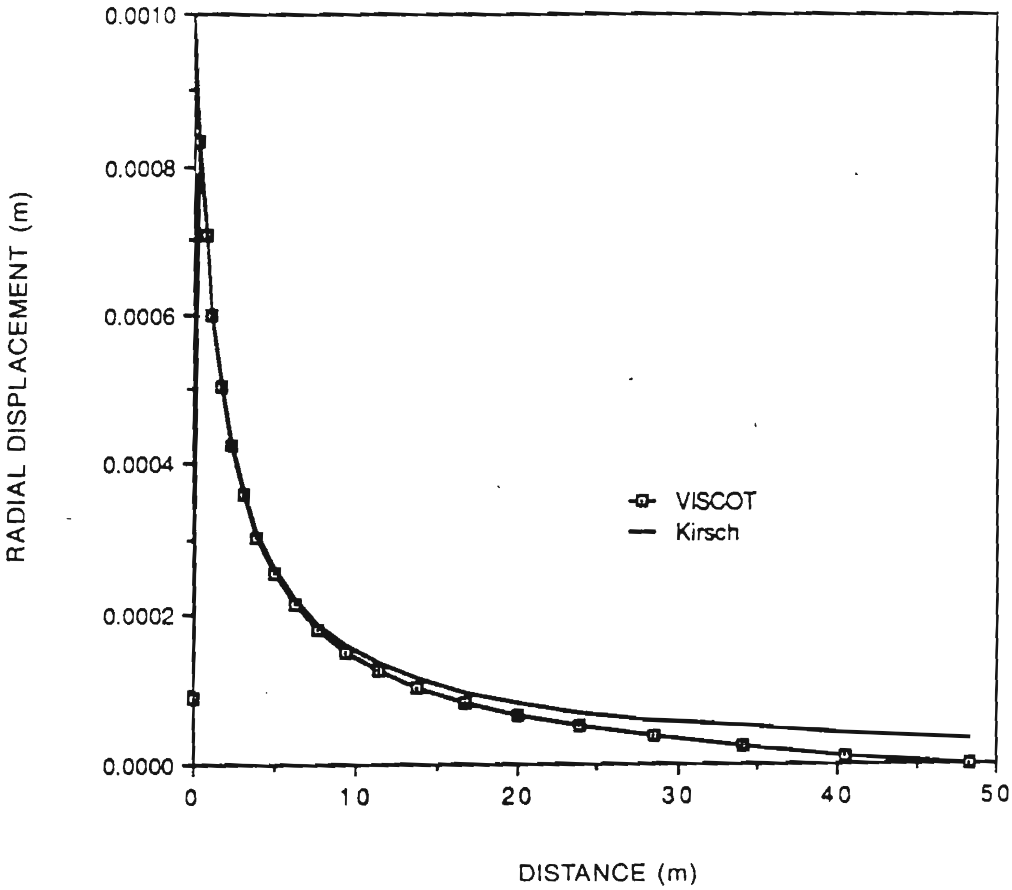
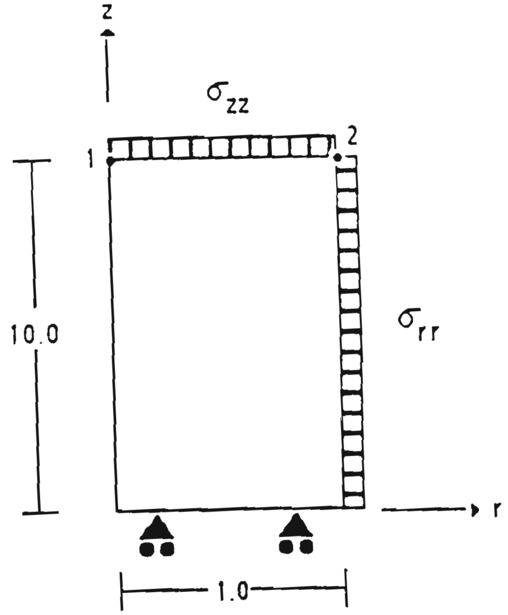


FIGURE J-7 KIRSCH AND VISCOT RADIAL DISPLACEMENTS



Loading Conditions

case no.	σ_{zz}	σ_{rr}
1	-5.0	0.0
2	0.0	-5.0
3	-5.0	-2.0

Summary of Properties Used

$Q/R = 3468.0$

$A = .154E\text{-}6\,(MPa^{-n}\text{-}secs)$

$n = 1.39$

$T = 373\ K$

$E = 10{,}000.0$

$\nu = 0.3$

FIGURE J–8 CYLINDRICAL SALT SPECIMEN SUBJECT TO TRIAXIAL COMPRESSION

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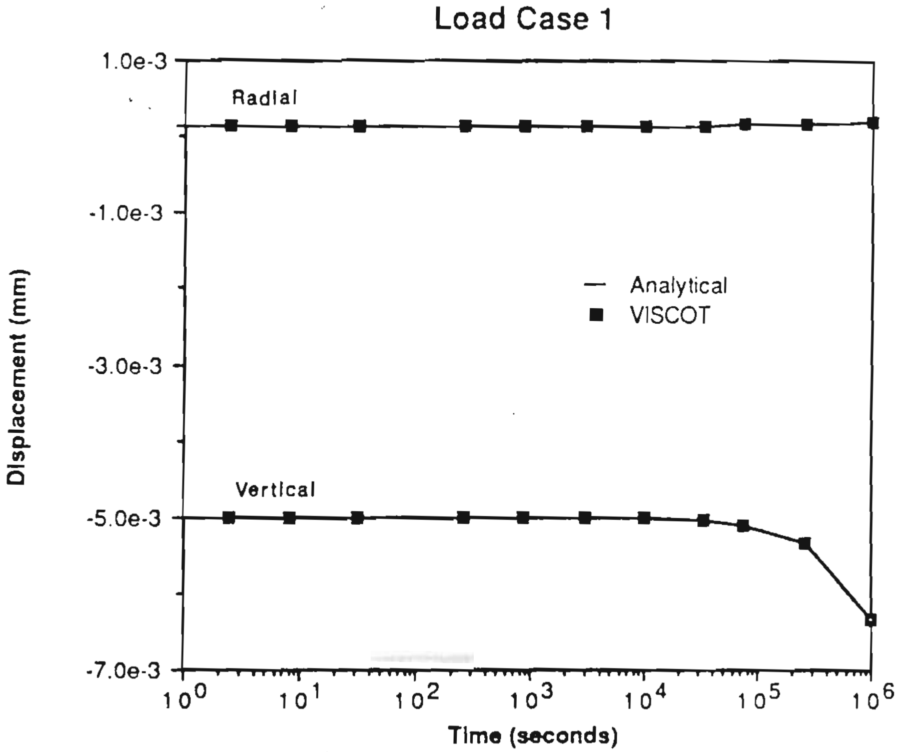

FIGURE J-9 UNIAXIAL COMPRESSION OF ROCKSALT

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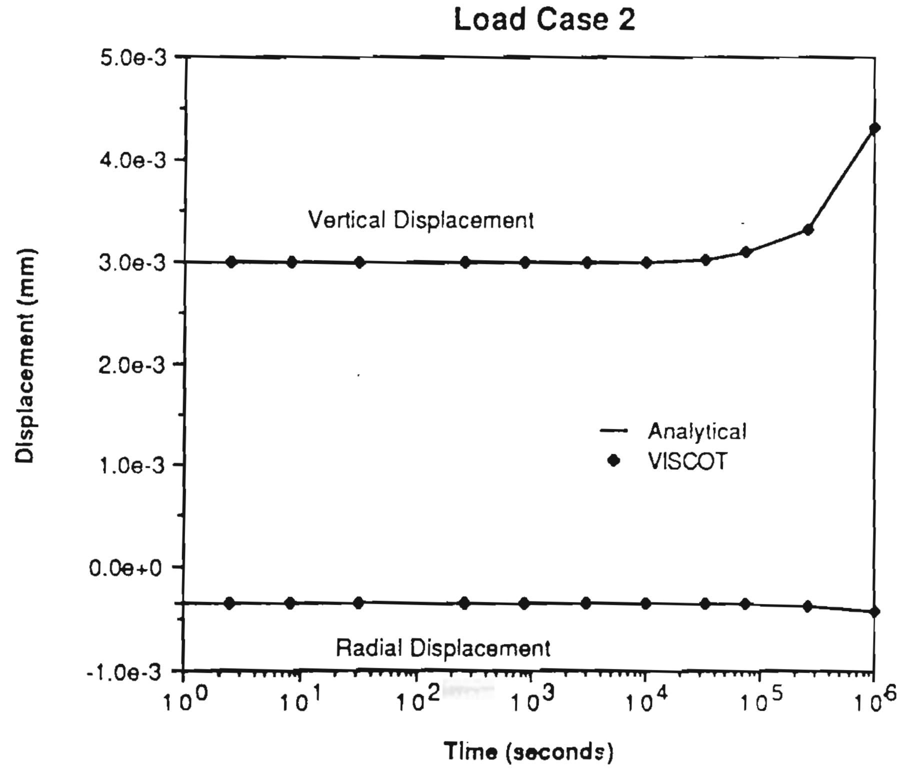

FIGURE J-10 RADIAL COMPRESSION OF SALT

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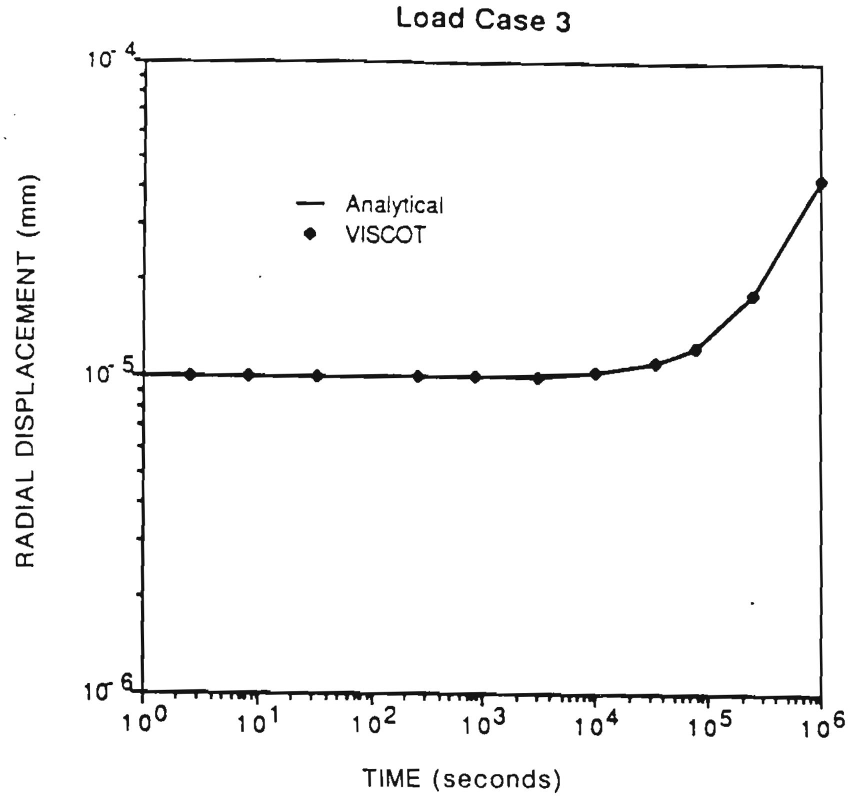

FIGURE J-11 TRIAXIAL COMPRESSION OF SALT, RADIAL DISPLACEMENT

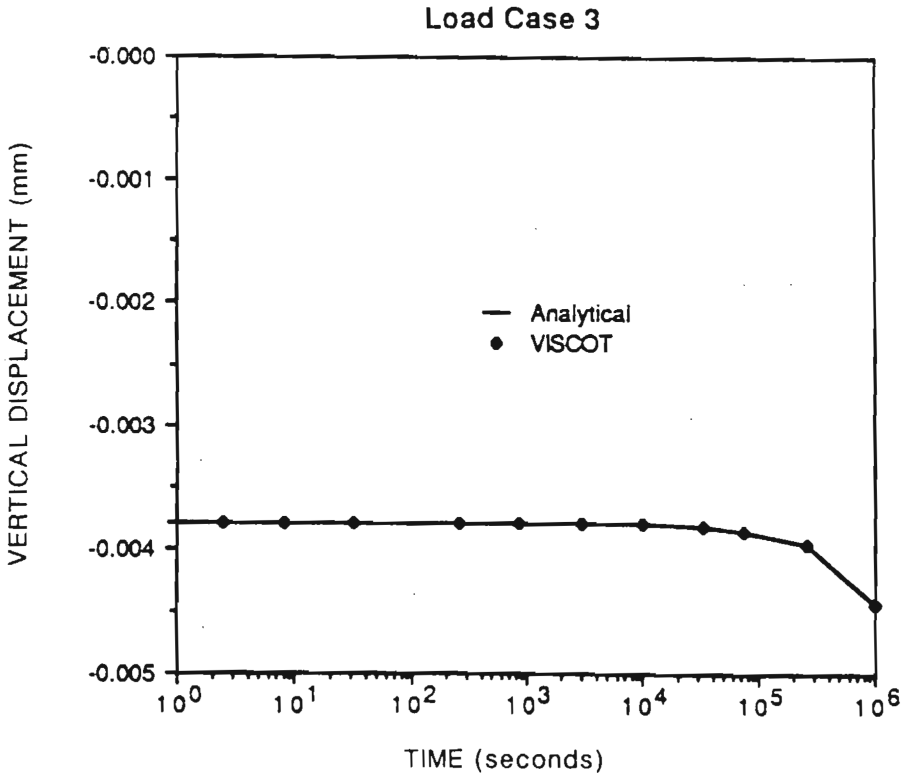

FIGURE J-12 TRIAXIAL COMPRESSION OF SALT, VERTICAL DISPLACEMENT change was the inclusion of the strain term that describes the contribution of fluid from the compaction or expansion of the rock matrix. The strain term is a sum of the elastic strains. It is passed to the fluid-flow module from the salt-creep module. The modifications to the code were verified to the extent possible through comparison with hand calculations. The code was verified against the Theis solution for drawdown versus radius and time. A problem involving a single well pumping within an infinite confined aquifer of constant thickness was evaluated. The aquifer was assigned an isotropic, homogeneous permeability distribution and screened portions of the well fully penetrated the aquifer.

The Theis method was applied to this aquifer system to calculate drawdown at any point in the aquifer at any time. The following two relations (Freeze and Cherry, 1979) were employed:

$$s = \frac{Q}{4\pi T'} W(u) \tag{J.59}$$

and

$$u = \frac{r^2 S'}{T'} \tag{J.60}$$

where

$s(x,y,t)$ = drawdown,
$Q(t)$ = constant pumping rate,
$W(u)$ = well function,
T' = transmissivity,
$r(x,y)$ = radius, and
S' = storage coefficient.

Values of W(u) versus u can be found in a table provided by Lohman (1972). The verification involved using the same parameters to run the modified SUTRA code as those used to calculate drawdown by the Theis method. The comparisons between solutions are summarized in Figures J-13 and J-14.

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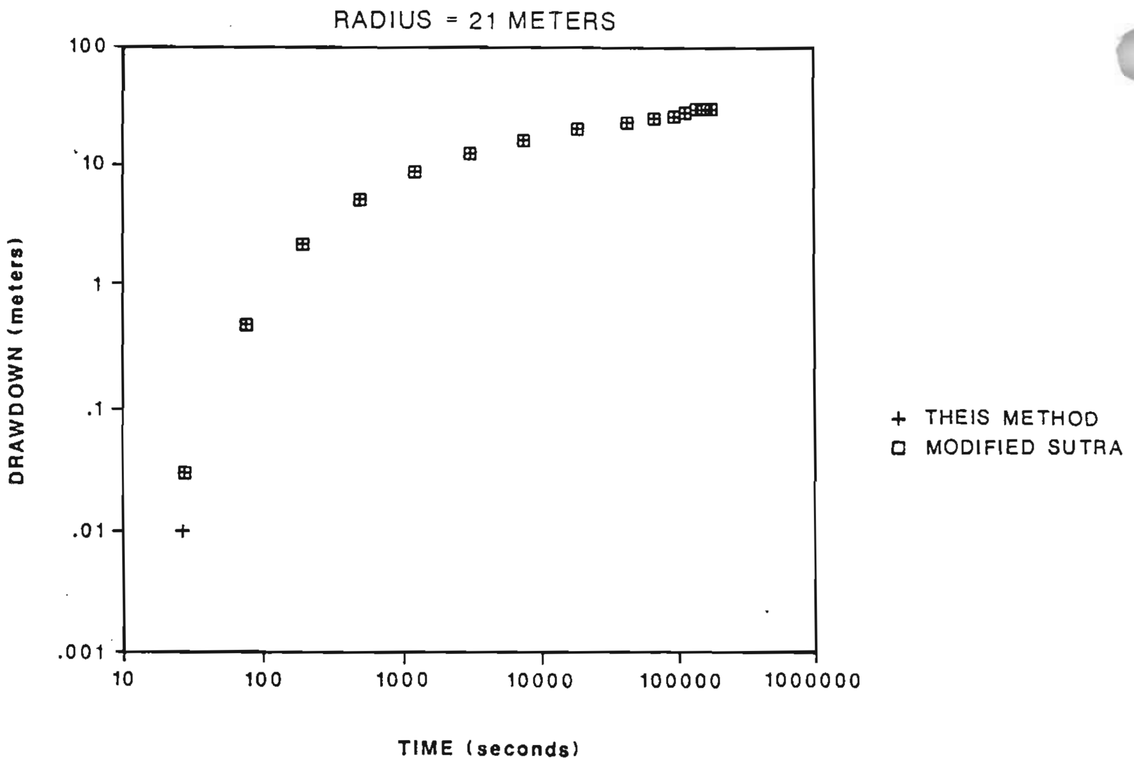

FIGURE J-13 THEIS COMPARISON VERSUS TIME

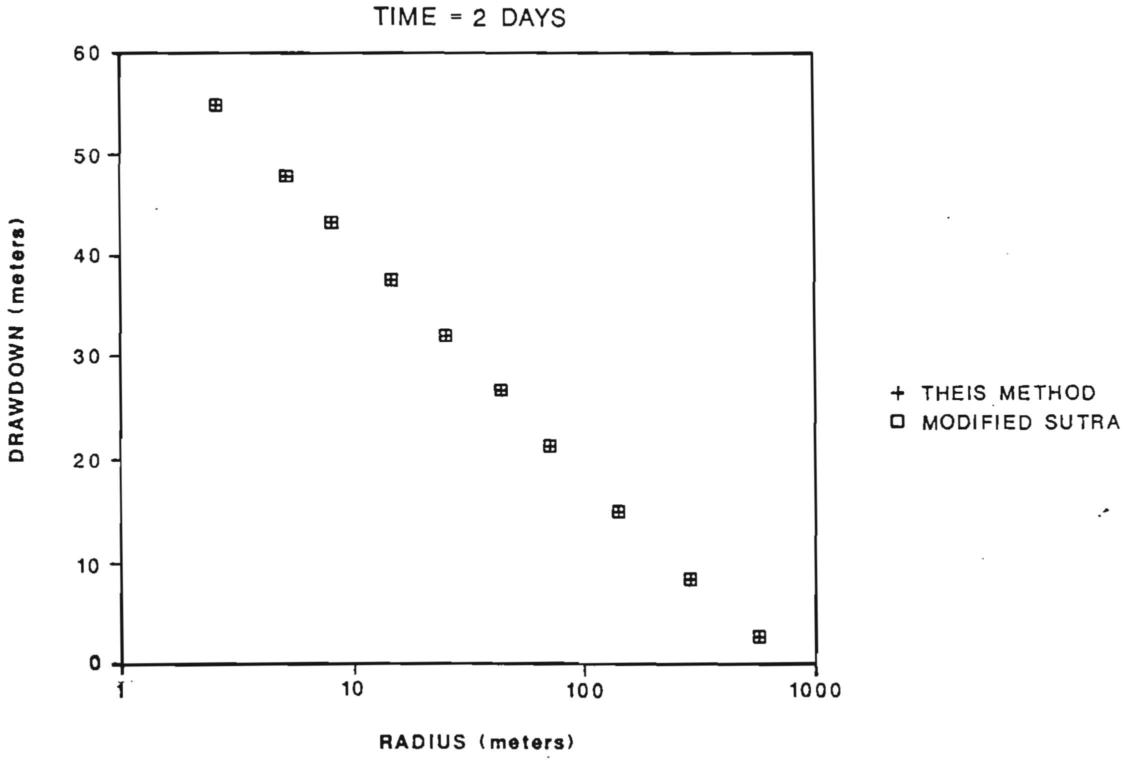

FIGURE J-14 THEIS COMPARISON VERSUS DISTANCE

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