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Analysis of Solutes in Groundwaters from the Rustler Formation At and Near the Waste Isolation Pilot Plant Site

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Karen L. Robinson

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Analysis of Solutes in Groundwaters from the Rustler Formation At and Near the Waste Isolation Pilot Plant Site

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ABSTRACT

Between 1976 and 1986, groundwater samples from more than 60 locations in the vicinity of the Waste Isolation Pilot Plant site were collected and analyzed for a variety of major, minor, and trace solutes. Most of the samples were from the Rustler Formation (the Culebra Dolomite, the Magenta Dolomite, or the zone at the contact between the Rustler and underlying Salado Formations) or the Dewey Lake Red Beds.

Between 1984 and 1986, the analytical laboratory at United Nuclear Corp. (UNC) Technical Services (formerly Bendix Field Engineering Corp.), Grand Junction, CO, determined the following parameters in 44 samples for Sandia National Laboratories (SNL): Cl^-, $SO_4^=$, alkalinity, Ca, Mg, K, Na, Br^-, I^-, F^-, B, Cs, Li, Sr, SiO_2, Fe, Mn, and sometimes NO_3^-. Before 1984, SNL's Analytical Chemistry Division, UNC/Bendix, KC Services, the University of Arizona, and the Kansas Geological Survey determined a variety of solutes in many groundwater samples for SNL or one of SNL's subcontractors. The analytical data from the laboratories are presented here with accompanying discussions of sample collection methods, supporting field measurements, and laboratory analytical methods.

In addition to SNL's analytical work, groundwater samples have been analyzed by the United States Geological Survey (USGS), IT Analytical Services (ITAS), and the New Mexico Bureau of Mines and Mineral Resources for the New Mexico Environmental Evaluation Group (EEG); data from these sources are summarized in this report.

A comparison of the SNL, USGS, ITAS, and EEG data sets and a preliminary evaluation of the data for the major solutes (Cl^-, $SO_4^=$, Na, K, Ca, and Mg) shows that the data for samples analyzed by UNC/Bendix for SNL seem to be the most reliable, but that at some locations, samples representative of the native, unperturbed groundwater have not been collected. At other locations, the water chemistry has apparently changed between sampling episodes.

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Mary Gonzales assisted in the initial preparation of the database files from which some of the tables in this report were created.

Dan Garber facilitated the preparation of this report.

Ed Lorusso, Debbie Rivard, and Frances Forrest (Tech Reps, Inc.) helped prepare the manuscript for publication.

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1.0 INTRODUCTION

1.1 Purpose

The Waste Isolation Pilot Plant (WIPP) is a facility operated by the United States Department of Energy (DOE) to demonstrate the safe disposal of transuranic (TRU) nuclear waste generated by defense programs.

Solute data from regional groundwater studies are important to the WIPP site characterization program, the long-term monitoring programs (radionuclide and environmental), and the performance assessment program, because groundwater movement is considered to be a potentially important method of nuclide transport between the WIPP facility and the accessible environment.

The purposes of this report are the following:

- to publish Sandia National Laboratories' (SNL's) available groundwater solute data and associated (but previously unpublished) field data
- to identify, begin to understand, and, where possible, begin to reconcile the discrepancies between various sets of analyses and various samples of groundwater from the same location (that is, the same stratigraphic zone at the same hydropad)
- for the major solutes (Cl^-, $SO_4^=$, Na, K, Ca, and Mg) in groundwaters from the sampled localities, to begin to develop a set of recommended, defensible analytical data for use by other WIPP project personnel

1.2 Scope and Organization of Report

This report includes solute data for groundwater samples from the Rustler Formation and related rocks in the vicinity of the WIPP site that were analyzed for SNL (or SNL's subcontractors) between 1979 and 1986. It also includes selected solute data for WIPP groundwaters reported by the United States Geological Survey (USGS), the WIPP Management & Operating Contractor (MOC), and the New Mexico Environmental Evaluation Group (EEG).

The quality of the major-solute data from SNL, the USGS, the MOC, and the New Mexico Environmental Evaluation Group (EEG) are compared and evaluated. Some trace- and minor-solute data from SNL, the USGS, the MOC, and the New Mexico Environmental Evaluation Group (EEG) are included, but are discussed only briefly and are not evaluated.

Section 1.0 contains introductory material, including the following:

- a discussion of some of the terminology, abbreviations, and conversion factors used in this report (Section 1.3)
- a list of the agencies that collected and/or analyzed the groundwater samples discussed here (Section 1.4)

- a brief description of the study area (Section 1.5)

Section 2.0 discusses ways of evaluating the data, including the following:

- methods of evaluating the representativeness of the samples
- methods of evaluating the stability (shelf life) of the samples
- methods of evaluating the quality of the analyses

Section 3.0 presents the analytical data that were generated by or specifically for SNL, including discussions of the sample collection methods, the analytical methods used in the field, the results of field measurements, the analytical methods used in the laboratory, and the results of laboratory measurements.

In Section 3.0, samples are divided into six groups, according to when and by whom they were collected.

- samples collected before 1980 by the USGS
- samples collected in 1980 in Nash Draw by SNL
- samples collected in 1980/1981 by SNL during hydrologic tests
- samples collected in 1983/1984 by Hydro Geo Chem (HGC) during hydrologic tests
- samples collected in June and August 1984 by Hydro Geo Chem (HGC) during convergent-flow tracer tests
- samples collected in 1985/1986 during round one of the Water Quality Sampling Program (WQSP)

Section 4.0 presents the analytical data that have been published or made available by:

- the USGS
- the New Mexico Environmental Evaluation Group (EEG)
- the DOE MOC

Section 5.0 presents a comparison of the data from all the agencies and a preliminary evaluation of the data for the major solutes (Cl^-, $SO_4^=$, Na, Ca, Mg, and K).

1.3 Terminology, Abbreviations, and Conversion Factors

This section has descriptions and definitions of many of the terms and phrases used in this report. Because many readers will be familiar with at least some (if not all) of this material, the following subsections are organized so they may be easily skimmed.

Section	Contents
1.3.1	Well nomenclature
1.3.2	Statistical terms
1.3.3	Terms used to describe groundwater samples and sampling programs

1.3.4 Terms used to describe the analyses and the evaluation of data

1.3.5 Abbreviations used in this report

1.3.6 Conversion factors

1.3.1 Well Nomenclature

Most of the wells mentioned in this report were drilled specifically for the WIPP project. A few stock wells (ranch wells that produce water suitable for watering stock but not for human consumption) are also included. Because knowing exactly which well was sampled can be important in evaluating the solute data, and because a well is sometimes known by more than one name, well nomenclature is discussed in some detail here.

1.3.1.1 STOCK WELLS

Stock wells are identified in this report by their locally used names. Some of the wells have, or have had, more than one locally used name. Table 1 includes the stock wells, the names used in this report, and some of their synonyms (names by which these wells have been identified in other reports).

1.3.1.2 WIPP WELLS

Each well drilled for the WIPP project is given a name at the time of drilling. This name often appears in various documents (field notes, memoranda, laboratory documentation and reports, published reports, etc.) in a variety of forms (abbreviations or synonyms). Some well names are changed (that is, given suffixes) when an additional wells are subsequently drilled at the same hydropad.

At multi-well hydropads, knowing exactly which well was sampled may be important for evaluating the representativeness of samples for various solutes because different wells, even on the same hydropad, may have different configurations and histories.

Because the same well may appear under different names in various reports (a source of confusion for those not intimately familiar with the project), the conventions used in naming wells drilled for the WIPP are explained here.

Wells drilled for the WIPP project are designated by a prefix followed by a one- or two-digit number and sometimes a suffix. Examples include WIPP-25 and H-3B3.

<u>Prefixes</u>

Each multiple-purpose well is given a prefix such as AEC, ERDA, WIPP, or DOE, depending on when it was drilled. Wells originally intended for potash resource assessment or hydrologic testing and monitoring are given the prefixes "P" and "H," respectively. (Note that because some

wells are later recompleted or configured, the prefix does not necessarily indicate the current status of the well.)

Suffixes

When more than one well is located on a hydropad, the well names include suffixes. Some hydropads originally contained three wells. These were given the suffixes A, B, and C (or a, b, and c), indicating completion in the Magenta, Culebra, and Rustler/Salado contact zone, respectively, or the suffixes B1, B2, and B3, indicating that all three were completed in the Culebra. Some examples are the H-2 hydropad (H-2A, H-2B, and H-2C) and the H-11 hydropad (H-11B1, H-11B2, and H-11B3).

Because additional wells have been drilled at some hydropads, including H-2, H-3, and H-7, the suffixes of some older wells have been modified. For example, H-2B is now H-2B1. Table 1 indicates which wells have "new" names and why.

Variations of Names of WIPP Wells

A given well name may be "spelled" in a variety of ways.

- The prefix may be spelled out or abbreviated, for example, WIPP or W.
- The prefix and number may be separated by a hyphen or not, for example, WIPP-25 or WIPP 25 or WIPP25.
- The number, if a single digit, may be preceded by a zero or not, for example, H-08 or H-8. The former designation allows convenient sorting (alphabetizing) by computer programs.
- The suffix letters may be upper or lower case, for example, H-10A or H-10a.

Thus, a single well may be identified by several names. For example, H3b3, H-3b3, H03b3, H3B3, H-3B3, and H-03B3 all refer to the same well; similarly WIPP-25, WIPP 25, W25, W 25, and W-25 are different designations for one well.

Conventions Used in this Report

In this report, the following conventions have been used in referring to WIPP wells:

- Prefixes are spelled out.
- A hyphen separates the prefix and the number.
- One-digit numbers are not given a leading zero.
- Suffix letters are upper case.

Some examples are H-3, H-10A, and WIPP-25.

In some data tables, however, the well names are abbreviated to save space. Table 1 lists both the well names used in the text and the abbreviations used in some of the data tables.

To facilitate comparison of the various data sets included in this report (from the USGS, the MOC, the New Mexico Environmental Evaluation Group (EEG), and SNL), wells that have been renamed are referred to by their current names. For example, when the USGS collected samples at the H-3 hydropad in 1977 and 1978, there was a single well there, designated H-3. When additional wells were drilled at that hydropad, the original well was designated H-3B1. Table 68, which summarizes the USGS data from Mercer (1983), thus refers to H-3B1 (the designation used in this report), rather than H-3 (the designation used by Mercer, 1983).

1.3.2 Statistical Terms

The following concepts are briefly discussed here:

- accuracy
- precision
- confidence limits

For a detailed discussion of the statistical treatment of analytical data, the reader may refer to statistics texts such as Caulcutt and Boddy (1983) or Natrella (1966).

1.3.2.1 ACCURACY

Accuracy refers to the closeness of a measured value (or the average of a set of measured values) to the actual or "true" value of a parameter. Sources of inaccuracy in a measurement include the following (Caulcutt and Boddy, 1983; Keith et al., 1983):

- random errors (imprecision)
- gross errors
- systematic errors (bias)

Random errors are discussed under "precision" in the next subsection.

Gross errors have been defined as errors "which differ from random or systematic errors in that they are rare occurences which do not fit into the usual pattern of errors associated with a particular situation" (Caulcutt and Boddy, 1983). Examples of gross errors that could affect some of the WIPP solute data include the following:

- using the wrong equipment – for example, using a 5-mL instead of a 10-mL pipette
- incorrectly identifying the analyte – for example, using the wrong peak in a spectrum
- incorrectly calculating or reporting the results – for example, using the wrong equation or data, miscopying a number from a notebook, or making an arithmetic error

If there is sufficient evidence that a value is incorrect because of a gross error (one that cannot be corrected), then that value should be discarded. If, however, the error can be corrected (for example, if an arithmetic error can be identified and corrected) then the incorrect value can, of course, be replaced.

Systematic errors, or **bias**, affect a group of determinations equally, although these errors may be different from one group of determinations to the next. Causes of systematic errors that could affect some of the WIPP solute data include the following:

- the analytical method used – for example, one that fails to correct for a positive or negative interference
- the analyst – for example, an individual who consistently misidentifies the endpoint of a titration
- the equipment or reagents used – for example, a miscalibrated balance

The systematic error associated with a measurement can only be quantified if the true value of the measured parameter is known. Thus, for a given water sample, the systematic error cannot be quantified.

However, the functioning of the method, equipment, reagents, and analyst can be verified by the analysis of standard and control samples. The analysis of spiked samples allows for possible recognition of bias introduced by the sample itself (such as an interferent in the sample matrix). In addition, bias can sometimes be recognized by comparing results from different laboratories for samples of the same composition or by comparing results for the same sample obtained by different methods in the same laboratory.

The required accuracy of a measurement depends on the intended use of the data. For example, for many analytes determined for the monitoring programs, it may be important only to know if a species is present in amounts greater than some specified quantity defined by a regulatory agency; that agency may specify the required accuracy (and/or precision) for the analyses. For other programs it may be important to recognize and measure changes in concentrations from year to year, in which case the accuracy must be sufficient to allow such changes to be recognized.

1.3.2.2 PRECISION

Precision refers to the reproducibility of a measurement, or how closely together replicate measurements cluster. Imprecision in a group of replicate measurements is caused by **random errors**. The precision of a measurement of an analyte will vary with the method used, the sample bulk composition or matrix, and often with the analyst and equipment used.

A measure of precision, the **standard deviation**, σ, of a set of measurements is estimated by the parameter "s," calculated as follows:

$$s = \left[\frac{1}{n-1} \sum_{i=1}^{i=n} (x_i - \overline{x})^2 \right]^{1/2} \qquad [1]$$

where x_i = value of the ith result

$\overline{x}$ = average result ($\sum x_i / n$)

n = number of replicates

The number of degrees of freedom (DF) associated with a calculated standard deviation, s, is n-1.

If more than one set of measurements, each with a calculated s, has been made and if all of these sets can be assumed to have the same population standard deviation, σ, then the calculated standard deviations (the s's) may be averaged as follows:

$$s_{avg} = \left[\frac{\sum_{i=1}^{i=k} DF_i (s_i^2)}{\sum_{i=1}^{i=k} DF_i} \right]^{1/2} \qquad [2]$$

where k = the number of sets of measurements

s_i = the calculated standard deviation for the ith set

DF_i = the number of degrees of freedom associated with the ith set

The number of degrees of freedom associated with s_{avg} is $\sum_{i=1}^{i=k} DF_i$.

In this report, estimates of precision are given in two ways:

- as a relative standard deviation
- as a relative percent difference

The **relative standard deviation (RSD)**, in percent, is calculated by the following equation, with s calculated in equation 1:

$$RSD(\%) = \frac{s}{\bar{x}} \cdot 100 \qquad [3]$$

The **relative percent deviation (RPD)**, in percent, can be used when two measurements were made; it is calculated as follows:

$$RPD(\%) = \frac{[x_1 - x_2]}{\bar{x}} \cdot 100 \qquad [4]$$

As with accuracy, the required precision of a measurement depends on the intended use of the data. For example, in analyzing parameters in serial samples, the precision must be good enough to allow the field chemist to recognize fairly small changes from sample to sample.

1.3.2.3 CONFIDENCE LIMITS

Confidence limits for a given confidence level are calculated as follows:

$$CL = \frac{t \cdot s}{(n)^{1/2}} \qquad [5]$$

where s = estimated standard deviation (may be an "average" s, calculated as in equation 2, if appropriate)

n = number of replicate measurements

t = Students t factor; the value decreases with an increasing number of degrees of freedom associated with s and increases with an increasing desired confidence level

For example, a value reported as "1200 ± 100 mg/L (95% C.L., 1 rep)" means that we are 95% confident that the "true" value represented by a single measurement of 1200 mg/L will lie between 1100 and 1300 mg/L.

Similarly, a value reported as "950 ± 50 mg/L (90% C.L., 2 reps)" means that if we have two measurements whose average is 950 mg/L, we are 90% confident that the "true" value will lie between 900 and 1000 mg/L.

1.3.3 Terms Used to Describe Groundwater Samples and Sampling Programs

The following terms are defined in this section:

- representative sample
- serial sample
- steady state
- final sample
- Water Quality Sampling Program (WQSP)

1.3.3.1 REPRESENTATIVE SAMPLE

A **representative sample** is a sample that represents the native unperturbed groundwater. Colton and Morse (1985) defined a representative sample as one that is "chemically identical to the aquifer groundwater in its pristine and unaltered physico-chemical state, i.e., completely unaltered by the effects of drilling and any post drilling processes and reactions and sampling procedures, organic and inorganic."

Colton and Morse recognized that their definition described an unobtainable theoretical ideal. A sample may be, and often will be, representative with respect to some parameters but not to others (this is discussed in more detail in Section 2.0).

In this report, "representative" usually refers to a sample that is considered representative with respect to the major solutes (Cl^-, $SO_4^=$, Na, K, Mg, and Ca) but not necessarily with respect to other parameters.

Although a thorough discussion of the possible sources of contamination in nonrepresentative samples is beyond the scope of this report, among the sources will be the following:

- contamination introduced during drilling and (re)completion of the well, such as, drilling brines, materials used to control lost circulation, lubricants, and so forth
- products from the reaction of groundwater with materials left in the well, such as cement, casing, screen, pumps, and so forth
- products from the reaction of introduced materials with the surrounding rock
- contamination introduced during hydrologic testing, such as tracers and so forth
- contamination introduced by the sampling and preserving procedures

Representativeness must be evaluated separately for each parameter in each sample. Users should be cautious about using and interpreting data for unevaluated parameters. Methods of evaluating representativeness are discussed in Section 2.0 of this report.

1.3.3.2 SERIAL SAMPLE

Serial samples are groundwater samples collected and analyzed for selected parameters in the field, usually during a lengthy pump test; they are used to help evaluate sample representativeness. Serial samples are usually collected at regular intervals (for example, every four hours or every day) until the measured parameters reach "steady state" (see below).

1.3.3.3 STEADY STATE

When a parameter is monitored in the field by means of the collection and analysis of serial samples, the measured values typically start at some value and increase or decrease with time until a constant value, or a value about which the measured values oscillate, is reached; this value is called the **steady-state** value.

1.3.3.4 FINAL SAMPLE

Final samples are samples that are collected and sent to various laboratories for analysis. Ideally, final samples should be representative with respect to the parameters that will be determined in the laboratory. For many parameters, however, such as the minor and trace solutes, sample representativeness may not have been evaluated. Some parameters (for example, pH, alkalinity, and Eh, all of which may be unstable with time) are usually measured in the field at the time final samples are collected.

1.3.3.5 WATER QUALITY SAMPLING PROGRAM (WQSP)

The **Water Quality Sampling Program (WQSP)** is a long-term, regional, groundwater-sampling program conducted by the DOE. For the WQSP, selected wells will be sampled many times (typically annually or biennially) in the next few years. Serial samples are collected, several parameters are measured in the field, and final samples are collected after the values of certain parameters reach steady state. The WQSP is fully described in Colton and Morse (1985) and in the Water Quality Sampling Manual (WP 7-2); in this report, Section 4.2 gives more information about the WQSP.

1.3.4 Terms Used to Describe the Analyses and the Evaluation of the Data

The following terms are defined in this section:

- acid blank
- alkalinity
- charge-balance error (CBE)
- control sample
- density/specific gravity
- divalent cations
- equivalence and equivalent weight
- spiked sample
- total dissolved solids (TDS)

1.3.4.1 ACID BLANK

An **acid blank** is a sample of deionized water to which acid has been added. It is prepared in the field using the same acid (that is, from the same stock bottle) that was used to acidify the groundwater samples to pH < 2. The acid is added to the deionized water in the same proportion in which it was added to the samples.

For example, if 1 mL of nitric acid was added to each liter of sample, then the blank is prepared by adding 1 mL of nitric acid to 1 L of deionized water (or 0.5 mL of nitric acid to 0.5 L of deionized water).

1.3.4.2 ALKALINITY

Alkalinity refers to the ability of a solution to neutralize acids. Total alkalinity is the equivalent sum of the bases that are titratable with a strong acid (Drever, 1982; Stumm and Morgan, 1981). These bases may include species such as $HCO_3^-, CO_3^=, B(OH)_4^-, H_3SiO_4^-, HS^-$, phosphates, organic bases, and OH^-. In many groundwaters, the alkalinity is dominated by bicarbonate (HCO_3^-) and/or carbonate ($CO_3^=$).

Because most of the noncarbonate species listed above occur in the Rustler groundwaters in negligible quantities, the total alkalinity in these waters is assumed to be equal to HCO_3^- plus $CO_3^=$, with the ratio of the two species varying with pH. Although many of the Rustler groundwaters contain appreciable silica and boron, these are assumed to be present mostly as $B(OH)_3$ and H_4SiO_4, typical of most groundwaters (Stumm and Morgan, 1981), and thus are assumed to not contribute to the total alkalinity.[1]

Alkalinity is measured by titration with a standard acid (Lambert and Robinson, 1984; Colton and Morse, 1985; ASTM D1067-82 and ASTM D3875-80) and may be reported as meq/L or as some convenient compound. For example, alkalinity is often reported as $CaCO_3$, although such a value does not necessarily say anything about the concentrations of Ca or $CO_3^=$ actually present in the solution.

Because, for the groundwaters discussed in this report, the total alkalinity can be assumed to be HCO_3^- plus $CO_3^=$, presentation of the alkalinity results as concentrations of HCO_3^- and $CO_3^=$ is reasonable. However, many of the laboratory results included in this report were reported by the laboratories as mg/L $CaCO_3$.

Conversion of results to other units: For most of the groundwaters discussed in this report, alkalinity values reported as mg/L $CaCO_3$ may be converted to mg/L HCO_3^-. At a pH of less than ~8.1 (true for most of these groundwaters) the $CO_3^=$ concentration will be negligible, with HCO_3^- dominating. For these samples, results reported as $CaCO_3$ can be converted to HCO_3^- by the following equation:

$$\text{alkalinity (mg/L } HCO_3^-) = \text{alkalinity (mg/L } CaCO_3) \times \frac{61}{50} \qquad [6]$$

For samples with a pH greater than 8.1 or for samples with unknown pH, the conversion should not be made.

To convert results from mg/L HCO_3^- and/or mg/L $CO_3^=$ to meq/L, the following equation is used:

$$\text{alkalinity (meq/L)} = \frac{1}{61}\,[\text{alkalinity (mg/L } HCO_3^-)] + \frac{1}{30}\,[(\text{alkalinity (mg/L } CO_3^=)] \qquad [7]$$

To convert to mg/L $CaCO_3$, the result in meq/L is multiplied by 50.

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[1]This assumption will not be appropriate for certain other water samples of interest to the WIPP, for example, some brines from the repository level in the Salado Formation.

1.3.4.3 CHARGE-BALANCE ERROR (CBE)

In a solution, the sum of the positive ionic charges must equal the sum of the negative ionic charges. The **charge-balance error (CBE)** is a measure of the apparent deviation from neutrality. A large CBE may be caused by errors in the reported concentrations of the major species or by important ionic species not being included in the calculation, presumably because they were not measured.

The CBEs given in this report were calculated by summing the quantities of the major anions in meq/L (Cl^- plus $SO_4^=$ plus laboratory or field HCO_3^- and $CO_3^=$, if available, plus NO_3^- in selected Dewey Lake samples) and the major cations in meq/L (Na plus K plus Mg plus Ca) and calculating the CBE in percent using the following equation:

$$CBE(\%) = \frac{\sum cations(meq/L) - \sum anions(meq/L)}{\sum cations(meq/L + \sum anions(meq/L)} \cdot 100 \qquad [8]$$

For most of the samples discussed in this report, bicarbonate/carbonate can be safely ignored in the CBE calculation. In most of these waters, the Cl^- and $SO_4^=$ concentrations are much greater than the HCO_3^- and $CO_3^=$ concentrations; therefore, HCO_3^- and $CO_3^=$ do not contribute significantly to the charge-balance error (CBE).

In some of the fresher waters (such as the Culebra and Magenta samples from H-7, H-8, H-9, and Engle Well), the bicarbonate/carbonate contribution becomes noticeable. For example, using the EEG data from the H-9B Culebra sample, the CBE is +2.1% when bicarbonate/carbonate is excluded and +0.1% when a field bicarbonate/carbonate value is included. Both charge-balance errors (CBEs) are, however, acceptably low.

In very fresh waters (such as the Dewey Lake sample from Twin Wells/Pasture Well), bicarbonate is a major contributor to the charge-balance error (CBE) and must be included to calculate a meaningful CBE.

1.3.4.4 CONTROL SAMPLE

A **control sample** is a sample with "known" concentrations of certain analytes of interest. A control may be a well-characterized sample (as those available from the National Bureau of Standards, the Environmental Protection Agency, the USGS, and so forth) or a synthetic standard. A control is analyzed as an unknown in the laboratory.

1.3.4.5 DENSITY/SPECIFIC GRAVITY

The terms density and specific gravity are often used interchangeably, although they are not exactly the same.

- **Density** is the mass per unit volume of a substance.

- **Specific gravity** is the mass of a volume of a substance divided by the mass of an equal volume of a standard substance (which for liquids is pure water) with the temperature of the sample and the standard being specified.

The density of a given sample varies with temperature and pressure. The density of aqueous solutions is usually reported in g/mL; temperature should also be specified. In the 20 to 30°C temperature range, the change of density with temperature is typically ~0.0002 - 0.0003 g/mL/°C; it is somewhat less at lower temperatures (Kell, 1968). The density of a groundwater sample is usually measured in the laboratory by pipetting (with a volumetric pipette) and weighing an aliquot of the sample; the temperature of the sample should also be measured and recorded, although often it is not.

Specific gravity is a unitless quantity; however,the temperature of both the sample and the standard should be specified. Specific gravity is usually measured in the field with a specific gravity hydrometer certified for sample and pure water temperatures of 60°F (15.6°C). Temperature corrections, which are typically not made in this project, could be made as follows: correct to 60°/60°F by adding 0.0002 for each degree above 60°F (ASTM D1429-76).

Because the density of pure water is close to 1 in the temperature range 15°- 30°C[2], the differences between densities and specific gravities of most groundwaters are small and are generally ignored. Similarly, the inaccuracies introduced by ignoring temperature differences in this range are ignored.

In this report, both field-measured specific gravities and laboratory-measured densities are given in the data tables[3]. For samples that are thought to be representative of the same groundwater (that is, from the same stratigraphic zone at the same hydropad), differences in the reported numbers of up to ~0.005 may be attributed to temperature variations and/or some values being density and some being specific gravity. Larger differences may be caused by measurement inaccuracies (from inaccurate equipment such as hydrometers and volumetric ware or from analyst error), or the samples may really be different.

1.3.4.6 DIVALENT CATIONS (X^{++})

The term **divalent cations** (or total divalent cations), sometimes abbreviated X^{++}, is a synonym for hardness of water caused by alkaline earths. In Rustler and Dewey Lake groundwaters, the primary divalent cations are calcium and magnesium, with strontium usually and barium always being negligible.

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[2]0.99913 g/mL at 15°C, 0.99823 at 20°C, 0.99708 at 25°C, 0.99568 at 30°C (Kell, 1968).

[3]In the data tables, densities have the units g/mL. Specific gravities are indicated by the initials "s.g."

Divalent cations are measured in the field in serial samples by the EDTA-titration method (Lambert and Robinson, 1984; Colton and Morse, 1985). The results are reported here in meq/L. Laboratory "divalent cation" values are simply the sum of the reported calcium and magnesium values, again reported in meq/L.

1.3.4.7 EQUIVALENCE AND EQUIVALENT WEIGHT

The **equivalent weight** of an atomic or molecular species is the weight of the substance that would react with, or be produced by, the reaction of 1 mole of hydrogen atoms or 1/2 mole of oxygen atoms.

For inorganic ionic species in groundwaters, the equivalent weight is therefore the atomic (or molecular) weight divided by the ionic charge. Some examples are shown in the following list.

Species	Atomic Weight	Equivalent Weight
Cl^-	35.5	35.5
Na^+	23.0	23.0
Ca^{++}	40.0	20.0
$SO_4^=$	96.0	48.0

To convert concentrations in mg/L to meq/L, divide by the equivalent weight.

1.3.4.8 SPIKED SAMPLE

A **spiked sample** is an aliquot of sample to which a known amount of the analyte has been added. The spiked sample is analyzed as an unknown.

The spike recovery, in percent, is the amount of additional analyte measured divided by the amount added and multiplied by 100.

1.3.4.9 TOTAL DISSOLVED SOLIDS (TDS)

Total dissolved solids (TDS) refers to the quantity of solids dissolved in a water sample. There are two common ways of determining TDS.

- Sum the analytical results for the individual solutes.
- Evaporate an aliquot of the sample to dryness, dry the residue to a constant weight at a specified temperature, and weigh the residue; the results from this method are sometimes known as residue on ignition (ROI).

In general, results from the two methods, applied to the same sample, will not be the same. For Rustler groundwaters, the residue on ignition (ROI) value will typically be higher than the calculated TDS, because the residue will contain hydrated mineral species. (For other samples, the residue on ignition (ROI) might be lower than the calculated total dissolved solids (TDS), if volatile species were lost during ignition.)

In this report, the total dissolved solids contents (TDS-calc), were calculated by summing the concentrations, in mg/L, of Cl^-, $SO_4^=$, Na, K, Mg, and Ca. Laboratory values of HCO_3^- and $CO_3^=$ were included in the calculation of total dissolved solids (TDS) when available. For some of the fresher waters from the Dewey Lake Red Beds, silica and nitrate were included in the calculation if they constituted a significant portion of the dissolved solids.

Laboratory measurements of TDS-ROI are also given when available, and the temperature at which the residue was dried is reported with the result.

1.3.5 Abbreviations Used in This Report

Abbrev.	Explanation
D	deuterium (^2H)
ft	foot/feet
g	gram(s)
gal	gallon(s)
gph	gallon(s) per hour
gpm	gallon(s) per minute
hr	hour(s)
km	kilometer(s)
L	liter(s)
m	meter(s)
meq	milliequivalent(s)
mg	milligram(s)
mi	mile(s)
min	minute(s)
mL	milliliter(s)
µS/cm	microsiemens per centimeter (formerly, micromhos per centimeter)
°C	degrees Celsius
°F	degrees Fahrenheit

1.3.6 Conversion Factors

To convert from:	to:	multiply by:
ft	m	0.3048
L	gal	0.2642
L/min	gph	15.82
L/min	gpm	0.2642
mi	km	1.609

1.4 Agencies Responsible for Collecting and/or Analyzing Samples

A number of agencies were responsible for collecting samples, performing analyses, and reporting the data used in this report. Most of these agencies are more conveniently referred to by acronyms or abbreviations. Key personnel are also acknowledged here.

Bendix (BFEC): Bendix Field Engineering Corp, Grand Junction, CO, a facility run for the DOE and administered by Bendix. The analytical laboratory, managed by Ronald B. Chessmore, performed many of the the analyses that are reported here. On 10/01/86, administration of the facility was assumed by United Nuclear Corp. (UNC), but the analytical-laboratory personnel and facilities remained the same. Most of the analyses for SNL that are in this report were done while the facility was managed by Bendix. In this report, the name "UNC/Bendix" is used; BFEC is used as an abbreviation in some data tables.

EEG: the New Mexico Environmental Evaluation Group (EEG), responsible for conducting an independent technical evaluation of the WIPP. The EEG is a part of the Environmental Improvement Division, which is a component of the New Mexico Health and Environmental Department.

HGC: Hydro Geo Chem, Inc., Tucson, AZ, a former Sandia subcontractor, responsible for hydrologic testing and groundwater sampling in many wells. Seth Gifford was responsible for many of the field measurements and collecting most of the samples in 1983 and 1984. Wayne Stensrud, now with Intera Technologies, was responsible for coordinating many of the hydrologic field activities.

IT Corp.: International Technologies Corp., an MOC subcontractor. IT personnel were responsible for implementing and performing the WQSP. Dan Colton and John Morse were instrumental in setting up the program. Doug Uhland had the primary responsibility for implementing the program. During round 1 of the WQSP, field-laboratory support was supplied by personnel from IT Corp. and the MOC, including Gordie Tatro, Mike Debes, Bill Randall, Terry Szepesi, and others. Field hydrology support was provided by personnel from IT Corp. and the MOC, including Dan Winstanley, Ron Richardson, Rey Carrasco, Mel Balderrama, and others.

ITAS: International Technologies Analytical Services Laboratory, Murraysville, PA, the analytical laboratory of IT Corp. ITAS has performed chemical analyses for MOC.

MOC: the DOE's Management and Operating Contractor for the WIPP project, formerly known as the Technical Support Contractor.

NMBM&MR: New Mexico Bureau of Mines & Mineral Resources, Socorro, NM. Dr. Lynn Brandvold analyzed solutes in many WQSP samples for the EEG.

SNL: Sandia National Laboratories, Albuquerque, NM. SNL serves as scientific advisor to the DOE and has been responsible for site-characterization efforts.

UNC or UNC Technical Services: United Nuclear Corp., on 10/01/86 replaced Bendix as manager of the DOE facility at Grand Junction, CO. See "Bendix."

USGS: the United States Geological Survey. The USGS, particularly through its personnel from the Water Resources Division, Albuquerque, NM, has been active in investigating the geohydrology of the WIPP area.

1.5 Study Area

1.5.1 Location and Stratigraphy

The WIPP site is located in southeastern New Mexico (see Figure 1). The wells discussed in this report are located in an ~25 mi by 30 mi region; the well locations are shown in Figure 2.

This report includes data from 48 wells, many of which have been sampled in more than one stratigraphic zone.

The stratigraphy of the WIPP site and vicinity has been presented elsewhere (Snyder, 1985; Mercer, 1983; Powers et al., 1978) and will not be discussed in this report. For the convenience of the reader, the stratigraphy is summarized in Figure 3.

Most of the samples discussed here come from the Culebra Dolomite or the Magenta Dolomite of the Rustler Formation or the "brine aquifer" of the Rustler/Salado contact zone. Samples were also collected from four stock wells completed in the Dewey Lake Red Beds. In addition, one sample came from the Bell Canyon Formation in well DOE-2, and one came from the alluvium in well WIPP-15.

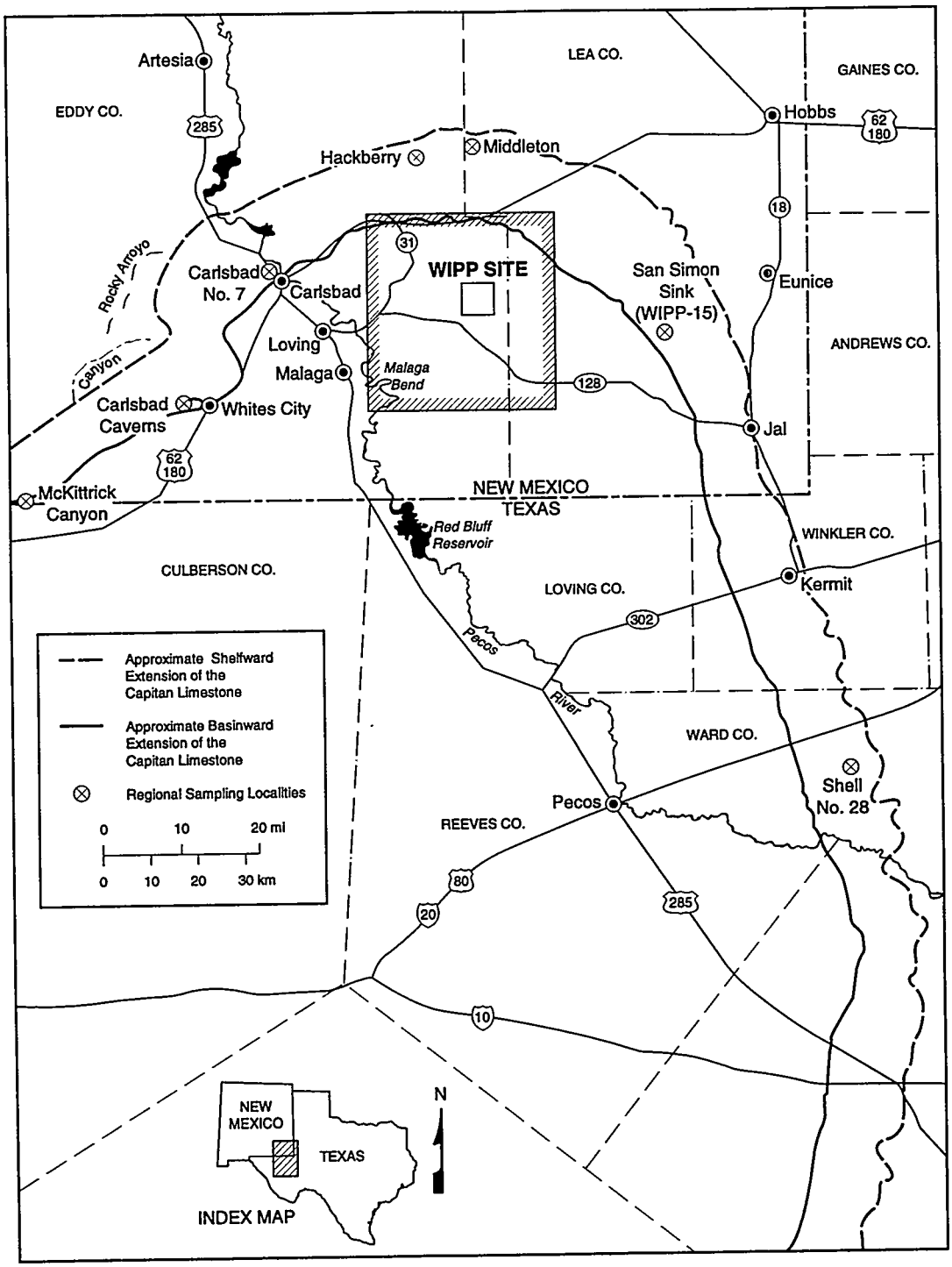

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Figure 1. Map of southeastern New Mexico showing location of WIPP site and of Well WIPP-15 (figure 1 of Lambert and Harvey, 1987).

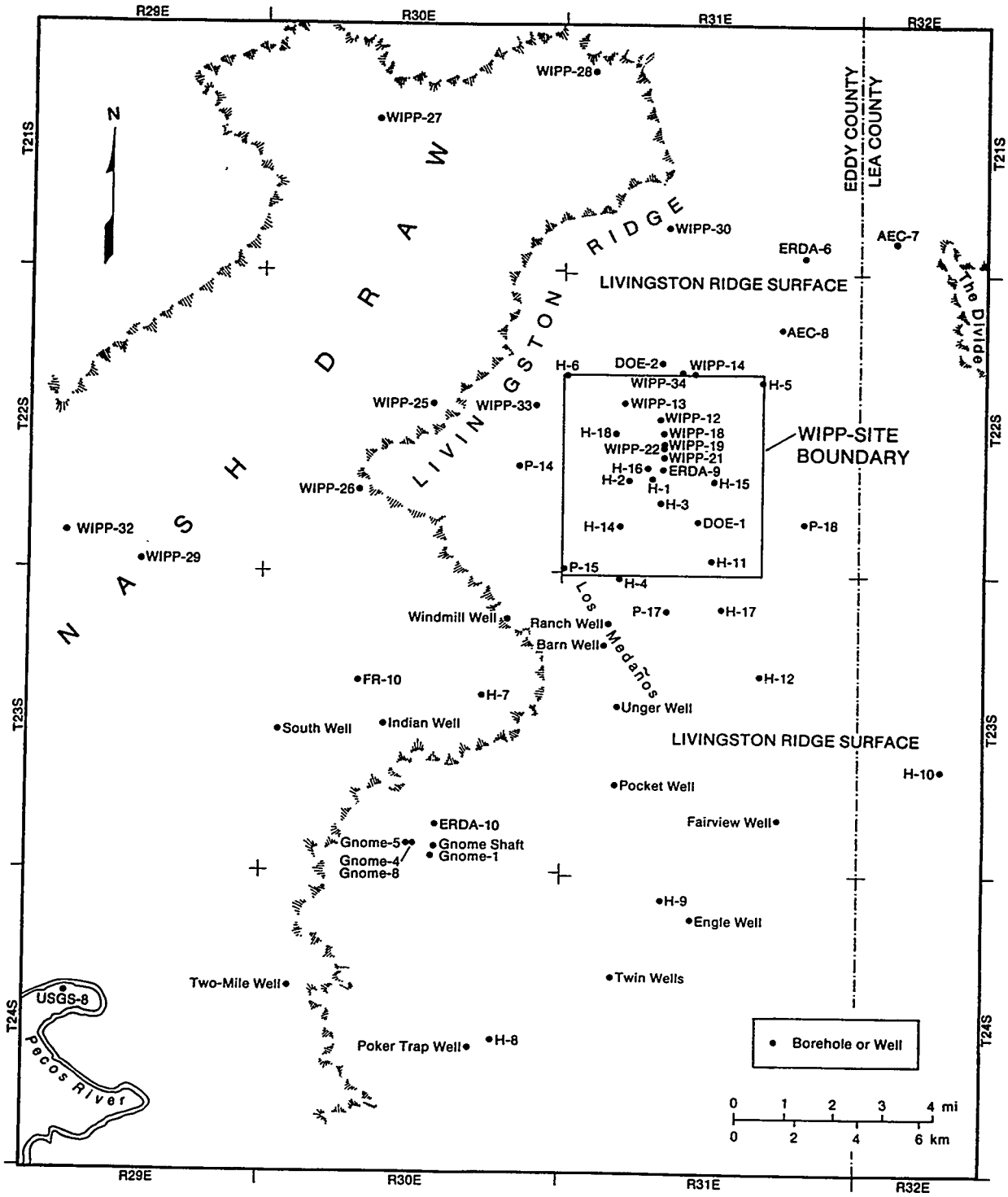

Figure 2. Map of WIPP and vicinity showing well locations. Well WIPP-15 is shown on Figure 1.

System	Series	Group	Formation	Member
Recent	Recent		Surficial Deposits	
Quaternary	Pleistocene		Mescalero Caliche	
			Gatuña	
Triassic		Dockum	Undivided	
Permian	Ochoan		Dewey Lake Red Beds	
			Rustler	Forty-niner
				Magenta Dolomite
				Tamarisk
				Culebra Dolomite
				unnamed lower
			Salado	
			Castile	
	Guadalupian	Delaware Mountain	Bell Canyon	
			Cherry Canyon	
			Brushy Canyon	

Figure 3. Generalized stratigraphic column of rocks at and near the WIPP site (figure 2-1 of Beauheim, 1987).

1.5.2 Groundwater Samples

1.5.2.1 WELLS AND STRATIGRAPHIC ZONES SAMPLED

Table 1 lists all the wells included in this report and the zones sampled in each well. Details about these wells (drilling histories, stratigraphies, and so forth) are found in various basic data reports and summary reports. The relevant references for each well are included in Table 1.

1.5.2.2 TESTS DURING WHICH GROUNDWATER SAMPLES WERE COLLECTED

This report contains solute data for samples collected during 116 different tests, either hydrology tests or pumping tests conducted with the primary purpose of providing representative samples. Table 2 lists the tests and includes the date of the test, the agency that collected the final samples, the average pumping rate during the test, and the approximate quantity of water removed before final samples were collected.

1.5.2.3 SAMPLES COLLECTED

During many tests, suites of final samples were collected and sent to various laboratories for solute and other (for example, isotope) analyses. Table 3 lists all the samples for which solute data are included in this report. With the exception of the samples for stable isotopes of chlorine, samples for isotope analyses (D, ^{18}O, ^{14}C, and uranium) are not included in this table.

Also included in Table 3 are "field" samples, designated by "FLD" in the laboratory column. These are not actually single samples. Rather, data given in subsequent tables for these "samples" are the steady state (or best available) values of selected parameters that were measured in the field, usually during serial sampling.

For each sample, Table 3 gives the well name, stratigraphic zone, the date of sample collection (or range of dates during which field measurements were made), the agency that collected the sample, the laboratory that analyzed the sample, and a sample identification code for cross-referencing to other data tables.

2.0 METHODS OF EVALUATING SOLUTE DATA

2.1 Background

In conducting a program to study the geochemistry of the groundwater in a region, one attempts to collect samples that are representative of the unperturbed groundwater for the parameters of interest, preserve the samples without changing the parameters of interest until they can be analyzed, and determine those parameters with the accuracy and precision required by the program or data user.

In practice, one often encounters some other situation. For example, in some cases, the samples and data were collected for some other program; the user must now evaluate the data for their suitability for the current project. In other cases, two or more sets of data for the "same" samples give conflicting results; the user must determine which results, if any, to believe.

In evaluating the data – that is, in determining how well the data represent the native unperturbed groundwater – one must consider two questions:

- Was the sample representative for the parameters of interest?
- Were the analyses of that sample reliable?.

Obviously, an excellent analysis of a nonrepresentative sample will be of little use. Although a poor analysis of a representative sample is also of little use, the analysis can sometimes be repeated (if sufficient sample was left over or archived) to give useful results.

The following sections discuss some ways of evaluating the samples and analyses. These sections summarize the processes the author used to develop the preliminary evaluation given in Section 5.0.

Section	Contents
2.2	Evaluating the representativeness of samples
2.3	Evaluating the stability (shelf life) of samples
2.4	Evaluating the quality of the analyses
2.5	Summary

Although the considerations for evaluating the samples and analyses are presented as separate topics, in practice one considers them simultaneously, and the evaluation of the samples and analyses becomes an iterative process.

2.2 Evaluating the Representativeness of Samples

This section discusses ways of determining if the samples collected represent the unperturbed native groundwater. The discussion comprises three parts.

- Background
- Discussion of representativeness
- Methods of evaluating the representativeness of samples

2.2.1 Background

Before 1980, groundwater samples that were collected and analyzed for the WIPP project were usually collected by bailing or swabbing during or after hydrologic testing at a well.

In 1980, Lambert and Robinson (1984) conducted a sampling program in which they demonstrated that:

> "any arbitrarily chosen sample from a pumped or bailed well cannot be shown as representative of the nearly unperturbed subsurface reservoir... The well system, which includes local reservoir rock and the sampling system, must be purged of introduced material and stagnant products of the interaction of water with metal before a geologically significant water sample can be collected and analyzed."

Lambert and Robinson (1984) further showed that:

> "criteria for determining a samples's significance are not absolute, but must instead be based on long-term observations of the well that include withdrawal of water and periodic measurements."

Useful criteria that can be measured precisely in the field include some major solutes (such as chloride and total divalent cations), alkalinity, and iron.

Since 1980, most samples have been collected after lengthy (days to weeks) pumping episodes, during which serial samples were collected and analyzed in the field for some or all of those parameters.

2.2.2 Discussion of Representativeness

A representative sample was defined in Section 1.3.3 as a sample that represents the native unperturbed groundwater. Because it is impossible to collect a sample without perturbing at least some parameters, in practice we accept as representative a sample in which the parameters of interest have not been perturbed.

A sample that is representative for some parameters need not be and often will not be representative for other parameters.

This is sometimes seen during a serial-sampling program. Assuming for the moment that a steady-state value represents the unperturbed groundwater (not always a valid assumption, as will be discussed below), if several parameters are measured in serial samples, some parameters may reach steady state while others do not.

For example, in some tests, after the Cl^- and X^{++} field values reached steady state, the alkalinity was still changing (see, for example, Section 3.3.2.2). The samples were considered representative with respect to the major solutes but not with respect to alkalinity.

2.2.3 Methods of Evaluating the Representativeness of Samples

There are several questions that can be considered in evaluating the representativeness of a sample for a given parameter.

If parameters were measured in serial samples, were steady-state values reached?

- If steady state was not reached, the sample will not be representative for this parameter.
- Even if steady state was reached, the sample may not be representative. (See, then, the next question.)

If a steady-state value was reached, is there reason to believe that the steady-state value is representative or to believe that it is not representative of the unperturbed groundwater?

- If the steady-state value is a function of pumping rate, type of pump or other sampling apparatus (tubing, etc.), time of day, well-bore pressure, or some other nongeochemical or hydrochemical factor (as in the example that follows), then the probability of collecting a representative sample for that parameter is slight: the achievement of steady state will not mean that the samples are representative.

  Example in which a steady-state value is not representative: Iron is often used as a field indicator of steady state for trace metals. However, the iron steady-state value is sometimes a function of the pumping rate. This was demonstrated during round two of the Water Quality Sampling Program (WQSP), when the Culebra at H-6B was being sampled. When the pumping rate was halved for a few days, the iron concentration increased dramatically; when the pumping rate was increased to its former value, iron dropped to its former "steady-state" concentration (Uhland et al., 1987). In such a case, even the lowest observed iron concentrations are unlikely to represent the native groundwater. In contrast, the major solutes, Cl^- and X^{++}, had reached steady state before the pumping rate was decreased and remained constant throughout the remainder of the test, independent of the pumping rate.

- If the steady-state value is not a function of any circumstantial factors, then we are more confident that the value is representative. Note, however, that an apparent steady-state

value may not really be "steady state" but may be slowly changing or varying in some way not obvious to the field chemist. For example, the apparent steady-state value may be changing too slowly to be observed during a test lasting a few days to weeks. Or, the test may be sampling a large contamination plume (Colton and Morse, 1985).

Example in which a steady-state value is usually representative: Chloride and divalent cations (X^{++}) are considered useful indicators of representativeness of a sample for the major solutes Cl^-, $SO_4^=$ Na, Ca, Mg, and K for the following reasons. First, at several locations, values of Cl^- and X^{++} have repeatedly reached the same steady-state values in different tests and, as mentioned above, in a test during which the pumping rate varied by a factor of two, Cl^- and X^{++} remained constant once steady state was reached. Second, in final samples from those tests (different times at the same location), laboratory values for all the major solutes are the same, within expected analytical variation; that is the Na results agree with each other, the K results agree with each other, and so forth. (Note, however, that at a few locations, different "steady-state" values of Cl^- and X^{++} were reached during different tests. These cases are discussed in Section 5.0.)

During many tests we do not know if steady-state values are factors of nongeochemical or hydrochemical conditions for two reasons.

First, pumping and sampling tests are performed with a set of sampling apparatus (pump, tubing, discharge pipe, and so forth) and generally are conducted at a constant pumping rate. Although possible, it is time consuming and expensive to conduct multiple tests at various pumping rates to check for correlation of steady-state values with pumping rate. In practice, this exercise has not been performed intentionally, but has sometimes been mandated by the test conditions, as at H-6B described above.

Second, varying the sampling apparatus and well conditions ranges from difficult to impossible. For example, once the well casing is in place, it usually stays there. Nonetheless, such variation has occurred occasionally because different agencies have conducted tests in the same wells during the history of the WIPP project and some wells have been reconfigured to meet the needs of a specific test.

Because of this, knowing the borehole histories and well configurations at the time of sampling is important in evaluating the data for some solutes.

How well do the results compare with results for other samples from the same location in the same stratigraphic zone and at the same hydropad?

- If, in samples collected at different times (perhaps by different methods), the concentrations of the parameter(s) of interest are the same, we have greater confidence that the samples were representative.
- If the concentrations are different, other questions must be asked to determine why they are different. For example:
  - — Did the samples degrade between the times of collection and analysis?

— Were the analyses of poor quality?

— Did the composition of the produced water change with time?[4]

If the answer to each of these questions is no, then at least one of the samples must have been nonrepresentative.

Other considerations

Some workers (Meijer et al., 1987; Bodine and Jones, 1986; Bodine et al., 1988) have evaluated the representativeness of some WIPP groundwater samples for certain parameters by running geochemical codes such as PHREEQE and SNORM. The modeling results are compared with the observed mineralogies and are checked for consistency. The presence of extraneous components such as certain major solutes (from, for example, drilling fluids, casing cements, acid from acidization, and so forth) can sometimes be demonstrated this way. This report, which gives a preliminary evaluation of the data quality, does not use these modeling techniques.

2.3 Evaluating the Stability (Shelf Life) of Samples

This section discusses ways of determining if the composition of a sample changed between the time of collection and the time of analysis. The discussion comprises three parts.

- Background
- Shelf-life studies
- Methods of evaluating stability (shelf life) of samples

2.3.1 Background

The composition of a groundwater can change as it is being collected, as it is being preserved, or between the times of preservation and analysis.

2.3.1.1 CHANGES DURING COLLECTION OF SAMPLES

The composition of a sample can and probably does change somewhat as it is being collected, that is, as it is coming up the sampling tube or pipe from aquifer depth to the surface.

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[4]The chance of the water quality varying with time depends on both the geographic location of the well and the stratigraphic zone being sampled. For example, the water quality of the Magenta and Culebra in WIPP-27 and the Culebra in WIPP-29 appear to be influenced by surface activities such as potash mining activities in nearby parts of Nash Draw. Thus, variations in water samples collected at different times in parts of Nash Draw are thought to be real but caused by surface activities.

For example, when a sample is brought from depth to the surface, it may lose some gases such as dissolved CO_2. Similarly, when the sample comes in contact with air, the ratios of different oxidation states of some multivalent elements may change.

Because these processes aren't believed to affect the concentrations of the major solutes, these problems are not considered further in this report. But anyone who uses other data from these samples should be aware of the potential for a problem; for example, all pH and alkalinity data should be used with caution.

2.3.1.2 CHANGES RESULTING FROM PRESERVATION PROCEDURES

A sample could be contaminated in various ways during the preservation process. In particular, a sample could be contaminated by the following:

- the filter membrane or filtering apparatus
- dirt or residue in the container in which it will be stored
- the acid used as a preservative

Although the possibility of contamination during the preservation process is considered negligible for the major solutes, it will have to be considered in evaluating the minor and trace element data.

The sample collection procedure includes several steps to minimize the chances of contamination during the collection and preservation operations and to help recognize contamination if it occurs.

- To minimize the chance of contamination from the filter apparatus or membrane, when a new membrane is put in the membrane holder, the first aliquot of filtered water (typically ~50 mL) is discarded.
- To remove any trace metals left on the surface from the manufacturing process, the plastic sample bottles are washed with nitric acid before they are used. The washing step also removes any dirt or other residue that might be in the bottles.
- To aid in identifying contamination introduced by the acid used as a preservative, acid-blank samples are prepared and analyzed.

2.3.1.3 CHANGES DURING STORAGE

The sample may gain solutes from or lose solutes to its container, between the time it is bottled up and the time it is analyzed.

During storage, solutes can increase, or apparently increase, in concentration by several mechanisms.

- absorbtion from the container walls (a concern in trace-constituent analyses)
- evaporative loss of water from the container
- dissolution of the suspended solids in nonfiltered samples, leading to an increase in certain solutes

The first two mechanisms are not of concern for the samples and parameters considered in this report. The third mechanism does not seem to be a problem in the samples reviewed. However, because of this possibility, samples that have been filtered in the field immediately after collection are preferred.

Similarly, solutes can be lost by more than one mechanism.

- adsorption onto the container walls
- precipitation

Adsorption may be a problem for certain trace constituents of interest here, and precipitation may be a problem for some of the samples of interest here.

Acidifying a sample inhibits the loss of many solutes, especially the cations. However, some parameters, notably the anions, are better determined in an unacidified sample. In fact, the unacidified samples usually do contain some solid material by the time they reach the laboratory, even if received just a few days after collection. This solid material is usually removed by filtration before analysis. The small quantities observed have been considered negligible with respect to the major solutes but may be significant for some minor or trace constituents.

2.3.2 Shelf-Life Studies

Although the shelf lives of the WIPP groundwater samples have not been specifically tested, this could be done by collecting a large quantity of selected samples and analyzing each sample immediately after collection as well as at specified intervals (for example, one wk, one mo, six wk, three mo, six mo, one yr, two yr, and so forth) after collection. This test could be done for groundwater samples of varying ionic strengths.

However, because some WIPP groundwater samples had to sit for months to years before being analyzed (because of manpower and budget constraints), there is some indirect evidence that sample stability is not necessarily a problem with these samples.

Samples collected in 1980 and 1981 remained at SNL until 1985, when they were shipped to UNC/Bendix for analysis. The samples did not appear to degrade, at least with respect to the parameters of interest, between the time of collection and time of analysis.

- The resulting data sets had small CBEs, even though the cations were determined in field-acidified samples, which are expected to be very stable, and the anions were determined in

field-filtered unacidified samples, which might be expected to degrade over a several-year period.

- For the 1980 samples, the agreement between the field and laboratory chloride and divalent cation values is excellent, indicating that there was no loss of chloride from the unacidified samples or of calcium or magnesium from the acidified samples. (Because these solutes were not determined in the field in 1981, the comparison cannot be made for the 1981 samples.)
- Several sites sampled in 1980 and 1981 (the Culebra in H-4B, H-5B, H-6B, WIPP-25, WIPP-26, and WIPP-29) were resampled during round one of the WQSP in 1985 and 1986. The samples were analyzed by UNC/Bendix within a few weeks or months of collection. The agreement between the "old" and "new" samples is good, and the observed differences cannot be explained by degradation or instability of the older (1980/1981) samples. (See also Section 5.0 for discussions of specific sites.)

The shelf life of the unfiltered/unacidified samples has not been systematically considered, but it is expected to be similar to the shelf life of the field-filtered/unacidified samples.

The preceding discussion refers to the author's samples, which were stored at ambient laboratory temperatures (60 to 75°F) until they could be analyzed. Samples stored at extreme temperatures are more likely to degrade. For example, if an unacidified sample gets very cold, species that are close to saturation at warmer temperatures may precipitate. These reactions are typically not reversible (on a laboratory time scale); that is, the solids do not redissolve when the sample is warmed up again. Thus, knowledge of the history of a sample, that is, its storage and shipping conditions, may sometimes be useful in evaluating sample stability.

2.3.3 Methods of Evaluating the Stability (Shelf Life) of Samples

Even though there is no evidence of degradation of any of the samples analyzed by UNC/Bendix for SNL, the possibility of sample degradation cannot be ignored when discrepancies between data sets exist.

In evaluating the stability of samples, several questions may be considered.

- Are the solute concentrations in the unacidified samples (field-filtered or not) significantly lower than values observed during field analyses?
- Are the total meq/L of anions in an unacidified sample significantly lower than the total meq/L cations in the acidified fraction?
- For two samples collected at the same place and time, are the solutes in an unacidified sampled analyzed in one laboratory significantly lower than the solutes in a demonstrably stable sample analyzed in another laboratory?

If the answer to any of these questions is yes, the sample may have degraded. In all cases, however, one must rule out the possibility that analytical error is the cause of the differences.

2.4 Evaluating the Quality of the Analyses

This section discusses ways of evaluating the quality of the analyses. The discussion comprises two sections:

- Background
- Methods of evaluating the quality of the analyses

2.4.1 Background

In principle, one should be able to evaluate the quality of the laboratory data without considering the quality of the sample. In practice, one often doesn't have all the information needed to do so, but can qualitatively evaluate the data by indirect means.

To evaluate the reliability of the data, without regards to the source or quality of the sample, one needs to know that the analytical method is appropriate for this type of sample and have access to all of the laboratory data, including results from analyses of replicates, control samples, spiked samples, and standards.

Without that information (for example, when using published data from another source), then one can only evaluate the data by comparing them to other data.

2.4.2 Methods of Evaluating the Quality of the Analytical Data

In evaluating the quality of analyses, several questions can be considered.

Are the data internally consistent; that is, is the charge-balance error reasonable?

- Charge-balance errors (CBEs) can be calculated when all of the major solutes are determined. For most of the Rustler waters, which contain just a few major solutes, CBEs of less than ± 3% have been routinely obtained by UNC/Bendix.
- If the CBE is large, one or more of the major solute values may be incorrect; however, it is necessary to first consider the possibility that one or more major solutes was not determined. For example, a large positive CBE for the Ranch Well Dewey Lake sample, a relatively fresh water, led UNC/Bendix to determine nitrate in the sample; nitrate proved to be an important constituent in the Ranch Well water.
- If the CBE is small, this is only an indication of apparent internal consistency and, by itself, does not guarantee the quality of the data. For example, errors in two or more solutes could cancel each other out and would not show up in the CBE calculation.
- In addition, because just two or three solutes dominate the composition of many WIPP waters (for example, Na and Cl^-, or Mg, Ca, and $SO_4^=$), large inaccuracies in the other solutes (including some considered "major") will not be reflected in the CBE. For

example, many of the USGS potassium values appear to be in error by as much as two orders of magnitude (see Section 4.1.3), yet the CBEs are reasonable.

Do the calculated total dissolved solids and the measured residue-on-ignition agree?

- If the full suite of major solutes is determined, the total dissolved solids (TDS) content of the sample can be calculated. If the residue-on-ignition (ROI) is also measured in the laboratory (as described in Section 1.3.4), the calculated TDS is expected to be slightly less than the observed ROI, as the residue will probably contain excess water (in hydrated mineral precipitates). If the calculated TDS is much larger than the observed ROI, the analytical results should be viewed with suspicion.

Do the results meet the precision and accuracy requirements of the user?

- If replicates were analyzed, does the calculated precision meet the needs of the data user or program?
- If a laboratory has determined the same analyte by two methods, do the results agree within the limits of the methods? For example, UNC/Bendix determined bromide in a sample of water from the Culebra at H-3B3, collected in June 1984, by X-ray fluorescence (XRF) and differential pulse polarography (DPP). The results differed by less than 10 percent.
- If spiked samples were analyzed, do the recoveries meet the accuracy requirements of the data user or program?
- If control samples were analyzed, do the results agree with the "true" values within the limits of the analytical method?

If parameters were determined in the field, do the laboratory and field results agree within the limits of the analytical methods?

- If the laboratory results are lower, the problem could be caused by sample instability, or either of the analyses could be incorrect.
- If the laboratory results are higher, either of the analyses could be in error.
- If the laboratory and field results agree, but were determined by the same method, then sample stability is indicated, but nothing is learned about the accuracy of the method because both results could be inaccurate by the same amount.
- If they agree and were determined by different methods (for example, Cl^- by titration in the field and ion-specific electrode in the laboratory; X^{++} by titration in the field and atomic-absorption or inductively coupled plasma spectrophotometry in the laboratory), then both the sample stability and the quality of the analyses appear satisfactory.

If different laboratories analyzed samples collected at the same time from the same place (such as Water Quality Sampling Program samples), are the results the same, within the limits of the analytical methods?

- If the results are different, and if sample instability can be ruled out as the cause of the difference, then at least one of the results is in error.
- If the results are the same, but were determined by the same methods, then again sample stability is indicated, but nothing is learned about the accuracy of the method.
- If the results are the same and were determined by different methods, then both the sample stability and the quality of the analyses appear satisfactory.

2.5 Summary of Methods of Evaluating Solute Data

In summary, the evaluation of quality of the analyses and the representativeness of the samples cannot usually be separated.

If appropriate laboratory data (especially analyses of replicates, spiked, and control samples) and field data are available, one may be able to distinguish differences in supposedly similar samples caused by the following:

- normal analytical variation
- analytical error
- nonrepresentative samples
- real changes in water quality at a location with time

If the problem is nonrepresentativeness, and if appropriate field data are available, one may be able to determine why the sample was not representative.

- a nonrepresentative sample was collected
- the sample was contaminated during preservation or it degraded in the bottle

Unfortunately, for some of the data considered in this report, we do not have enough information to evaluate the quality of the samples or the analytical results. These data must be used with caution.

Although the considerations for evaluating the samples and data were presented here as separate topics, in practice one considers them simultaneously, and the evaluation of the samples and data becomes an iterative process.

3.0 DATA FROM SNL AND SNL'S SUBCONTRACTORS

3.1 Introduction

Since the late 1970s, SNL has been involved in the sampling and analysis of groundwaters from many wells in the vicinity of the WIPP. For convenience in this report, the samples in which various solutes were analyzed either by SNL or by a subcontractor are divided into six groups. For these groups, field data summaries, sample collection methods, and solute data are discussed in the sections indicated in the following list. Section 3.8 gives the analytical methods used by UNC/Bendix, who did most of SNL's laboratory analyses. Other methods are discussed in Sections 3.2 through 3.7 where appropriate.

Section	Samples collected
3.2	before 1980 by the USGS and analyzed by SNL's Analytical Chemistry Division
3.3	in 1980 by SNL and analyzed by UNC/Bendix
3.4	in 1981 by SNL and analyzed by UNC/Bendix
3.5	in 1983/1984 by HGC and analyzed by various HGC subcontractors
3.6	in the summer of 1984 by HGC and analyzed by UNC/Bendix and others
3.7	in 1985/1986 during round one of the WQSP and analyzed by UNC/Bendix.

Field data are included for serial samples collected in 1981, 1983, and 1984 because these data have not been published elsewhere.

Steady-state values or, in the absence of serial-sampling data, the best available field values for selected parameters are given for all samples. Steady-state values for various solutes (such as Cl^-, X^{++}, Fe) are included to allow comparison with laboratory results for the final samples.

The steady-state values were selected by the author after examination of all the serial-sampling data. Note that a steady-state value reported here is not necessarily the same as the value measured in the last serial sample. Once a parameter reaches steady state, the measured value will vary within the limits of analytical precision. Thus, a steady-state value given here is the average of the serial-sampling values measured after that parameter had, in the author's opinion, reached steady state. Apparent outliers were rejected.

The steady-state values were rounded as follows:

- pH to 0.1 unit
- specific gravity to 0.01 or 0.001
- HCO_3^-, $CO_3^=$, Cl^-, X^{++}, and Ca to 2 significant figures
- $SO_4^=$ and Fe to 1 significant figure

The concept of steady state is not meaningful for temperature, which often varies diurnally, especially at low pumping rates; temperatures are therefore given as ranges of the minimum to maximum values observed during serial sampling.

Steady-state values are not included for specific conductance, which is at best a crude indicator of total dissolved solids (TDS), or Eh, which is not well understood. Although Eh can be a useful indicator of steady state (Lambert and Robinson, 1984), the observed value varies with the method of measurement, and the interpretation of the results is debated.

Serial-sampling data were not available for some samples and parameters. In those cases, the best available (often the only available) field values are given.

3.2 Samples Collected Before 1980

3.2.1 Program Description and Wells Sampled

In the late 1970s, the USGS performed hydrologic tests at many WIPP wells and collected water samples in conjunction with many of these tests. The USGS work is discussed further in Section 4.1. Bottles of some of the samples were sent to Sandia for solute and/or stable isotope (D and ^{18}O) analyses. The stable isotope results are reported by Lambert and Harvey (1987).

Solute analyses are given in this section for samples from the following nine locations:

Stratigraphic Zone	Well(s)
Alluvium	WIPP-15
Culebra	P-15
Magenta	H-3B1
Rustler/Salado	H-4C, H-5C, H-6C, P-15, P-17, P-18

3.2.2 Field Data and Sample Collection

As is discussed in Section 4.1, samples were collected by bailing or swabbing according to standard USGS protocols. Samples sent to SNL for solute analyses were collected in one-liter plastic bottles and were not field filtered or acidified. These samples were stored at ambient temperature at SNL until analysis.

Serial samples were generally not collected or analyzed during these tests, but some parameters such as pH and alkalinity were sometimes measured in the field at the time samples were collected. Mercer (1983) published the field data along with the USGS laboratory results (see Section 4.1); these data are included in Table 68 of this report.

3.2.3 Solute Data

Solutes were analyzed by SNL's Analytical Chemistry Division in late 1979 and early 1980. Suspended solids were removed by filtration through Whatman 42 paper, which the manufacturer states has a 2.5-μm-particle-size retention, or by high speed centrifugation when filtration failed. A density for each sample was determined by weighing a 10-mL aliquot at room temperature.

Solutes were determined as follows:

Solute(s)	Method
$CO_3^{=}$ and HCO_3^-	titration with standard hydrochloric acid solution to the phenolphthalein and methyl-red endpoints, respectively
$SO_4^{=}$	gravimetry: precipitation as barium sulfate
Cl^-	titration with silver nitrate
Na and K	atomic absorbtion
Ca and Mg	atomic absorption and/or EDTA titration

The data are presented in Table 16. Total dissolved solids contents and charge-balance errors were calculated as discussed in Section 1.3.4.

Precisions can be estimated for some, but not all, of the measured parameters. Density was determined just once for each sample so the analytical precision for density cannot be estimated. Bicarbonate, carbonate, chloride, and sulfate were determined in duplicate and the precisions (95% confidence limits, two replicates) have been estimated as follows:

Solute	Applicable Concentration Range	Estimated Confidence Limits
Cl^-	<20000 mg/L Cl^-	± 100 mg/L
	20000 - 100000 mg/L	± 300 mg/L
	>100000 mg/L	± 1000 mg/L
$SO_4^{=}$	<1000 mg/L $SO_4^{=}$	± 10 mg/L
	1000 - 8000 mg/L	± 100 mg/L
HCO_3^-, $CO_3^{=}$		± 10 mg/L

The author has been unable to determine if the major cations were analyzed in replicate and is therefore unable to estimate the precisions of those analyses.

3.3 Samples Collected in Nash Draw in 1980

3.3.1 Program Description and Wells Sampled

In 1980, SNL and the USGS undertook a program of hydrological and geochemical studies in Nash Draw, west of the WIPP site. The following 15 locations were tested:

Stratigraphic Zone	Wells
Culebra	WIPP-25, WIPP-26, WIPP-27, WIPP-28, WIPP-29, WIPP-30
Magenta	WIPP-25, WIPP-27, WIPP-30
Rustler/Salado	WIPP-25, WIPP-26, WIPP-27, WIPP-28, WIPP-29, WIPP-30

The Magenta was not tested in wells WIPP-26, WIPP-28, or WIPP-29 because there was too little water to pump at WIPP-26 and WIPP-28, and the Magenta is nonexistent (eroded away) at WIPP-29.

The USGS field activities are described in Richey (1987), and SNL's field activities are summarized in Lambert and Robinson (1984). In brief, in each of the six wells, the process was the following:

- The USGS perforated the well casing, tested and collected samples from the Rustler/Salado contact zone in the spring of 1980, and performed additional hydrologic tests in the Rustler/Salado contact zone in July 1980.
- When the USGS was finished at a well, SNL did hydrologic tests and collected samples.
- After SNL was finished with the Rustler/Salado contact zone, a bridge-plug packer was set below the Culebra, the Culebra was perforated, and the USGS did a series of hydrologic tests and collected samples.
- Again, when the USGS was finished, SNL did hydrologic tests and collected samples.
- When SNL finished testing the Culebra, the procedure was repeated for the Magenta: a bridge-plug packer was set below the Magenta, the zone was perforated, the USGS tested and collected samples, and finally Sandia tested and collected samples.

The USGS testing and sampling chronologies are given in Richey (1987), and their laboratory solute data are given in Mercer (1983). The USGS solute data are summarized in this report in Section 4.1.

3.3.2 Field Data and Sample Collection

SNL's sample-collection program is described in detail in Lambert and Robinson (1984) and is summarized here. During extended (>24 hr.) pumping tests that were performed with jack pumps or submersible pumps, serial samples were periodically collected and analyzed in the field for parameters including temperature, pH, Eh, specific gravity, specific conductance, alkalinity, and concentrations of Cl^-, X^{++}, and total Fe. Final samples were collected only after certain parameters (usually Cl^-, X^{++}, alkalinity, and Fe) reached steady state.

During three sampling episodes, one or more parameters failed to reach steady state; as a result, the usual suites of final samples were not collected. Specifically, from the Culebra at WIPP-28, a limited suite of final samples was collected, and from the Rustler/Salado contact at WIPP-27 and the Magenta at WIPP-30, no final samples were collected. These three cases are discussed in more detail in Sections 3.3.2.1 through 3.3.2.3.

The methods of measuring parameters in the field, criteria for collecting samples, methods of collecting samples, and descriptions of the collected samples, as well as all of the serial-sampling data, are given in Lambert and Robinson (1984). Steady-state field values for pH, specific gravity, alkalinity, Cl^-, X++, Ca, $SO_4^=$, and Fe and the range of temperatures observed during serial sampling are given here in Table 11.

Note that because of uncertainties regarding the accuracy of the analyses, Lambert and Robinson (1984) presented their field solute data (Cl^-, X^{++}, Ca^{++}, and $SO_4^=$) as ratios to the initial values in their Tables 4-1 through 4-15 and as approximate values rounded to one significant digit in their Table 6-1. Because it was not possible, at that time, to analyze control samples and spiked samples in the field, there was not sufficient information to evaluate the accuracy of the methods. However, subsequent comparisons of the field data with laboratory data have shown that the field titrimetric measurements of Cl^-, Ca^{++}, and X^{++} agree with the laboratory values quite well (generally to better than ± 10%), so field measurements for those three parameters are given here as actual concentrations rounded to two significant figures.

In contrast, the field $SO_4^=$ and Fe measurements were made by less accurate methods than are used in the laboratory. For example, samples were diluted using plastic measuring pipettes and graduated cylinders rather than glass volumetric pipettes and flasks (Lambert and Robinson, 1984). Therefore, field $SO_4^=$ and Fe measurements are given as approximate values rounded to one significant figure.

Although limited time and manpower precluded the routine analysis of replicates in the field, enough replicates were analyzed to allow crude estimations of analytical precision either as confidence limits (95% C.L., 1 replicate) or relative standard deviations (RSDs). As reported by Lambert and Robinson (1984) the estimates were the following:

Parameter	Estimated Precision
temperature	±1°C (conf. limits)
pH	±0.1 (conf. limits)
specific gravity	±0.02 (conf. limits)
HCO_3^-, $CO_3^=$	±6 mg/L (conf. limits)
Cl^-, Ca, X^{++}	±2% (RSD)
Fe	±10% (RSD)
$SO_4^=$	±10% (RSD) for <5000 mg/L $SO_4^=$
	±20% (RSD) for 10000 - 20000 mg/L $SO_4^=$

The samples for solute analysis were stored at ambient temperature in the author's laboratory in Albuquerque until June 1985, when they were sent to Grand Junction, CO, for analysis by UNC/Bendix. Samples collected for analyses of stable isotopes (D and ^{18}O), radioisotopes (^{3}H and ^{14}C), and uranium isotopes have also been analyzed; the results are presented in Lambert and Harvey (1987), Lambert (1987), and Lambert and Carter (1987), respectively. In addition, Hydro Geo Chem sent aliquots of Culebra samples from WIPP-26, WIPP-28, WIPP-29, and WIPP-30 to the Kansas Geological Survey (KGS) for halide analyses (see Section 3.5.3 and Table 18).

The following three subsections contain details about the three tests during which full suites of final samples were not collected: WIPP-27 Rustler/Salado; WIPP-28 Culebra; and WIPP-30 Magenta.

3.3.2.1 WIPP-27 RUSTLER/SALADO (JULY 1980)

As the Rustler/Salado contact zone at WIPP-27 was being tested, field measurements indicated apparent steady state after 24 hr of pumping. However, by this time the pumping rate had dropped to less than two gph (from an initial rate of ~eight gph), the water level in the borehole had continually dropped, indicating that the well was nearly "dry," and the iron concentration was high (~20 mg/L), indicating prolonged contact with the well casing and/or discharge pipe. Because there was sufficient reason to doubt that the water being produced at such a low pumping rate was representative of the reservoir, final samples were not collected from the Rustler/Salado contact zone at WIPP-27 (Lambert and Robinson, 1984).

3.3.2.2 WIPP-28 CULEBRA (SEPTEMBER 1980)

After the Culebra at WIPP-28 had been pumped for one day, all parameters except alkalinity had stabilized. After two days of pumping, the alkalinity values were still slowly but steadily decreasing. Samples were taken for solute analyses and isotope (D, ^{18}O, and uranium) analyses, but not for radiocarbon analyses. A representative alkalinity value for the Culebra at WIPP-28 is not available (Lambert and Robinson, 1984).

3.3.2.3 WIPP-30 MAGENTA (DECEMBER 1980)

As the Magenta at WIPP-30 was being tested, the pumping rate was very low (<100 mL/min). During the first 48 hr of pumping, the major solutes appeared to be close to steady state, with chloride, divalent cations, and calcium varying ± 5% and sulfate ± 10% in the three serial samples analyzed. However, a day later the sulfate value had tripled and the chloride, calcium, and divalent-cation values had approximately doubled (see Section 5.3.12 for a discussion of the possible cause). During the next few days, the major solutes decreased steadily. After five additional days of pumping, the chloride value had dropped to 80% of its original value, while the divalent-cation and calcium values were still ~50% and ~70% above their original values, respectively. Because the spectrometer malfunctioned, sulfate analyses had been discontinued two days after the abrupt rise. At that time sulfate was ~2.5 times its original value. As there was

no indication that steady state was being approached, the test was terminated without final water samples being collected (Lambert and Robinson, 1984).

3.3.3 Solute Data

Samples were analyzed by UNC/Bendix during the fall of 1985. Analytical methods are described in Section 3.8 and are summarized in Table 65.

UNC/Bendix results for the 13 samples from Nash Draw are given in Tables 20 to 32 and are summarized in Table 64. Total dissolved solids contents and charge-balance errors were calculated as discussed in Section 1.3.4. The calculation of analytical uncertainties is discussed in Section 3.8.

3.4 Samples Collected in 1980-1981 During Hydrologic Tests

3.4.1 Program Descriptions and Wells Sampled

In 1980 and 1981 SNL and Hydro Geo Chem (HGC) performed a two-well recirculation tracer test at the H-2 hydropad. In December of 1980 the author, at the request of SNL's staff hydrologist, made some field measurements at H-2. These measurements are discussed below (Section 3.4.2.1).

In 1981, SNL and HGC performed a series of interference pumping tests in the Culebra at hydropads H-4, H-5, and H-6. These tests are described in detail in HGC (1985) and are summarized here. Three wells are located on each hydropad, denoted with the suffixes A, B, and C. The wells were originally drilled in 1978 and were completed in the Magenta, Culebra, and Rustler/Salado, respectively. The "A" and "C" wells were later re-configured to allow access to the Culebra (HGC, 1985). In each "C" well, a packer was set above the Rustler/Salado, and the Culebra was perforated. Each "A" well was deepened to just below the Culebra, and a packer was set to isolate the Culebra from the Magenta.

For the interference tests at each hydropad, first the "B" well was pumped while the "A" and "C" wells were observed. Then the "C" well was pumped while "A" and "B" served as observation wells. Because at that time SNL's staff hydrologist was interested in continuing the radiocarbon sampling program started in Nash Draw the previous year, serial samples were collected, selected parameters were measured in the field, and final samples for solute and/or isotope analyses were collected from five wells, H-4B, H-5B, H-5C, H-6B, and H-6C.

3.4.2 Field Data and Sample Collection

Field procedures and data for the test at H-2 are discussed in Section 3.4.2.1.

At the H-4, H-5, and H-6 hydropads, the author used a modified version of the Nash Draw procedures of Lambert and Robinson (1984). The primary purpose of this sampling program was to obtain representative samples for attempted radiocarbon dating. Because of a lack of available manpower, only the following parameters could be measured in the field: pH, Eh, specific gravity, specific conductance, temperature, alkalinity, and occasionally sulfate. The groundwater was considered representative when four parameters (alkalinity, specific conductance, specific gravity, and pH) reached steady state after a lengthy pumping period. Samples were collected in a polyethylene bucket from the discharge line and were transferred to the appropriate containers.

Parameters were measured in the field using the methods described in Lambert and Robinson (1984); they are summarized below. Temperature, specific gravity, specific conductance, pH, and Eh were measured immediately after each serial sample was collected. In addition, immediately after collection, one liter of sample was transferred to a polyethylene bottle for alkalinity and sulfate determinations to be done as soon as possible.

Parameters were measured as follows:

- Temperature was measured with an American Society for Testing Materials (ASTM) #1C thermometer. (The thermometer was not calibrated.)
- Specific gravity was measured with a hydrometer with a range of 1.000 to 1.2200. (The hydrometer was not calibrated.)
- Specific conductance was measured with a Lab-Line Mark V conductance meter, Model MC-1, and a beaker-type cell with a cell constant of 1.0.
- The pH was measured with an Orion model 399 A/F meter and model 91-04 combination pH electrode. Before each measurement, the pH measuring system was standardized with two buffer solutions, either pH 4 and 7 or pH 7 and 10, chosen to bracket the sample pH value.
- Eh was measured with an Orion model 399 A/F meter and model 96-78 redox electrode. The system was checked with ZoBell solutions each day.
- Alkalinity was determined by titrating with a standard sulfuric acid solution to a pH of 4.5 and is reported as bicarbonate. In all these samples, carbonate alkalinity was negligible.
- Sulfate was determined by the turbidimetric method using a Hach portable field spectrometer.

Analytical precisions, either confidence limits (95% C.L., 1 replicate) or relative standard deviations (RSDs), are assumed to be the same as in Nash Draw (Lambert and Robinson, 1984):

Parameter	Estimated Precision
Temperature	± 1 °C (conf. limits)
Specific gravity	± 0.02 (conf. limits)
pH	± 0.1 (conf. limits)
Specific conductance	± 2 x 10^4 µS/cm (conf. limits)
Bicarbonate	± 6 mg/L (conf. limits)
Sulfate	± 10% (RSD)

Precision for Eh was not determined; the manufacturer reports the accuracy of the measuring system is better than ± 10 mV.

The methods of collecting and treating final samples (filtering, acidifying, radiocarbon chemistry) were the same as those used by Lambert and Robinson (1984). Depending on the intended use, samples were either untreated (unfiltered and unacidified), filtered through a 0.45μm membrane, or filtered and acidified to pH < 2 with high-purity nitric acid. The treatment of samples for radiocarbon analysis is given in Lambert and Robinson (1984).

The samples for solute analyses were stored at ambient temperature in the author's laboratory in Albuquerque until June 1985, when they were shipped to Grand Junction, CO, for analysis by UNC/Bendix. Samples collected for various isotopic analyses have been analyzed, and the results are presented in Lambert and Harvey (1987), Lambert (1987), and Lambert and Carter (1987).

The next six subsections give some observations made during the tests at six wells, H-2C, H-4B, H-5B, H-5C, H-6B, and H-6C.

3.4.2.1 H-2C CULEBRA (DECEMBER 1980)

H-2 is a multi-well pad with the Culebra accessible in all the wells. In early 1980, a tracer test was begun in which Culebra water was pumped from H-2B1 and reinjected, along with added tracers (sodium benzoate, sodium pentafluorobenzoate, and a suite of halocarbons - CCl_4, $CFCl_3$, CF_2Cl_2), into well H-2C. The test was terminated prematurely because of equipment failure. In July 1980, the system was reconfigured and a second test was started with H-2C as the pumping well, H-2B1 as the injection well, and sodium thiocyanate and difluorochlorobromomethane as the added tracers (HGC, 1985 and 1986).

On 12/10/80 at the request of SNL's staff hydrologist, the author collected a groundwater sample from a spigot that had been placed in the circulating system near the pump to allow withdrawal of samples for tracer analysis. Temperature, pH, Eh, specific gravity, and specific conductance were measured in the field using the same equipment and methods that were being used in Nash Draw at the time (Lambert and Robinson, 1984; see also Section 3.3). The field results are included in Table 12.

Samples were also collected for laboratory analysis, but they had not yet been analyzed when the data for this report were compiled because of serious doubts about their representativeness (see Section 5.2.5).

3.4.2.2 H-4B CULEBRA (MAY 1981)

During two pumping tests at the H-4 hydropad, H-4B was pumped with a jack pump with a single-action pump cylinder. The first test started at 09:00 on 05/14/81. After two days of pumping at an average rate of 20 gph, water stopped flowing at ~11:00 on 05/16/81. The test was terminated later that day. During the two days of pumping, the water produced was clear

and odorless, and the slight effervescence observed at the start of the test disappeared after one day of pumping. Four serial samples were collected during the test; Eh increased, pH decreased, and the sulfate concentration fluctuated.

The second test started at 12:30 on 05/21/81 and continued until 05/30/81 with an average pumping rate of 15 gph (HGC, 1985). Serial sampling began on 05/27/81 and continued though 05/29/81. The water was clear, odorless, and very slightly effervescent. Field parameters had reached steady-state by 05/27/81, when serial sampling resumed; that is, the measured values were the same, within the limits of precision of the measurements, as they had been when the pump failed on 05/16/81, and they did not change over the next two days.

Serial-sampling data from both pumping tests are shown in Table 4 and steady-state field values are in Table 12.

On 05/29/81, final samples for the analysis of solutes, stable isotopes (D and ^{18}O), and uranium isotopes were collected. In addition, ~38 gallons of unfiltered/unacidified groundwater were collected in red plastic jerrycans for radiocarbon analysis.

3.4.2.3 H-5B CULEBRA (MAY THROUGH JUNE 1981)

H-5B was pumped with a jack pump with a single-action pump cylinder. The pumping test started at 12:30 on 05/27/81. Pumping was interrupted the evening of 05/29/81 because of a pump failure and resumed at 11:10 on 05/30/81. The pump failed again at ~15:20 on 06/02/81 and was not restarted. The average pumping rate had been ~12 gph (HGC, 1985).

Four serial samples were collected between 05/29 and 06/02/81. At the start of pumping on 05/27/81, the produced water was "milky" in color, but by the time serial sampling began, it was clear and odorless and remained so throughout the test. On 06/02/81, all parameters except alkalinity appeared to have reached steady state. Alkalinity appeared to be decreasing slowly at a rate of ~1 mg/L per day.

Serial-sampling data are shown in Table 5 and the steady-state field values are in Table 12.

Because of concerns about the stability of the pump, final samples for solute, stable isotope (D and ^{18}O), and uranium isotope analyses were collected on 06/02/81. When the pump failed later that day, the decision was made to terminate the test and collect radiocarbon samples during a later test at the H-5 hydropad.

3.4.2.4 H-5C CULEBRA (OCTOBER 1981)

H-5C was pumped with a jack pump with a single-action pump cylinder. The pumping test began at 09:35 on 10/07/81 and continued until 10/16/81. The average pumping rate was ~7.5 gph (HGC, 1985).

Serial sampling began on 10/12/81 and continued through 10/15/81. The produced water was clear and odorless. The specific gravity, specific conductance, pH, and Eh values were the same as they had been at H-5B in May and June, while the alkalinity was slightly higher. At H-5B, the alkalinity was 84 mg/L HCO_3 on 05/29/81 and decreased to 80 mg/L on 06/02/81. At H-5C, it was 90 mg/L HCO_3 on 10/12/81 and decreased to 86 mg/L on 10/15/81. The rate of decrease was very small, but steady, and at the time, the author was not sure if it was a real trend or an analytical artifact.

Serial-sampling data are shown in Table 6 and the steady-state field values are in Table 12.

On 10/15/81 final samples for solute, stable isotope (D and ^{18}O), and uranium isotope analyses were collected. Because there was a reasonable chance that the apparent decreasing trend in the alkalinity values was an analytical artifact (and thus that the samples might be representative with respect to inorganic carbon), 25 gal of unfiltered/unacidified groundwater were collected in red plastic jerrycans for radiocarbon analysis. However, Lambert (1987) has since shown that the Culebra waters at H-5 in 1981 were contaminated with modern carbon. Thus, the decreasing trend for alkalinity was apparently real and the samples were not representative with respect to inorganic carbon.

3.4.2.5 H-6B CULEBRA (MAY 1981)

H-6B was pumped with a submersible pump. The pumping test began at 10:20 on 05/01/81 and continued through 10:20 on 05/03/81. The average pumping rate was ~23 gpm (HGC, 1985).

Serial samples were taken on 05/01 and 05/02/81. The water was clear and odorless, and an initial effervescence disappeared after the first day of pumping. Field parameters appeared to be at steady state after a few hours of pumping, exhibiting no change after ~24 hr of pumping at 23 gpm.

Serial-sampling data are shown in Table 7 and the steady-state field values are in Table 12.

On 05/02/81 final samples were collected for solute, stable isotope (D and ^{18}O), and uranium isotope analyses. A sample for radiocarbon analysis was not collected because two data points were not considered adequate to indicate steady-state conditions for alkalinity, which had been seen to exhibit very small but steady rates of change in some tests (for example, at WIPP-28 Culebra in 1980). The decision was made to collect a radiocarbon sample during a test at H-6C, scheduled for later that month.

3.4.2.6 H-6C CULEBRA (MAY 1981)

H-6C was pumped with a submersible pump; two pumping tests were performed. The first test began at 16:05 on 05/12/81 and continued until 01:10 on 05/14/81, when the generator failed. The average pumping rate was ~19 gpm (HGC, 1985). A serial sample collected on 05/13/81

showed that field parameters, including alkalinity, were the same as they had been at H-6B in early May. The water was clear, odorless, and frothy.

A second test began at 10:45 on 05/21/81 and continued until 15:12 on 05/27/81 with an average pumping rate of ~17 gpm (HGC, 1985). Again, the water was clear, odorless, and frothy or foamy. A serial sample taken on 05/27/81 showed no change from that taken on 05/13/81.

Serial-sampling data from both pumping tests are shown in Table 8 and the steady-state field values are in Table 12.

On 05/27/81 a final sample was collected for stable isotope (D and ^{18}O) analysis and 1 liter of unfiltered/unacidified sample was collected and archived. In addition, 150 liters of water were collected and chemically treated to precipitate the inorganic carbon as $BaCO_3$ for subsequent radiocarbon determination (see Lambert and Robinson, 1984, for a detailed description of the chemical procedure).

3.4.3 Solute Data

Samples from H-4B, H-5B, H-5C, and H-6B were analyzed by UNC/Bendix during the fall of 1985. Analytical methods are described in Section 3.8 and are summarized in Table 65.

The analytical results from UNC/Bendix are given in Tables 33 to 36 and are summarized in Table 64. Total dissolved solids contents and charge-balance errors were calculated as discussed in Section 1.3.4. The calculation of analytical uncertainties is discussed in Section 3.8.

3.5 Samples Collected in 1983-1984 During Hydrologic Tests

3.5.1 Program Description and Wells Sampled

In 1983 and 1984 a variety of hydrological tests were performed at several wells by Hydro Geo Chem (HGC) for SNL. During many of these tests, water-quality parameters such as temperature, specific conductance, and specific gravity were monitored during testing, and samples were collected for subsequent laboratory analysis of solutes and/or isotopes. Samples were collected and later analyzed from the Culebra at DOE-1, FR-10, H-9, Engle Well, and H-12 and from the Dewey Lake Red Beds in Pocket Well and Unger Well.

3.5.2 Field Data and Sample Collection

Because the testing and field-measurement procedures varied from test to test, each test is discussed separately below. In general, the methods and equipment used are not well documented but are believed in many cases to be the same as or similar to those given in Hydro Geo Chem (1984). For example, we think that in most cases temperature was measured with a mercury-filled thermometer or a YSI thermistor probe, specific gravity with a hydrometer, pH with an

Orion 399A/F meter and combination pH electrode, Eh with the Orion 399A/F meter and a combination redox electrode, and specific conductance with a Lab-line conductance meter and beaker-type cell.

Alkalinity was determined by titrating with standard acid to a pH of 4.5 or to the methyl-red endpoint. However, because of several factors, the uncertainty associated with these alkalinity values must be considered quite large.

- the uncertain quality of the standard acid, which that was probably commercially prepared, possibly several years old, and probably not re-standardized before use in the field
- the small (<5 mL) quantities of acid used in each titration
- the unspecified method of determining the endpoint (dye indicator or pH)
- the lack of documentation regarding the method and equipment

The data are therefore presented as approximate values and should be used with extreme caution (for example, to corroborate other data).

Most final samples were collected in polyethylene bottles, were filtered when appropriate through a 0.45 μm membrane, and were acidified when appropriate with nitric acid. Samples for tritium, D, and ^{18}O analyses were collected in glass bottles with screw caps that were sealed with a paraffin/beeswax mixture. Samples for radiocarbon analysis were collected in 500-mL stainless-steel sample cylinders (see HGC, 1984).

3.5.2.1 DOE-1 CULEBRA (APRIL 1983)

In the spring of 1983 the Culebra at DOE-1 was tested using a jack pump. A 15-day pumping test began on 04/13/83. The average pumping rate was ~0.5 gpm.

Temperature and specific conductance were monitored during the test, and specific gravity was measured occasionally. After one day of pumping, the specific conductance values stabilized at 125000 ± 5000 μS/cm. Temperature ranged from 20 to 22°C. The specific gravity was a steady 1.090 ± 0.002 from the fifth day of pumping through the end of the test. On 04/21/83, the pH was 7.6 and alkalinity was 65-70 $mg/L\ HCO_3^-$. Field data are summarized in Table 13.

Final samples were collected for stable isotope (D and ^{18}O) and ^{37}Cl analyses. Because conflicting dates appear in the field notes and laboratory reports, the date on which final samples were collected is uncertain, but is either 04/19, 04/20, or 04/21/83. In this report the 04/19/83 date is used arbitrarily. The stable isotope data are reported by Lambert and Harvey (1987). The ^{37}Cl results are given in Table 19 and are discussed in Section 3.5.3.

3.5.2.2. FR-10 CULEBRA (OCTOBER 1983)

On 10/06/83 the Culebra at FR-10 was tested. Because of the condition of the well, the pump intake was set just five feet below the water level. The pump was turned on for 10 sec, or until the pump broke suction, at 7 to 10 min intervals for an 8.5-hr period, during which time ~220 gal of water were removed from the well.

During the test, temperature and specific conductance were monitored. The temperature ranged from 21 to 23°C and specific conductance was 3200 ± 100 µS/cm. Late in the test, the pH was 7.4 and the specific gravity was 1.000. The alkalinity was ~260 mg / L HCO_3^-. Field data are summarized in Table 13.

After the test, a suite of final samples was collected over a four-hr period. Final samples were collected for solute, halide, stable isotope (D and ^{18}O), ^{37}Cl, and radiocarbon analyses. The stable isotope and radiocarbon results are discussed in Lambert and Harvey (1987) and Lambert (1987), respectively. The solute, halide, and ^{37}Cl data are given in Tables 17, 18, and 19, respectively, and are discussed in Section 3.5.3.

3.5.2.3 H-9B CULEBRA (SEPTEMBER THROUGH OCTOBER 1983)

In September 1983 the Culebra at the H-9 hydropad was tested using a submersible pump. H-9B was pumped for nine days while H-9A and H-9C served as observation wells (Intera Technologies and HGC, 1985); the average pumping rate was 10 gpm. After eight days of recovery, a second, brief (~two-hour-long) pumping test was performed, during which final samples were collected.

During the first test, specific conductance and temperature were periodically measured. The specific conductance held constant at 3900 µS/cm and the temperature ranged from 24 to 25°C (Intera Technologies and HGC, 1985, Table 4-8).

For the second test, the pump was started on 10/07/83 at 13:54; the average pumping rate was 10 gpm. Final samples were collected at 14:40 that day and the test was terminated approximately one hour later. At the time samples were collected, several parameters were measured: temperature, 24°C; specific conductance, 3600 µS/cm; specific gravity, 1.000; pH, 7.9; alkalinity, ~240 mg / L HCO_3^-. The field data for both tests are summarized in Table 13.

Final samples were collected for solute, halide, stable isotope (D and ^{18}O), ^{37}Cl, and radiocarbon analyses. The stable isotope and radiocarbon results are discussed in Lambert and Harvey (1987) and Lambert (1987), respectively. The solute, halide, and ^{37}Cl data are given in Tables 17, 18, and 19, respectively, and are discussed in Section 3.5.3.

3.5.2.4 H-12 CULEBRA (JANUARY 1984)

In January 1984, the Culebra at the H-12 hydropad was tested twice using a jack pump. The first test ran from 01/07/84 to 01/12/84. The average pumping rate was 8.4 gph. Recovery was monitored until 10:18 on 01/23/84 (Intera Technologies and HGC, 1985). On 01/23/84 at 10:30 the second test, lasting two and one half days, was started; the pumping rate was 13.5 gph.

During the first test, specific conductance and specific gravity were monitored periodically. The data were reported in Table 3-1 of Intera Technologies and HGC (1985). The specific conductance data are considered unreliable because the measuring equipment malfunctioned. The specific gravity was initially ~1.07 and increased to 1.115 during the first day of pumping; the value then decreased slowly to 1.090 on the last day. Final samples were collected from a 7-ft extension off the pump jack at ~07:30 on 01/11/84, after four days of pumping. The pH was 7.9 at 14:00 that day. Field data are summarized in Table 13.

No field measurements were made during the second test. Between 15:00 and 16:00 on 01/25/84, after more than two days of pumping, final samples were collected. After sampling, the 0.45 μm filter membrane was observed to have accumulated a "thick coat of grey-green mud".

On 01/11/84, during the first test, final samples were collected for solute, halide, and ^{37}Cl analyses. On 01/25/84, during the second test, final samples were collected for solute, halide, and tritium analyses. The tritium results are discussed in Lambert and Harvey (1987). The solute, halide, and ^{37}Cl data are given in Tables 17, 18, and 19, respectively, and are discussed in Section 3.5.3.

3.5.2.5 ENGLE WELL – CULEBRA (NOVEMBER 1983)

Engle Well was tested in November 1983 using a submersible pump. A step-drawdown pumping test was performed on 11/03/83, and ~1240 gal were pumped from the borehole. On 11/04/83 a week-long pumping test began; the average pumping rate was 9.8 gpm.

During the step-drawdown test and subsequent week-long pumping test, temperature and specific conductance were periodically monitored. During the step-drawdown test, the specific conductance decreased from 5000 to 4600 μS/cm. The water temperature was 23°C, and the water was black to blackish-brown. During the week-long pumping test, the specific conductance decreased from 4800 μS/cm at the beginning of the test to 3600 μS/cm approximately one day later and thereafter was constant at 3600 ± 200 μS/cm. The water temperature averaged 23 ± 1°C throughout the test. At the time final samples were collected, the temperature was 22°C, the specific conductance was 3600 μS/cm, and the pH was 7.3. Alkalinity was ~230 mg / L HCO_3^-. The field data are summarized in Table 13.

After five or six days of pumping, samples for laboratory analysis were collected from the end of the discharge line ~40 ft from the well head. The date on which the samples were collected is uncertain. Documents associated with the samples, such as HGC's water-sample forms and various laboratory reports, indicate that samples were collected on 11/10/83 at 16:00 hr.

However, the field hydrology notebook indicates that samples were collected on 11/09/83 at 16:00 hr. The 11/10/83 date is used here because it appears on more records and reports.

Final samples were collected for solute, halide, stable isotope (D and ^{18}O), ^{37}Cl, and radioisotope (^{14}C and ^{3}H) analyses. The stable isotope and radioisotope results are discussed in Lambert and Harvey (1987) and Lambert (1987), respectively. The solute, halide, and ^{37}Cl data are given in Tables 17, 18, and 19, respectively, and are discussed in Section 3.5.3.

3.5.2.6 POCKET WELL – DEWEY LAKE (OCTOBER - NOVEMBER 1983)

Pocket Well was tested in October and November 1983 using a submersible pump. A step-drawdown pumping test was performed on 10/26/83; ~610 gal were pumped from the well. A five-day pumping test was conducted from 10/27/83 through 11/01/83 at an average pumping rate of 4.9 gpm. After approximately one hr of recovery, a one-and-one-half-hour test was conducted at a pumping rate of 8.7 gpm. After an ~two-hr recovery period, the pump was again turned on at a pumping rate of ~ 8.6 gpm, and the pump was run for another day (through 11/02/83) in order to fill the stock tanks at the well.

During the five-day pumping test, specific conductance and temperature were periodically monitored. The temperature remained fairly constant at 20 ± 1 °C throughout the test. Specific conductance was 3400 µS/cm after ~one hr of pumping, increased to 3800 µS/cm an hour later, and stabilized at 3800 ± 200 µS/cm for the rest of the test. When final samples were collected, the temperature was 21 °C, the specific conductance was 3800 µS/cm, the pH was 7.7, and the specific gravity was 1.000. The alkalinity was ~140 $mg/L\ HCO_3^-$. Field data are summarized in Table 13.

Final samples were collected during this final pumping episode on 11/02/83 between 09:30 - 12:30. Final samples were collected for solute, halide, stable isotope (D and ^{18}O), ^{37}Cl, and radiocarbon analyses. The stable isotope and radiocarbon results are discussed in Lambert and Harvey (1987) and Lambert (1987), respectively. The solute, halide, and ^{37}Cl data are given in Tables 17, 18, and 19, respectively, and are discussed in Section 3.5.3.

3.5.2.7 UNGER WELL – DEWEY LAKE (JANUARY 1984)

Unger Well, which is thought to be completed in the Dewey Lake Red Beds, was tested in January 1984 using a submersible pump. A step-drawdown pumping test was performed on 01/24/84, during which ~2700 gallons of turbid water were pumped from the well. A 31-hr pumping test was then conducted on 01/25/84 and 01/26/84 at an average pumping rate of 9.6 gpm. The author was unable to find any records of field measurements in the field hydrology notebooks.

A sampling "T" was placed in the discharge line and final samples were collected at ~16:00 hr on 01/26/84. Final samples were collected for solute, halide, ^{37}Cl, and tritium analyses. The

tritium results are discussed in Lambert and Harvey (1987). The solute, halide, and ^{37}Cl data are given in Tables 17, 18, and 19, respectively, and are discussed in Section 3.5.3.

3.5.3 Solute Data

The solute data are presented as follows:

- Major, minor, and trace solutes
- Halides
- Chlorine-37

3.5.3.1 MAJOR, MINOR, AND TRACE SOLUTES

Selected solutes were analyzed by UNC/Bendix for HGC. The data are given in Table 17.

Samples were analyzed in 1983 and early 1984 using UNC/Bendix's standard methods for water analysis, which were not necessarily the same as those described in Section 3.8 of this report. Some of the methods described in Section 3.8 were developed specifically for the WIPP groundwater samples after June 1984.

Because a single value was reported for each parameter, analytical precisions cannot be estimated from the data available to the author. Solutes were analyzed in unfiltered/unacidified ("raw") samples or in field-filtered/acidified samples as follows:

Wells	Sample type	Parameters
H-9B, Engle, Pocket	unfiltered/ unacidified (frozen)	$SO_4^{=}$, Cl^-, NO_3^-, Si
H-9B, FR-10, Pocket	filtered/ acidified	Ca, Mg, Na, K, Li, Mn, Fe
H-12 (2 samples), Unger	unfiltered/ unacidified	Ca, Mg, Na, K, $SO_4^{=}$, Cl^-, NO_3^-, Br^-, I^-, Si
H-12, Unger	filtered/ acidified	Li, Mn, Fe

3.5.3.2 HALIDES

Halides were determined by Donald Whittemore of the Kansas Geological Survey (KGS). The data are presented in Table 18.

Unfiltered/unacidified samples were refrigerated at the KGS lab until the time of analysis. Bromide, chloride, and iodide were determined by automated methods using a Technicon autoanalyzer. Bromide was measured by the phenol-red method of Basel et al. (1982). Chloride was determined by the ferric thiocyanate method and iodide by the ceric-arsenious acid oxidation

method. USGS standard reference waters were analyzed periodically by the KGS laboratory as controls. Estimated precisions reported by Whittemore, who did not give the method of calculation, are:

Solute	Estimated Uncertainty	Applicable Concentration Range
Cl^-	± 2%	
Br^-	± 0.05 mg/L	Br^- <0.5 mg/L
	± 10%	Br^- 0.5 - 1.0 mg/L
	± 5%	Br^- 70 - 80 mg/L
I^-	± 10%	low I^- concentrations (or low I^- / Cl^- ratios)
	± 5%	high I^- concentrations (or high I^- / Cl^- ratios)

Two bottles of water from Pocket Well were sent to the KGS and were analyzed separately; hence there are two sets of analyses for Pocket Well in Table 18.

Bicarbonate was determined in some of the low-bromide waters. The method of bicarbonate analysis and estimated precision were not reported.

3.5.3.3 CHLORINE-37

Chlorine-37 was determined in unfiltered/unacidified samples by K.C. Services (KCS) and the University of Arizona Laboratory of Isotope Geochemistry (UA). The data are given in Table 19.

KCS analyzed seven WIPP groundwater samples, four of which were aliquots of samples collected by SNL in Nash Draw in 1980 (from the Culebra at WIPP-26, WIPP-28, WIPP-29, and WIPP-30). The $^{37}Cl/^{35}Cl$ ratio is reported in parts per thousand (per mil or ‰) as a delta value, δ, relative to standard mean ocean chloride (SMOC). The delta value is calculated as follows:

$$\delta(‰) = \frac{R_{sample} - R_{standard}}{R_{standard}} \times 1000$$

where $R = \frac{^{37}Cl}{^{35}Cl}$ in the sample or standard

The analytical precision was estimated by the KCS laboratory to be better than ± 0.24 per mil. KCS also determined total chloride by a gravimetric method; the analytical precision estimated by the lab was ± 10%.

The UA lab analyzed four WIPP groundwater samples, two of which were splits of samples collected from the Culebra at H-3B3 in June 1984 (by HGC) and February 1985 (by the WQSP) (see Sections 3.6 and 3.7). The UA lab determined the chlorine-isotope ratio by a mass spectrometric measurement on methylchloride gas that had been generated from the sample

(Kaufmann, 1984). The results are reported in per mil (‰) relative to SMOC. The analytical precision estimated by the laboratory is ± 0.1 ‰.

3.6 Samples Collected in June and August 1984 During Convergent-Flow Tracer Tests

3.6.1 Program Descriptions and Wells Sampled

In the spring of 1984, Hydro Geo Chem (HGC) developed a water sampling protocol for use in collecting groundwater samples during hydrologic pumping tests (HGC, 1984). The Culebra was sampled at H-3B3 in June 1984 using the protocol while it was in review. The Culebra at H-4C was sampled in August 1984.

3.6.2 Field Data and Sample Collection

Field procedures are described in HGC (1984) and are summarized here.

Temperature, pH, and Eh were measured in a flow cell similar to that described by Collins (1975).

- Temperature was measured with a thermistor thermometer (YSI model 43) that was periodically checked against a calibrated mercury thermometer.
- The pH was measured with a pH/mV meter (Orion model 399A/F) and combination pH electrode. Before each pH measurement, the system was calibrated with two buffer solutions, one with a pH of 7 and the other with a pH of either 9.2 or 10.
- The Eh was measured with the Orion 399A/F meter and a combination redox electrode.

Specific gravity and specific conductance were measured at atmospheric pressure in open containers.

- Specific conductance was measured with a Lab-line Mark V meter and a beaker-type cell with a cell constant of 1.0.
- Specific gravity was measured with a hydrometer.

The tracer tests during which the samples were collected are briefly summarized in the following two subsections.

3.6.2.1 H-3B3 CULEBRA (APRIL THROUGH JUNE 1984)

From April through June 1984, a convergent-flow tracer test was done at the H-3 hydropad. Starting on 04/22/84, H-3B3 was pumped at 3 gpm for 17 days. On 05/09/84, a sodium meta-trifluoromethylbenzoate tracer was injected in H-3B1 and a sodium pentafluorobenzoate tracer was injected in H-3B2. Pumping continued at H-3B3 until 06/11/84 (HGC, 1985).

On 06/10 and 06/11/84, five parameters (temperature, specific gravity, specific conductance, pH, and Eh) were measured in three serial samples. The Eh values, which are not reported here, are considered unreliable because they were measured in a flow cell, and subsequent work showed that the redox electrode was rapidly poisoned (that is, the electrode filling solution was contaminated with sample water) in this environment. Other serial-sample data are given in Table 9. Steady-state values are given in Table 14.

Final samples were collected on 06/11/84 for solute, stable isotope (D and ^{18}O), ^{37}Cl, and tritium analyses. The stable isotope and tritium results are discussed by Lambert and Harvey (1987) and Lambert (1987), respectively. The ^{37}Cl results are discussed in Section 3.5.3, and the solute results are discussed below.

3.6.2.2 H-4C CULEBRA (OCTOBER 1982 THROUGH OCTOBER 1984)

From October 1982 to October 1984, a convergent-flow tracer test was done at the H-4 hydropad. H-4C was pumped at ~15 gph for 3 days starting on 10/24/82. On 10/27/82, sodium thiocyanate and sodium meta-trifluoromethylbenzoate tracers were injected into H-4B, and on 11/05/84, sodium para-fluorobenzoate and sodium pentafluorobenzoate tracers were injected into H-4A. Pumping continued at H-4C for ~two yr, until 10/15/84. On 06/11/83, the pumping rate was increased from 15 gph to ~30 gph (HGC, 1985).

On 08/09 and 08/10/84, five parameters (temperature, specific gravity, specific conductance, pH, and Eh) were measured in four serial samples. The Eh values, which are not reported here, are considered unreliable because they were measured in a flow cell, and subsequent work showed that the redox electrode was rapidly poisoned (that is, the filling solution was contaminated with sample water) in this environment. Other serial-sample data are given in Table 10. Steady-state values are given in Table 14.

Final samples for solute analysis were collected on 08/10/84. The data are presented below.

3.6.3 Solute Data

The H-3B3 sample was analyzed by UNC/Bendix during the summer of 1984 and was used to validate their analytical methods (see Section 3.8). The H-4C sample was analyzed during the summer of 1985. Analytical methods are described in Section 3.8 and are summarized in Table 65.

The UNC/Bendix analytical results are given in Tables 37 and 38 and are summarized in Table 64. Total dissolved solids contents and charge-balance errors were calculated as discussed in Section 1.3.4. The calculation of analytical uncertainties is discussed in Section 3.8.

3.7 Samples Collected During Round One of the WQSP

3.7.1 Program Description and Wells Sampled

The Water Quality Sampling Program (WQSP) is a long-term regional groundwater sampling effort, conducted by the Management and Operating Contractor (MOC) for the Department of Energy (DOE), in which wells will be sampled many times in the next few years. The WQSP provides field data and samples to several monitoring programs and to SNL's site characterization program (Colton and Morse, 1985). The WQSP is discussed in more detail in Section 4.2 of this report. SNL received samples from the following 25 locations sampled in 1985-1986 during the first round of the WQSP.

Zone	Well(s)
Bell Canyon	DOE-2
Culebra	DOE-1, DOE-2, H-2A, H-3B3, H-4B, H-5B, H-6B, H-7B1, H-8B, H-9B, H-11B3, H-12, P-14, P-17, WIPP-25, WIPP-26, WIPP-29, Engle Well
Dewey Lake	Ranch Well, Twin Wells/Pasture Well
Magenta	H-3B1, H-4C, H-5C, H-6C

3.7.2 Field Data and Sample Collection

Field procedures and sample collection methods for the WQSP are discussed in Section 4.2. Steady-state field values of selected parameters are summarized in Table 15.

Two suites of samples were collected for SNL. One suite consisted of filtered/unacidified and filtered/acidified water samples for solute analysis and an acid blank (nitric acid in deionized water), all in plastic bottles; these samples were shipped directly to UNC/Bendix from the field and were stored there at ambient temperature.

The other suite included, in most cases, unfiltered/unacidified, filtered/unacidified, and filtered/acidified samples in plastic bottles for solute and possible uranium-isotope analyses, unfiltered/unacidified samples in glass bottles for possible stable-isotope analyses, an unfiltered/unacidified sample in a 500-mL stainless-steel sample cylinder for possible radiocarbon analysis, and an acid blank in a plastic bottle. These samples were sent to the author's laboratory in Albuquerque, NM, and were stored at ambient temperature.

Selected isotope analyses were done on some of these samples but will not be discussed in this report. UNC/Bendix has analyzed selected solutes in the samples sent directly to them; the results are discussed in the next section. The solute samples at SNL have been archived and may be analyzed as needed to help resolve discrepancies among the data sets from various laboratories analyzing WIPP groundwaters.

3.7.3 Solute Data

Samples were analyzed by UNC/Bendix in 1985 and 1986. Analytical methods are described in Section 3.8 and are summarized in Table 65.

The results for the WQSP samples are presented in Tables 39 to 63 and are summarized in Table 64. Total dissolved solids contents and charge-balance errors were calculated as discussed in Section 1.3.4. The calculation of analytical uncertainties is discussed in Section 3.8.

3.8 Analytical Methods Used by UNC/Bendix

3.8.1 Samples and Analytes

This report contains data from 44 samples analyzed by UNC/Bendix for SNL including:

- 13 collected by SNL in Nash Draw in 1980
- 4 collected by SNL during hydrologic testing in 1981
- 2 collected by HGC during tracer tests in 1984
- 25 collected during the first round of the WQSP

As is summarized in the following table, the major solutes, as well as some minor and trace solutes, were determined in all samples, alkalinity and other minor and trace solutes were determined in selected samples, and nitrate was determined in one sample.

Parameter(s)	Samples
Ca, Mg, Na, K, Cl^-, $SO_4^=$	all samples
Alkalinity, Br^-, B, Li, Si, Sr	samples for which there was sufficient quantity
F^-, I^-, Cs, Fe, Mn	selected samples
NO_3^-	the Ranch Well (Dewey Lake) sample

UNC/Bendix was sent samples of field-filtered/unacidified and field-filtered/acidified water for all wells, with one exception. (The H-11B3 Culebra "unacidified" sample had been inadvertently acidified in the field.) Most of the unacidified samples had to be filtered again in the UNC/Bendix laboratory before analysis because small amounts of precipitated matter were seen in many bottles.

In general, cations and trace metals were determined in the acidified fractions and anions and silica in the unacidified fractions. The exceptions were the following:

- Cl^-, $SO_4^=$, and Br^- were determined in the acidified fraction of the H-11B3 Culebra sample (other anions were not determined in this sample).
- Silica was determined in the acidified fraction of the H-11B3 Culebra sample, but the results are considered unreliable and are not reported here.

- $SO_4^{=}$ and F^- were determined in the acidified fraction of the H-3B3 Culebra sample of 06/11/84, although other anions and silica were determined in the unacidified fraction.

In addition, UNC/Bendix received acid blanks from many of the WQSP wells. Selected cations were determined in some of the acid blanks.

3.8.2 Analytical Methods and Method Validation

The analytical methods used by UNC/Bendix included:

- differential pulse polarography (DPP)
- flame atomic absorption spectrophotometry (flame AAS)
- graphite furnace atomic absorption spectrophotometry (GFAAS)
- inductively-coupled plasma atomic emission spectrophotometry (ICP)
- ion chromatography (IC)
- ion-selective electrodes (ISE)
- titrimetric methods
- ultraviolet/visible spectrophotometry (UV/VIS)
- x-ray fluorescence (XRF)

The following list summarizes the analytes and methods used to determined them.

Analyte	Method(s)
Alkalinity	Electrometric titration
B	ICP
Br^-	XRF; DPP; UV/VIS
Ca	Flame AAS; ICP
Cl^-	ISE; Mohr titration
Cs	GFAAS
F^-	ISE
Fe	Flame AAS; GFAAS
$I^-(IO_3^-)$	DPP
K	Flame AAS; ICP
Li	Flame AAS; ICP
Mg	Flame AAS; ICP
Mn	Flame AAS; GFAAS
Na	Flame AAS; ICP
NO_3^-	IC
SiO_2	UV/VIS; ICP

$SO_4^{=}$	IC
Sr	Flame AAS; ICP

Table 65 shows specifically which methods were used for each sample. All methods used by UNC/Bendix are documented in their in-house procedures manual (Bendix Field Engineering Corp., 1984). The methods, in alphabetical order, are briefly summarized here.

Differential Pulse Polarography (Br^-, I^-, IO_3^-)

Bromide (Br^-) was oxidized to bromate (BrO_3^-) with sodium hypochlorite and the bromate was determined by DPP. Sample blanks were analyzed to correct for bromate in the samples. Standardization was done by the method of additions. At least one control sample was analyzed with some sets of groundwater samples.

Iodide (I^-) was oxidized to iodate (IO_3^-) with bromine water at a pH of less than 2 and the iodate was determined by DPP. Blanks were analyzed to correct for iodate in the samples (measureable iodate was found in two WIPP samples). Standardization was done by the method of additions.

Flame Atomic Absorbtion Spectrophotometry (Ca, Fe, K, Li, Mg, Mn, Na, Sr)

Samples were diluted as necessary to bring the element of interest into the appropriate concentration range. Standard techniques were used (as given by the instrument manufacturer, Perkin-Elmer Corporation); ionization suppressants and interference inhibitors were added as necessary. Standardization was usually done by the standard curve method; the method of additions was used for some of the iron and manganese determinations. At least one spiked sample was analyzed with each set of groundwater samples. At least one control sample was analyzed with each set of groundwater samples.

Graphite-Furnace Atomic Absorbtion Spectrophotometry (Cs, Fe, Mn)

Iron and manganese were determined by standard methods (as given by the instrument manufacturer, Perkin-Elmer Corporation). Standardization was done by the standard curve method. Cesium was determined by the method of Grobenski et al. (1983): samples were diluted with 1% HNO_3 and 1% H_2SO_4 and analyzed using recommended instrumental conditions with standardization by the method of additions (Grobenski et al., 1983). At least one spiked sample was analyzed with each set of groundwater samples. For Fe and Mn, at least one control sample was analyzed with each set of groundwater samples.

Inductively Coupled Plasma Atomic Emission Spectrophotometry (B, Ca, K, Li, Mg, Na, Si, Sr)

Samples were diluted as necessary to bring the analyte into the appropriate concentration range. Standard methods were used (as given by the instrument manufacturer, Perkin-Elmer Corporation). Standardization was done by the standard curve method. At least one spiked sample was analyzed with each set of groundwater samples. At least one control sample was analyzed with each set of groundwater samples.

Ion Chromatography (NO_3^-, $SO_4^=$)

Sulfate ($SO_4^=$) and nitrate (NO_3^-) were determined by standard ion chromatographic methods (as given by the instrument manufacturer, Dionex Corporation). Standardization was done sometimes with a standard curve and sometimes with internal standards. At least one spiked sample was analyzed with most sets of groundwater samples. At least one control sample was analyzed with most sets of groundwater samples.

Ion-Specific Electrode (Cl^-, F^-)

Chloride (Cl^-) was determined in some samples with an Orion chloride electrode using the standard procedure for chloride determinations in brines (Orion Research, 1981). Standardization was by the standard curve method. At least one spiked sample was analyzed with most sets of groundwater samples. At least one control sample was analyzed with some sets of groundwater samples.

Fluoride (F^-) was determined with an Orion fluoride electrode using the method of Warner (1971). Standardization was by the method of additions. At least one control sample was analyzed with each set of groundwater samples.

Titrimetric methods (alkalinity, Cl^-)

Alkalinity was determined by titrating with standard sulfuric acid to an endpoint of 4.5 (APHA, 1975a). A control sample was analyzed with some sets of groundwater samples.

Total alkalinity was reported as $CaCO_3$. To allow easier comparison with other sets of data from the field and other laboratories, in the summary data tables (Tables 71 to 135) in this report, the results as calcium carbonate ($CaCO_3$) have been converted to bicarbonate (HCO_3^-) as described in Section 1.3.4.

Chloride was determined in some samples by titrating with silver nitrate (Mohr titration) (Blaedel and Meloche, 1963). At least one spiked sample was analyzed with each set of groundwater samples.

Ultraviolet/Visible Spectrophotometry (Br^-, SiO_2)

Bromide (Br^-) was determined in some samples by oxidizing the bromide to bromate (BrO_3^-), reacting the bromate with iodide (I^-) to produce iodine (I_2), and measuring the iodine spectrophotometrically. Iodide was determined independently and subtracted, if significant, from the apparent concentration to get the actual bromide concentration. (ASTM D1246-95; Bendix Field Engineering Corp., 1984) Standardization was done with a standard curve. At least one spiked sample and at least one control sample were run with each set of groundwater samples.

Silica was determined by the molybdosilicate method (ASTM D859-68; APHA, 1975b). Both molybdate-reactive silica and total (reactive plus unreactive) silica were determined, but only the

total silica values are reported here. Standardization was done with a standard curve. At least one spiked sample was analyzed with each set of groundwater samples.

X-Ray Fluorescence (Br^-)

Bromide (Br^-) was determined in one sample by XRF using the method of Smith (1981). Standardization was by the method of additions.

Method validation

In June 1984, a 10-L filtered/unacidified sample and a 10-L filtered/acidified sample of Culebra water from H-3B3, collected on 06/11/84, were sent to UNC/Bendix for method validation. All analytes were determined in triplicate, controls were analyzed when available, and spikes were analyzed in triplicate for all analytes except alkalinity and those determined by the method of standard additions. The results indicated that the laboratory's methods, with appropriate dilutions and instrumental operating conditions, met the SNL geochemists' requirements of analytical precision and accuracy with the exception of cesium. The cesium method of Grobenski et al. (1983) was later adopted for use in the laboratory, although in all samples analyzed to date, the cesium values have been below the laboratory's reporting limit (<0.001 to <0.01 mg/L depending on the bulk sample composition).

Bromide was first determined in the 06/11/84 H-3B3 Culebra sample by the XRF method. However, before the beginning of routine analyses of WIPP samples in the spring of 1985, UNC/Bendix's XRF spectrometer malfunctioned. The DPP method was developed and tested on some of the remaining 06/11/84 H-3B3 Culebra samples. Agreement between the two methods was very good. The XRF result was 28.3 mg/L (0.3 % RSD for 3 reps), and the DPP result was 26.2 mg/L (2.2 % RSD for 3 reps).

Strictly speaking, because method accuracy and precision are often a function of the sample bulk composition, the validation of the methods applied only to samples with compositions similar to H-3B3 Culebra water. Therefore, in the first sets of WQSP samples analyzed, all analytes were analyzed in triplicate and spiked samples were analyzed whenever possible.

After many samples had been analyzed, it became apparent that the methods were appropriate over the composition ranges of the WIPP samples. Thereafter, each analyte was routinely determined in duplicate. Spiked samples were analyzed periodically. If the duplicate results did not agree within specified limits (that is, if the RPD exceeded the value specified by SNL), a third or even a fourth replicate was analyzed to allow a "wild" value to be recognized and discarded or to bring the RSD of all the values to less than SNL's specified value. Sulfate was routinely run in triplicate, because the precision of the sulfate analytical technique is not quite as good as the precisions of the analytical techniques used to determine the other major solutes.

3.8.3 Data

The UNC/Bendix analytical data are given in Tables 20 through 63 and are summarized in Table 64.

Results of individual analyses are given to two or three "significant" figures although for the most solutes, the final digit will not truly be significant (because the precisions of most methods are better than the accuracies). The extra significant digits are reported here to allow the reader to perform additional statistical calculations if desired.

In the summary tables in Section 5.0, all results except those for the major solutes are rounded arbitrarily to two significant figures. The major solutes are all rounded to three significant figures. Again, the extra digits are given to allow the reader to perform additional calculations if desired. Until confidence limits can be calculated, it remains unknown how many figures are truly significant for a value of a given parameter in a given sample.

Results from the analyses of the acid blanks are given in Table 67. Analytes in the blanks were below reporting limits in all the blanks, indicating that the nitric acid used for sample preservation was not a source of contamination for those analytes.

Charge-balance errors and total dissolved solids contents were calculated as discussed in Section 1.3.4.

3.8.4 Analytical Uncertainties and Accuracy

Each analyte was measured two, three, or even four times in each sample (with the exception of iodide in the H-4C Culebra sample, which was determined only once because of a limited quantity of sample). Precisions have been estimated and are shown as RPDs for two replicates, or RSDs, for three or four replicates, in Tables 20 to 63. Precisions are routinely better than ±3% for the major solutes and better than 10% for other analytes.

Confidence limits have not been calculated at this time because the large Student's t factors associated with one or two degrees of freedom (associated with the individual standard deviations) may lead to misleadingly large confidence limits, which in turn could obscure some real differences between analytical results. However, all the replicate data are presented so that the interested reader can perform these calculations if desired.

For the appropriate analytes in selected samples, spiked samples were analyzed. The spike recoveries are summarized in Table 66. Some of the recovery values are averages of two or three replicates. Spike recoveries were generally in the range of 95 to 105% for the major solutes and 85 to 115% for other analytes.

As discussed in Section 1.3.2, the required accuracy of a measurement depends on the intended use of the data. For their site characterization studies, the SNL geochemists requested accuracies of ±3 to 5% for the major solutes and ±10% for the minor and trace solutes. They also

specified a CBE of less than 3%. As accuracy itself cannot be measured, they used spike recoveries as checks on the analytical error.

Similarly, the required precision of a measurement depends on the intended use of the data. For their site characterization work, the SNL geochemists requested ±3 to 5% (RSD for more than two replicates, or RPD for two replicates) for the major solutes and ±10% (RSD or RPD) for the minor and trace solutes.

4.0 DATA FROM OTHER SOURCES

This section presents data from three other sources:

Section	Data reported by
4.1	the United States Geological Survey (USGS)
4.2	the Management and Operating Contractor (MOC)
4.3	the New Mexico Environmental Evaluation Group (EEG).

Only selected parameters of those reported by the USGS, MOC, and EEG are given here. Specifically, only those solutes that were also analyzed by UNC/Bendix for SNL are included: Cl^-, $SO_4^=$, Ca, K, Mg, Na, Br^-, I^-, F^-, NO_3^-, B, Cs, Fe, Li, Mn, Si, Sr, and alkalinity.

In addition, laboratory determinations of total dissolved solids (residue-on-ignition) and laboratory measurements of pH and density are included when available.

Charge-balance errors and total dissolved solids concentrations were calculated as described in Section 1.3.4.

4.1 Data Reported by the United States Geological Survey

4.1.1 Program Description and Wells Sampled

Between 1976 and 1980, during hydrologic testing at many WIPP wells, the USGS collected samples for subsequent laboratory analysis of various solutes and/or isotopes. The USGS has reported laboratory data from the following wells (Mercer and Orr, 1979; Mercer, 1983):

Zone	Well(s)
Culebra	H-1, H-2B1, H-2C, H-3B1, H-4B, H-5B, H-6B, H-7B1, H-8B, H-9B, H-10B, P-14, P-15, P-17, P-18, WIPP-25, WIPP-26, WIPP-27, WIPP-28, WIPP-29, WIPP-30
Magenta	H-1,H-2A,H-3B1, H-4A, H-5A, H-6A, H-8A, H-9A, H-10A, WIPP-25, WIPP-27, WIPP-30
Rustler/Salado	H-1, H-2C, H-3B1, H-4C, H-5C, H-6C, H-7C, H-8C, H-9C, H-10C, P-14, P-15, P-17, P-18, WIPP-25, WIPP-26, WIPP-27, WIPP-28, WIPP-29, WIPP-30

4.1.2 Field Data and Sample Collection

Field activities, hydrologic testing, and sample collection methods are described in several USGS documents. Mercer (1983) summarizes all the procedures and most of the laboratory data. In addition, the reports listed below describe specific tests and provide detailed information about the well configuration and condition during testing, the test methods and equipment used, basic hydrologic data from the tests, and the times and methods of sampling.

Document	Wells
Mercer and Orr (1979)	H-1, H-2A, H-2B1, H-2C, H-3B1, P-14, P-15, P-17, P-18
Mercer et al. (1981)	H-4A, H-4B, H-4C
Dennehy and Mercer (1982)	H-5A, H-5B, H-5C
Dennehy (1982)	H-6A, H-6B, H-6C
Richey (1986)	H-7A, H-7B1, H-7C, H-8A, H-8B, H-8C, H-9A, H-9B, H-9C, H-10A, H-10B, H-10C
Richey (1987)	WIPP-25, WIPP-26, WIPP-27, WIPP-28, WIPP-29, WIPP-30

In some cases, such as the sampling episodes in 1977, the test zone was bailed or swabbed until field measurements of water temperature, specific conductance, and density had stabilized (Mercer and Orr, 1979). At other sites, the test zone was bailed or swabbed to remove the water standing in the casing before samples were collected (Mercer et al., 1981; Dennehy, 1982). Often samples were collected after other hydrologic tests (bailing, slug, and so forth) had been performed. Samples were collected according to the standard USGS methods of Brown et al. (1970). Alkalinity and pH were usually measured in the field at the time of sample collection.

4.1.3 Solute Data

Solute data from Mercer and Orr (1979) and Mercer (1983) are summarized in Table 68. Alkalinity and pH were often determined in the field. Other parameters were determined in the USGS Central Laboratory according to the USGS standard procedures of Brown et al. (1970). Data were routinely reported with two significant figures.

Analytical uncertainties (standard deviations) are given by Brown et al. (1970) for most parameters, but were usually determined by analyzing a single sample many (often 20-30) times. Because the precision and accuracy of a method often varies with the sample composition, the reported precisions may not apply to the WIPP samples, particularly those with higher total dissolved solids (TDS) contents.

4.1.3.1 POTASSIUM DATA

A comparison of all of the USGS data with data from other laboratories showed that some of the USGS potassium values appear to be incorrect by as much as two orders of magnitude. In particular, several samples were collected in Nash Draw in August and September 1980, including five samples from the Culebra (at WIPP-25, WIPP-26, WIPP-27, WIPP-28, and WIPP-29) and one sample from the Magenta at (WIPP-25). The USGS potassium result for the WIPP-27 Culebra sample was a factor of 10 lower than the UNC/Bendix result for the SNL sample collected a few days later. The USGS potassium results for the other five samples were a factor of 100 lower than the UNC/Bendix results for the SNL samples collected a few days later. Because the USGS and SNL samples were otherwise similar (see Section 5.0), there is reason to doubt that the potassium concentrations were really different, at least not by one or two orders of magnitude.

One explanation for the apparently low potassium results is that the six samples may have been analyzed at the same time; all would have required dilution by a factor of 10, 100, or even 1000 before analysis. During data reduction, the results might not have been corrected for the dilutions (or the wrong dilution factors might have been used, such as 10 instead of 100 or 1000). In this report, although only circumstantial evidence supports this hypothesis, the apparently low USGS potassium values for the six samples listed above are attributed to "laboratory error," perhaps a missing or incorrect dilution factor correction.

Some other USGS potassium results differ from the results reported by other laboratories by factors of five low to as much as 200 high. However, these are all for samples collected at much different times, often years apart, whereas the USGS and SNL samples discussed above were collected a few days or, at most, weeks apart. Many of these other differences are therefore suspected to be real. The very high results, for example, could be caused by contamination of the USGS samples with a potassium-rich drilling brine. Thus the samples might not be representative, but the analyses would be reasonably accurate.

4.1.3.2 OTHER DATA

After the first draft of this report was written and reviewed, the author learned of another set of USGS analytical data for many of these samples. When USGS personnel collected and sent samples to the USGS Central Laboratories, they also sent replicates to Blair Jones of the USGS, Reston, VA. These samples were analyzed by Shirley Rettig, and the results are available in Bodine et al. (1988).

Because of time constraints, these data could not be considered in this report. However, in many cases we believe that Rettig's data are more reliable than those from the USGS Central Laboratories.

4.2 Data Reported by the Management and Operating Contractor

4.2.1 Program Description and Wells Sampled

The Water Quality Sampling Program (WQSP) is a long-term regional groundwater sampling program that provides samples to several programs including the MOC's Radiological Baseline and Ecological Monitoring Programs (RBP and EMPs) and SNL's site characterization program (Colton and Morse, 1985). More than 20 wells have been and will continue to be sampled approximately annually or biennially for the next several years.

The first round of sampling ran from January 1985 to November 1986. Round two began in April 1986 and was still in progress as work on this report began. Rounds one and two overlapped because the last few wells to be sampled in round one needed extensive recompletion work before they could be sampled. While this work was being planned and done, round-two sampling was started elsewhere.

Because very little round-two data were available to the author at the time this report was started, this report includes only the data from round-one samples collected in 1985 and 1986. At a few locations, where the solute data are particularly confusing, the available round-two data have been briefly considered, but they are not included in the data tables.

The following sites were sampled in 1985 and 1986 (WQSP round one):

Zone	Well(s)
Culebra	DOE-1, DOE-2, H-2A, H-3B3, H-4B, H-5B, H-6B, H-7B1, H-8B, H-9B, H-11B3, H-12, P-14, P-17, WIPP-25, WIPP-26, WIPP-29, Engle Well
Magenta	H-3B1, H-4C, H-5C, H-6C, H-8A
Dewey Lake	Twin Wells/Pasture Well, Ranch Well
Bell Canyon	DOE-2

In addition, a sample was collected from the Culebra at H-3B2 at the end of a long-term multi-pad pumping test.

Note: Other wells were added to the program in 1987; results were not available in time to be included in this report. These wells are not discussed further in this report; more information is in Randall et al. (1988). SNL's data for samples from these wells will be published in a future document.

4.2.2 Field Data and Sample Collection

The field-analysis and sampling procedures are described in Colton and Morse (1985) and the Water Quality Sampling Manual (WP 7-2). Serial samples were collected and several parameters were measured in the field, including the following:

Parameter	Method
alkalinity	titration with sulfuric acid to specified pH
Cl^-	titration with silver nitrate
Eh	platinum electrode
Fe	spectrophotometry
pH	glass electrode
specific conductance	specific conductance probe and meter
specific gravity	hydrometer
temperature	temperature probe or mercury thermometer
divalent cations (X^{++})	titration with EDTA

The serial-sampling field data from the WQSP are given in a series of annual reports: Uhland and Randall (1986), Uhland et al. (1987), Randall et al. (1988), Lyon (1989). This report includes some data from the first two annual reports. Steady-state values for selected parameters are summarized here in Table 15.

Final samples were collected when the solutes, alkalinity, and pH reached steady-state values. Several suites of final samples were collected and sent to various laboratories for analyses. Some samples were sent to SNL, to UNC/Bendix (for SNL), and to the New Mexico EEG; these samples are discussed elsewhere in this report.

The ITAS laboratory in Murraysville, PA, analyzed solutes for the MOC's Environmental Monitoring Program. The ITAS laboratory was sent bottles of field-filtered/acidified samples for metals and cation analyses, bottles of field-filtered/unacidified samples for anion analyses, bottles of unfiltered/unacidified samples for general chemistry (parameters such as pH, TDS, and sometimes anions), and an acid blank.

As was mentioned above, a sample was collected from the Culebra at H-3B2 at the end of a long-term multi-pad pumping test. The collection procedures and analyses are discussed in Uhland et al. (1987). The pumping test is described in Intera Technologies (1986).

4.2.3 Solute Data

The solute data from ITAS that are used in this report are taken from Uhland and Randall (1986) and Uhland et al. (1987). Selected parameters are summarized in Table 69. Note that the major solutes (Ca, Mg, Na, K, Cl^-, and $SO_4^=$) were not analyzed by ITAS in the first nine samples collected during the WQSP.

Methods of analysis and estimates of precision were not reported for the round-one data. However, some parameters were run in duplicate; the duplicate results were reported by Uhland and Randall (1986) and Uhland et al. (1987). Although only the averages are given here, the interested reader could estimate precisions for several parameters from the duplicate data in the source documents.

Uhland and Randall (1986) and Uhland et al. (1987) usually reported the ITAS laboratory results with one or two significant figures. Note that when an average value is given in this report, the average is presented here with one additional significant figure. As with the UNC/Bendix data (Section 3.8), the additional figures are probably not truly significant, but are presented here for the convenience of the reader who wants to do further statistical calculations.

4.3 Data Reported by the NM Environmental Evaluation Group

4.3.1 Program Description and Wells Sampled

The New Mexico Environmental Evaluation Group (EEG) was sent samples of water from wells sampled during the WQSP. Data from the following 18 wells were available for inclusion in this report and were provided to the author by J.B. Chapman:

Zone	Well(s)
Culebra	DOE-1, DOE-2, H-3B3, H-4B, H-5B, H-6B, H-8B, H-9B, H-11B3, H-12, P-14, P-17, WIPP-26, WIPP-29, Engle
Magenta	H-3B1
Dewey Lake	Twin Wells/Pasture Well
Bell Canyon	DOE-2

The data for these and other samples have since been published in Chapman (1988).

4.3.2 Field Data and Sample Collection

Field data and sample collection methods are summarized in Section 4.2. The EEG supplied its own sample bottles. The bottles were not pre-treated (such as by acid-washing) but were rinsed with sample water several times before filling, in accordance with the standard WQSP procedures of Colton and Morse (1985). Samples were treated (for example, filtered and

acidified) according to standard WQSP procedures. Samples supplied to the EEG included bottles of unfiltered/unacidified groundwater, field-filtered/unacidified groundwater, and field-filtered/acidified groundwater.

4.3.3 Solute Data

Solutes were analyzed by Lynn Brandvold, a Senior Chemist with the New Mexico Bureau of Mines and Mineral Resources, Socorro, NM.

Dr. Brandvold received either unfiltered/unacidified or field-filtered/unacidified groundwater samples. Some of the filtered samples arrived with a precipitate and continued to precipitate on standing; the precipitate did not dissolve when the sample was heated. Therefore, laboratory personnel routinely made 1:10, 1:100, and 1:1000 dilutions of the samples when the samples arrived. The diluted samples appeared stable with no further precipitation occurring. Major solutes were determined in the diluted samples.

Density was determined by shaking an undiluted sample, allowing it to settle, and pipetting and weighing an aliquot.

The solute and density data are presented in Table 70. Solutes were determined by the following methods:

Solute(s)	Method
Ca, Li, Mg, K, Na	atomic absorption spectrophotometry
Cl^-	titration by the mercuric nitrate method
$SO_4^=$	gravimetry as barium sulfate
F	ion-specific electrode

The author does not have sufficient information to estimate the analytical uncertainties or accuracies of these analytical results. However, Brandvold reported that standards were analyzed to verify the accuracy of their methods. Because they did not have reference standards with which to check the accuracy of their methods, laboratory personnel prepared synthetic water samples of varying TDS and analyzed one synthetic sample with each set of groundwater samples. If they found a greater variation than 3%, they rechecked those analyses.

In addition, laboratory personnel calculated a charge-balance error for each sample. They included laboratory determinations of alkalinity[5] in their CBE calculations. If the CBE exceeded 3%, the analyses of that sample were rechecked.

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[5]Because the EEG did not request the determination of alkalinity and did not request that the results be included in the reports to them, these data are not available to the author.

For the data tables in this report, charge-balance errors and total dissolved solids concentrations were calculated as described in Section 1.3.4. Alkalinity values were not included in the calculation of CBE, with the exception of the sample from the Twin Wells/Pasture Well, for which the field value was used. As explained in Section 1.3.4, for most of the samples discussed in this report, alkalinities can be safely ignored in the CBE calculation because in most of these waters the Cl^- and $SO_4^=$ concentrations are the predominant anions; HCO_3^- and $CO_3^=$ do not contribute significantly to the CBE.

In the fresher Culebra and Magenta waters (from H-7, H-8, H-9, and Engle Well), the alkalinity contribution becomes noticeable. For example, using the EEG data from the H-9B Culebra sample, the CBE is +2.1% when alkalinity is excluded and +0.1% when a field alkalinity value is included. Both CBE's are, however, acceptably low. In very fresh waters (such as the Dewey Lake sample from Twin Wells/Pasture Well), alkalinity is a major contributor to the CBE and must be included to get meaningful results.

5.0 COMPARISON AND PRELIMINARY EVALUATION OF THE DATA

5.1 Introduction

This Section (5.0) gives comparisons of various data sets and preliminary evaluations of the quality of the available major solute data. Because the evaluations are preliminary, when a more complete evaluation is done (including the data from subsequent rounds of the WQSP), some of the conclusions and recommendations given here may be contradicted. The information given here should, however, help users of this data to understand that not all of the available data are equally reliable and, in addition, may provide a reasonable data set for some calculations and modeling efforts.

Topics covered in the rest of this introductory Section (5.1) include:

- Summary of methods of evaluating data
- Comments about some parameters
- Organization of the remainder of this section

5.1.1 Summary of Methods of Evaluating Data

Methods of data evaluation were discussed in some detail in Section 2.0 and are summarized here. In evaluating the data included in this report, both the representativeness of the samples and the quality of the analyses were considered.

5.1.1.1 QUALITY OF THE ANALYSES

The qualities of various sets of analytical data were evaluated by examining their internal consistencies and considering supporting data (replicates, spiked samples, control samples) when available; by comparing the laboratory results for chloride and divalent cations with the field results, if available; and by comparing results from various laboratories for samples collected at the same time from the same well and zone.

The WQSP field results for the solutes (especially chloride, divalent cations, and iron) are considered highly reliable for several reasons:

- Duplicates were routinely analyzed; results agreed well
- At each well, one spiked sample for each solute was analyzed; spike recoveries were acceptable
- Standard solutions were restandardized at each well

The UNC/Bendix laboratory data are considered highly reliable for similar reasons:

- Replicates were routinely analyzed; results agreed well
- Spiked samples were analyzed when appropriate; spike recoveries were acceptable

- Control samples were analyzed when possible; results were acceptable
- Calculated CBEs were acceptably low

In addition, the general good agreement between the field and UNC/Bendix results for Cl^- and X^{++} indicated that both the laboratory and field results for those parameters were reliable.

Similarly, the good agreement between the UNC/Bendix laboratory data and the field results from the Nash Draw studies in 1980 (Lambert and Robinson, 1984) indicated that those field results were reliable.

The data from other sources (such as the New Mexico Environmental Evaluation Group (EEG) and the ITAS laboratory) are also supported, in many cases, by the analysis of replicates, spiked samples, and/or control samples. However, most of these supporting data were not available to the author and could not be used to evaluate the quality of those data sets. Those data were therefore evaluated by comparing them, if possible, with the field and UNC/Bendix data.

5.1.1.2 REPRESENTATIVENESS OF SAMPLES

Sample representativeness was evaluated by considering the method of collection; by considering the field (serial-sampling) data, if available; and by comparing analyses of samples collected during different hydrologic tests (sampling episodes) at the same location (hydropad and zone), if possible.

Samples collected after serial-sampling results for Cl^- and X^{++} reached steady state were initially assumed to be representative with respect to the major solutes. This includes all final samples collected in 1980 and during round one of the WQSP, with the exceptions of H-2A Culebra, which did not reach steady state, and H-8A Magenta, for which serial samples could not be collected. Laboratory results for these samples (that is, those assumed to be representative) provide most of the basis for evaluating the representativeness of other samples for which serial-sampling data are not available.

In a few cases, the initial assumption (that is, that steady-state conditions imply that the sample is representative with respect to the major solutes) has been shown to be of questionable validity, but for most of the samples the assumption appears reasonable.

5.1.1.3 FACTORS NOT CONSIDERED IN THIS WORK

Because this is a preliminary evaluation, some potentially important factors could not, at this time, be systematically considered in this evaluation process. In particular the following factors have, for the most part, been ignored for the time being:

- the well configuration at the time of testing (such as open hole versus cased/perforated, type and location of packers, and so forth)

- the test conditions (such as, for pumping tests, the type of pump, the pumping rate, and the total volume pumped before sampling)
- the well history, including possible additions to the groundwater (brine added during drilling and/or coring operations, other material added to control lost circulation or help dislodge a piece of equipment that was stuck in the borehole, fluids injected for tracer tests, and so forth) or possible removal of large quantities of water (because of many tests being conducted in the same wells over the years)

In a few cases, the author knew from personal experience that these factors might be important; in other cases, reviewers pointed out possible difficulties caused by one or more of the factors. For these few cases, some of the factors have been considered and are mentioned in the sections discussing the cases.

5.1.2 Comments About Some Parameters

5.1.2.1 MAJOR SOLUTES

This report primarily addresses the evaluation of the analytical data for the major solutes Na, K, Ca, Mg, Cl^-, and $SO_4^=$. Note that when samples are described as "representative" in Sections 5.2 to 5.6, this means representative with respect to those major solutes, but not necessarily representative with respect to any other solute or parameter.

5.1.2.2 MINOR AND TRACE SOLUTES

Minor and trace solute data are presented, but are only briefly discussed and are not evaluated here. The minor and trace solute data are presented for the convenience of those readers who may want to evaluate or use them.

For solutes such as silica and fluoride, the interlaboratory and intertest results tend to agree rather well, that is, they are the same order of magnitude. However, the data should be used with caution until the representativeness of the samples for these parameters can be evaluated.

For some other solutes, such as bromide and cesium, the interlaboratory results sometimes vary by as much as one or more orders of magnitude, although results from the same laboratory for samples from different tests at the same site are comparable. The interlaboratory analytical variations must be understood before the sample representativeness can be evaluated for these parameters, so again, the data must be used with extreme caution.

Because some, and perhaps all, final samples are not representative with respect to iron (see Section 2.0), all trace metal data must be viewed with suspicion until the sample representativeness for each specific metal of interest in each sample can be evaluated. Also, the large interlaboratory variations for some trace metal analyses must be understood before the sample representativeness for these parameters can be completely evaluated.

5.1.2.3 ALKALINITY AND pH

Field values for pH and alkalinity are recommended over the laboratory values. The laboratory values are primarily used to show how much (or little) a nonacidified sample may have changed between the time of collection and time of analysis and for calculations of charge-balance error for some samples.

However, even the field pH and alkalinity data must be used with caution for two reasons.

- First, the groundwaters in many wells have been contaminated with bicarbonate/carbonate, perhaps from bacterial degradation of organic materials introduced during drilling or coring operations (Lambert, 1987). Because of this modern contamination, the observed alkalinity and pH values in samples from these locations are probably not representative of the native, unperturbed groundwater.
- Second, even in uncontaminated wells, loss of carbon dioxide gas at the wellhead during the sampling operation will result in an increased pH (Stumm and Morgan, 1981). Although loss of CO_2 gas will not affect the total alkalinity, the increased pH will affect the bicarbonate/carbonate ratio (Stumm and Morgan, 1981). A loss of some CO_2 gas probably occurs during most of our sampling efforts, but the amount of the loss cannot be quantified. Therefore, even for samples with demonstrated minimal contamination of modern inorganic carbon, the field pH and alkalinity values must be used with caution.

5.1.3 Organization of the Remainder of Section 5.0

The remainder of Section 5.0 is organized as follows:

Subsection	Topic
5.2	Preliminary evaluation of data from the Culebra Dolomite
5.3	Preliminary evaluation of data from the Magenta Dolomite
5.4	Preliminary evaluation of data from the Rustler/Salado contact zone
5.5	Preliminary evaluation of data from the Dewey Lake Red Beds
5.6	Preliminary evaluation of data from other stratigraphic zones
5.7	Summary

Within each subsection, the WIPP wells are listed first, in alphabetical order, followed by the stock wells in alphabetical order. Wells located at the same hydropad are grouped together; for example, the Culebra samples from H-5B and H-5C are discussed and compared in the same sub-subsection.

For each location (hydropad and stratigraphic zone), a summary table shows the data from various laboratories and the field (these data are from Tables 11 to 15). Charge-balance errors and total dissolved solids contents were calculated as discussed in Section 1.3.4. To allow comparison of field divalent-cation values with laboratory data, the laboratory calcium and magnesium values (converted to meq/L) have been summed to give a laboratory divalent-cation

value. Alkalinity values are given both as mg/L $CaCO_3$ and as mg/L HCO_3^- plus mg/L $CO_3^=$. Conversions were made as described in Section 1.3.4.

Remember: when samples are described as "representative" in Sections 5.2 to 5.6, this means "representative with respect to the major solutes Na, K, Ca, Mg, Cl^-, and $SO_4^=$," but not necessarily representative with respect to any other solute or parameter.

5.2 Preliminary Evaluation of Data from the Culebra Dolomite

5.2.1 DOE-1 Culebra (Table 71)

The Culebra at DOE-1 was sampled by HGC in 1983 and during round one of the WQSP in 1985. It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Uhland et al. (1987) and Randall et al. (1988).

1983 Sample

During a 1983 pumping test, HGC made some field measurements and collected final samples for stable isotope (D and ^{18}O) and for ^{37}Cl analyses (see Section 3.5.2.1).

The KCS laboratory, which did the ^{37}Cl measurements, reported a total chloride concentration of 94000 ± 10000 mg/L, determined gravimetrically. Although the concentration is ~ 25% higher than the chloride concentration measured in the field and by UNC/Bendix for the WQSP sample, the results may be reasonable within the limits of the analytical methods. Therefore, we cannot evaluate the representativeness of the 1983 sample with the available information.

1985 Samples (WQSP round one)

UNC/Bendix and the EEG analyzed WQSP samples; ITAS did not determine major solutes in their samples. However, ITAS analyzed two different "metal" samples, collected on two days of final sampling, for selected minor and trace cations (Uhland et al., 1987).

Both the UNC/Bendix and EEG data sets seem to be internally consistent. However, for reasons that are not yet understood, the EEG's major solute determinations are systematically lower than those of UNC/Bendix. The UNC/Bendix results are considered more reliable because their Cl^- and X^{++} value values agree closely with the values measured in the field.

Preliminary recommendations

The representativeness of the 1983 sample cannot be evaluated.

The 1985 samples are considered representative with respect to the major solutes; the UNC/Bendix major-solute data are recommended.

5.2.2 DOE-2 Culebra (Table 72)

The Culebra at DOE-2 was sampled during round one of the WQSP in 1985. It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Uhland et al. (1987) and Lyon (1989).

1985 samples (WQSP round one)

UNC/Bendix and the EEG analyzed WQSP samples; ITAS did not determine major solutes in their sample. The UNC/Bendix and EEG data sets seem to be internally consistent. Differences between the two data sets are not systematic, and in most cases can be attributed to analytical variation. However, the EEG Ca value is significantly higher than the UNC/Bendix value. Correspondingly, the EEG X^{++} value is higher than both the UNC/Bendix value and the field value, which are in good agreement with each other. The EEG Ca value may be in error; for other major solutes, both the UNC/Bendix and EEG results are thought to be reliable.

Preliminary recommendations

The WQSP samples are considered representative with respect to the major solutes. The UNC/Bendix and the EEG major-solute results, with the exception of the EEG Ca value, are recommended.

Caution: Because large amounts of brine and diesel oil were used in drilling this well, and because some field personnel with sensitive noses could still detect a faint odor of diesel oil at the time final samples were collected, data for other constituents, such as trace metals and organics, must be used with extreme caution.

5.2.3 FR-10 Culebra (Table 73)

The Culebra at FR-10 was sampled by HGC in 1983 (see Section 3.5.2.2). This well is no longer available for testing or sampling. Selected cations were analyzed for HGC by UNC/Bendix, halides by the KGS, and ^{37}Cl by KCS. Neither the sample collection procedures nor the laboratory analyses are well documented; as a result, it is difficult to evaluate either the sample representativeness or the quality of the analyses. Because sulfate was not determined, a CBE cannot be calculated. However, the low chloride and low major-cation concentrations are consistent with the other relatively fresh Culebra waters found to the south of the WIPP site.

5.2.4 H-1 Culebra (Table 74)

The Culebra at H-1 was sampled by the USGS in 1976 and 1977. Both sets of USGS laboratory analyses seem to be internally consistent. The 1977 sample contained significantly more Cl^-, $SO_4^=$, Na, K, and Mg than the 1976 sample. Lambert and Harvey (1987) showed that the 1977 sample was probably contaminated with water from the Rustler/Salado contact zone in the same well. The 1977 sample is not considered representative. Because at this time we cannot

evaluate the representativeness of the 1976 sample, the USGS analyses of the 1976 sample should be used with caution.

5.2.5 H-2 Culebra (Table 75)

The Culebra at H-2 was sampled by the USGS in 1977 (H-2B1 and H-2C) and during round one of the WQSP in 1986 (H-2A). In addition, in December 1980, the author made some field measurements at H-2C during a recirculating tracer test. The Culebra at H-2 was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are reported in Randall et al. (1988) and Lyon (1989).

1977 samples

The USGS collected samples from H-2B1 in February 1977 and from H-2C in March 1977. Both sets of USGS laboratory results seem to be internally consistent. Most of the major solutes were comparable in the two samples, with the notable exception of Na and Cl^-. Both Na and Cl^- were ~70% higher at H-2C than they had been at H-2B1. Mercer (1983) used a density of 1.012 g/mL (in his Table 9) to correct the water level to a freshwater equivalent head, but he does not reference the source of this density value.

1980 sample

In December 1980, the author made some field measurements at H-2C during a recirculating tracer test (see Section 3.4.2.1). The specific gravity was 1.002. Of course, water sampled during a recirculating test cannot be expected to be representative of the native groundwater, because the added tracer-bearing fluid is a source of contamination and recirculating the pumped water does not allow for the flushing or purging of contaminants. However, in order for the recirculating water to have a density much lower than the native groundwater, the groundwater would have to have been diluted with very large quantities of a low density fluid. The amount of tracer-bearing fluid injected at this hydropad probably was not enough to affect the density of the groundwater at this site.

1986 samples (WQSP round one)

UNC/Bendix and ITAS analyzed WQSP samples. Both sets of laboratory data seem to be internally consistent. The major solute results from the two laboratories are comparable; sulfate differs by ~10% and the others agree more closely.

However, steady state had apparently not been reached at the time the WQSP samples were collected. Close examination of the field data in Uhland and Randall (1986) shows that the chloride values were still slowly decreasing, even after more than two weeks of pumping. The specific gravity measured in the field at the time of final sample collection was 1.009.

Preliminary recommendations

The specific gravity of 1.002 observed in 1980 may have been slightly low because of some dilution by tracer-bearing fluids. However, the accuracy of the 1977 density, 1.012, is also doubted because of the large dilution that would be needed to go from 1.012, in 1977, to the observed specific gravity of 1.002 in 1980.

The UNC/Bendix and ITAS results for the 1986 samples are comparable to the USGS results for the March 1977 H-2C sample. But (as discussed above) the 1986 samples are not considered representative because the field chloride concentration did not reach steady state.

At this time, none of the previously collected samples can be considered representative. Samples collected during later rounds of the WQSP may give more information about the chemistry of the Culebra water at H-2.

5.2.6 H-3 Culebra (Table 76)

The Culebra at H-3 was sampled by the USGS in 1977 (H-3B1), by HGC in 1984 (H-3B3), during round one of the WQSP in 1985 (H-3B3), and by WQSP personnel in December 1985 (H-3B2). The Culebra at H-3 was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Uhland et al. (1987) and Randall et al. (1988).

1977 and 1984 samples

The USGS laboratory results for the 1977 sample seem to be internally consistent, as do the UNC/Bendix results for the 1984 sample.

1985 samples (WQSP round one and H-3B2)

WQSP samples from H-3B3 were analyzed by UNC/Bendix and the EEG; ITAS did not determine major solutes in their sample. The UNC/Bendix and EEG results seem to be internally consistent. The two data sets are in good agreement and both sets are considered reliable.

The sample collected at H-3B2 in December 1985 was analyzed by ITAS; the results seem to be internally consistent.

Preliminary recommendations

Results from all of the sets of samples and analyses are comparable. The few significant differences (noted here) can be attributed to analytical variations and/or errors.

- the USGS $SO_4^{=}$ value is high
- the ITAS Ca value is high

- the February 1985 field value for X^{++} appears high[6]

All of the other field and laboratory major-solute data are considered reliable.

All samples are considered representative with respect to the major solutes. With the exceptions noted in the preceding paragraph, all of the major-solute data are considered reliable. However, because supporting field data and documentation are available for the WQSP samples, the UNC/Bendix and EEG major-solute data for the WQSP round-one samples are recommended.

5.2.7 H-4 Culebra (Table 77)

The Culebra at H-4 was sampled by the USGS in 1978 (H-4B), by SNL in 1981 (H-4B), by HGC in 1984 (H-4C), and during round one of the WQSP in 1985 (H-4B). The Culebra at H-4 was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Uhland et al. (1987) and Randall et al. (1988).

1978, 1981, and 1984 samples

The USGS laboratory results for the 1978 sample seem to be internally consistent, as do the UNC/Bendix results for the 1981 and 1984 samples.

1985 samples (WQSP round one)

UNC/Bendix and the EEG analyzed WQSP samples; ITAS did not determine major solutes in their sample. The UNC/Bendix and EEG data sets both seem to be internally consistent. The EEG $SO_4^{=}$, Ca, Mg, and K results are comparable to the UNC/Bendix results, but, for reasons that are not yet understood, their Na and Cl^- results are significantly lower. The UNC/Bendix chloride value agrees closely with the field value, and therefore the UNC/Bendix Na and Cl^- data are recommended; the $SO_4^{=}$, Ca, Mg, and K results from both laboratories are considered reliable.

Preliminary recommendations

The USGS 1978 sample contained significantly less Ca and $SO_4^{=}$ than the later samples; its representativeness is doubted. The 1981, 1984, and 1985 samples, which are all thought to be representative with respect to the major solutes, contained comparable quantities of major solutes, although the Na and Cl^- concentrations seem to be slightly lower in the 1985 samples. As the difference is slight, ~6%, we cannot say whether it is caused by analytical imprecision, with both

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[6]The high field X^{++} value apparently resulted from improper standardization of the EDTA solution used in the titrimetric analysis. This was the first well sampled during the WQSP, and procedures were being developed and tested. Uhland et al. (1987) report a round-two field X^{++} value of ~140 meq/L, which agrees with the Bendix and EEG lab values for the round one samples. The inaccurate standardization during round one does not affect the conclusion that stability for this parameter was reached.

Na and Cl^- coincidentally varying by the same amount, or whether there was a real difference in the water samples.

For the 1981 and 1984 samples, the UNC/Bendix major-solute data are considered reliable. For the WQSP samples, both the UNC/Bendix and the EEG major-solute data, with the exception of the EEG Na and Cl^- values, are considered reliable.

5.2.8 H-5 Culebra (Table 78)

The Culebra at H-5 was sampled by the USGS in 1978 (H-5B), by SNL in 1981 (H-5B and H-5C), and during round one of the WQSP in 1985 (H-5B). The Culebra at H-5 was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Uhland et al. (1987) and Lyon (1989).

1978 and 1981 samples

The USGS laboratory results for the 1978 sample seem to be internally consistent, as do the UNC/Bendix analyses of the 1981 samples.

1985 samples (WQSP round one)

UNC/Bendix, ITAS, and the EEG analyzed WQSP samples. All three data sets seem to be internally consistent. However, for reasons that are not yet understood, the EEG results are consistently lower than the UNC/Bendix results. The ITAS results are, with the exception of Cl^- and K, also lower than the UNC/Bendix results. The differences between the three data sets may be caused by analytical variation and error and/or to sample degradation. Because the UNC/Bendix Cl^- and X^{++} results agree with those obtained in the field, the UNC/Bendix major-solute data tentatively are considered more reliable.

Preliminary recommendations

The USGS 1978 sample contained significantly less $SO_4^=$ and Ca than the later samples and its representativeness is questioned.

The 1981 and 1985 samples, which are all thought to be representative with respect to the major solutes, contained comparable amounts of the major solutes; observed differences between 1981 and 1985 may be attributed to analytical variation. The UNC/Bendix major-solute data for the 1981 and 1985 samples are recommended.

5.2.9 H-6 Culebra (Table 79)

The Culebra at H-6 was sampled by the USGS in 1978 (H-6B), by SNL in 1981 (H-6B), and during round one of the WQSP in 1985. Also, SNL made some selected field and isotope measurements at H-6C in 1981. The Culebra at H-6 was sampled again during rounds two and

three of the WQSP; the field and ITAS laboratory data are given in Uhland et al. (1987) and Randall et al. (1988).

1978 and 1981 samples

The USGS laboratory data for the 1978 sample seem to be internally consistent, as do the UNC/Bendix data for the 1981 sample.

1985 samples (WQSP round one)

UNC/Bendix, ITAS, and the EEG analyzed samples from the WQSP. The UNC/Bendix and EEG data seem to be internally consistent and are in good agreement with each other and the field measurements of Cl^- and X^{++}. The ITAS results have a large CBE (-11%) and, except for Cl^- and Ca, show poor agreement with the other data sets. The UNC/Bendix and EEG major-solute data are considered more reliable.

Preliminary recommendations

The USGS sample contained somewhat less Cl^- and Ca than the later samples; its representativeness is doubted.

The 1981 and 1985 samples, which are all thought to be representative with respect to the major solutes, contain comparable amounts of the major solutes. The slightly higher $SO_4^=$, Na, and Ca values in the 1981 samples are attributed to analytical variations, although the possibility that the differences are real cannot be ruled out at this time. The UNC/Bendix major-solute data for the 1981 samples and the UNC/Bendix and EEG major-solute data for the 1985 samples are recommended.

5.2.10 H-7 Culebra (Table 80)

The Culebra at H-7 was sampled by the USGS in 1980 (H-7B1) and during round one of the WQSP in 1986 (H-7B1). It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

1980 sample

The USGS laboratory data seem to be internally consistent.

1986 samples (WQSP round one)

UNC/Bendix and ITAS analyzed samples from the WQSP. The UNC/Bendix data seem to be internally consistent and their values for Cl^- and X^{++} are in good agreement with the field data for those parameters. The ITAS data show poor internal agreement with a CBE of -20% and a higher calculated TDS than observed ROI. The ITAS chloride value is nearly twice those reported by UNC/Bendix and observed in the field, and the ITAS sulfate value is ~25% higher than the UNC/Bendix value, indicating a possible problem with the ITAS anion sample. The ITAS major-cation data agree well with the UNC/Bendix data. The UNC/Bendix major-anion

data are considered more reliable; the major-cation data from both UNC/Bendix and ITAS are considered reliable.

Preliminary recommendation

With the exception of K, which is ~five times lower in the USGS 1980 sample than in the 1985 WQSP samples, the 1980 and 1985 samples contain comparable quantities of the major solutes. Because the apparently low USGS K value could be a laboratory error and because the other major solutes are the same in the USGS and WQSP samples, the USGS sample was probably representative with respect to the major solutes. The 1985 samples are considered representative with respect to the major solutes. For the 1985 samples, the UNC/Bendix data for the major anions and cations and the ITAS data for the major cations are recommended.

5.2.11 H-8 Culebra (Table 81)

The Culebra at H-8 was sampled by the USGS in 1980 (H-8B) and during round one of the WQSP in 1986 (H-8B). It was sampled again during rounds two and three; the field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

1980 sample

The USGS laboratory results for the 1980 sample seem to be internally consistent.

1986 samples (WQSP round one)

UNC/Bendix, ITAS, and the EEG analyzed WQSP samples. The UNC/Bendix and EEG data seem to be internally consistent and are generally in good agreement; the EEG K value of 4.6 mg/L is ~20% higher than the UNC/Bendix value. The ITAS results seem to be less internally consistent, with a CBE of +8%. The ITAS $SO_4^{=}$ value is significantly lower than the UNC/Bendix and EEG results, which could explain the CBE. The ITAS Cl^- and major cation values agree with the results from the other laboratories within acceptable analytical limits. Major-solute data from all three laboratories are therefore considered reliable with the exception of the ITAS $SO_4^{=}$ value.

Preliminary recommendation

The USGS 1980 sample contained significantly more Na and Cl^- than the WQSP 1986 samples, although the other major solutes were the same in 1980 and 1986. The representativeness of the USGS sample is questioned.

The WQSP samples are considered representative with respect to the major solutes, and the major-solute results from all three laboratories, with the exception of the ITAS $SO_4^{=}$ value, are recommended.

5.2.12 H-9 Culebra (Table 82)

The Culebra at H-9 was sampled by the USGS in 1980 (H-9B), by HGC in 1983 (H-9B), and during round one of the WQSP in 1985 (H-9B). It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

1980 sample

The USGS laboratory data for their 1980 sample are apparently not internally consistent. However, the CBE of +26% could be caused by an incorrect K value. The K value is a factor of 200 higher than the values reported by the other laboratories for samples collected in later years.

1983 sample

The UNC/Bendix data for the 1983 sample seem to be internally consistent.

1985 samples (WQSP round one)

UNC/Bendix, ITAS, and the EEG analyzed WQSP samples. The UNC/Bendix and EEG results seem to be internally consistent and are in good agreement with each other. The ITAS results show poorer internal consistency. The CBE of +10% is attributed to a low $SO_4^{=}$ value; the ITAS $SO_4^{=}$ value is ~25% lower than the UNC/Bendix and EEG values. The ITAS Cl^- and major cations values agree with those reported by UNC/Bendix and the EEG within acceptable limits. Major-solute data from all three laboratories are therefore considered reliable, with the exception of the ITAS $SO_4^{=}$ value.

Preliminary recommendations

The USGS 1980 sample contained significantly higher quantities of Na and Cl^- than the later samples. The representativeness of the USGS sample is questioned.

The 1983 and 1985 samples contained comparable quantities of major solutes, with differences observed being attributable to analytical variation. Both groups of samples are considered representative with respect to the major solutes, but the major-solute data from the 1985 samples, with the exception of the ITAS $SO_4^{=}$ value as explained above, are recommended because the documentation of sample collection and analysis is better.

5.2.13 H-10 Culebra (Table 83)

The Culebra at H-10 (well H-10B) was sampled by the USGS in 1980. The USGS laboratory data seem to be internally consistent. However, because we cannot evaluate the representativeness of this sample, the data should be used with caution.

5.2.14 H-11 Culebra (Table 84)

The Culebra at H-11 was sampled during round one of the WQSP in 1985 (H-11B3). It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Uhland et al. (1987) and Randall et al. (1988).

1985 samples (WQSP round one)

UNC/Bendix and the EEG analyzed WQSP samples; ITAS did not determine major solutes in their sample. The UNC/Bendix and EEG results both seem to be internally consistent. However, for reasons that are not understood, the EEG Cl^- value is slightly lower than the UNC/Bendix value and the $SO_4^=$ and K values are significantly lower. Na, Ca, and Mg agree within the limits of analytical precision. The UNC/Bendix major-solute results are considered more reliable because the UNC/Bendix Cl^- value agrees with the field value.

Preliminary recommendation

The samples are considered representative with respect to the major solutes and the UNC/Bendix major-solute results are recommended as explained above.

5.2.15 H-12 Culebra (Table 85)

The Culebra at H-12 was sampled twice by HGC in 1984 and during round one of the WQSP in 1985. It was sampled again during rounds two and three of the WQSP; the field and ITAS data are given in Randall et al. (1988) and Lyon (1989).

1984 samples

UNC/Bendix analyzed the 1984 samples for HGC, and the analytical results for the two samples seem to be internally consistent. The two sets of results show good agreement except for $SO_4^=$, which varies by a factor of two, 8400 versus 4000 mg/L. This difference is not understood.

1985 samples (WQSP round one)

UNC/Bendix, ITAS, and the EEG analyzed samples from the WQSP. All the data sets seem to show internal consistency. However, for reasons that are not yet known, the EEG results are consistently lower than those from UNC/Bendix. The ITAS $SO_4^=$, Na, and Mg results are lower than those from UNC/Bendix, while the ITAS K result is slightly higher. Because the UNC/Bendix Cl^- and X^{++} results agree with the field data, the UNC/Bendix major-solute results are considered more reliable.

Preliminary recommendations

The major-solute contents of the 1984 and 1985 samples are comparable. The observed differences could be caused by analytical variation, or the 1984 samples might have been slightly contaminated. The WQSP samples are considered representative with respect to the major solutes, and the UNC/Bendix major-solute data are recommended.

5.2.16 P-14 Culebra (Table 86)

The Culebra at P-14 was sampled by the USGS in 1977 and during round one of the WQSP in 1986. It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

1977 sample

The USGS laboratory results for the 1977 sample seem to be internally consistent.

1986 samples (WQSP round one)

UNC/Bendix, ITAS, and the EEG analyzed WQSP samples. The data sets seem to be internally consistent. The EEG K results are higher than those from the other labs. Major-solute results from all three laboratories, with the exception of the EEG K value, are considered reliable.

Preliminary recommendations

The USGS sample contained significantly more Na and Cl^- than the WQSP samples, and its representativeness is questioned.

The WQSP samples are considered representative with respect to the major solutes, and the major-solute results from all three laboratories, with the exception of the EEG K value, are recommended.

5.2.17 P-15 Culebra (Table 87)

The Culebra at P-15 was sampled by the USGS in 1977 and 1979. The USGS laboratory data for the 1977 sample seem to be internally consistent, as do the SNL laboratory data for the 1979 sample. The 1979 sample contained significantly higher amounts of the major solutes than the 1977 samples. Lambert and Harvey (1987) suspected that the 1979 samples were contaminated; they are not considered representative. Because the representativeness of the 1977 sample cannot be evaluated, the USGS data should be used with caution.

5.2.18 P-17 Culebra (Table 88)

The Culebra at P-17 was sampled by the USGS in 1977 and during round one of the WQSP in 1986. It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Uhland et al. (1987) and Randall et al. (1988).

1977 sample

The USGS laboratory results for the 1977 sample seem to be internally consistent.

1986 samples (WQSP round one)

UNC/Bendix, ITAS, and the EEG analyzed samples from the WQSP. All the data sets seem to be internally consistent and are in agreement, with a few exceptions. For reasons that are not understood, the EEG Na and Cl^- results are slightly lower than those from the other two laboratories, and the ITAS $SO_4^=$ result is higher than the values reported by the other two other laboratories. Major-solute results from all three laboratories are considered reliable, except for the EEG Na and Cl^- and the ITAS $SO_4^=$ results.

Preliminary recommendations

The USGS 1977 sample contained slightly less $SO_4^=$ and K and slightly more Cl^- than the WQSP samples. Lambert and Harvey (1987) suspected a packer leak and resulting contamination with water from the Rustler/Salado zone in this well. The 1977 sample is not considered representative.

The WQSP samples are considered representative with respect to the major solutes, and the major-solute results from all three laboratories, with the exceptions of the EEG Na and Cl^- and the ITAS $SO_4^=$ results, are recommended.

5.2.19 P-18 Culebra (Table 89)

The Culebra at P-18 was sampled by the USGS in 1977. The USGS analyses seem to be internally consistent. However, Lambert and Harvey (1987) doubted the representativeness of the sample because of the extremely low productivity of the well. The sample is not considered representative.

5.2.20 WIPP-25 Culebra (Table 90)

The Culebra at WIPP-25 was sampled by the USGS and SNL in 1980 and during round one of the WQSP in 1986. It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

1980 samples

The USGS laboratory data for their 1980 sample seem to be internally consistent, as do the UNC/Bendix data for SNL's 1980 sample. However, the USGS K value is apparently low by a factor of 100; this is attributed to a laboratory error (see Section 4.1.3).

1986 samples (WQSP round one)

UNC/Bendix and ITAS analyzed samples from the WQSP. Both sets of results seem to be internally consistent and are in agreement with each other. Both sets of major-solute data are considered reliable.

Preliminary recommendations

The USGS 1980 sample contained significantly more Na and Cl than the other samples, and its representativeness is doubted.

The 1980 SNL and 1986 WQSP samples were all thought to be representative of the groundwater at the time the samples were collected because the serial-sampling parameters had reached steady state in both cases. However, the 1986 samples contained ~20% more Cl , Ca, and Mg and ~40% more K than the 1980 samples. Some observations about the 1980 and 1986 tests follow.

- The 1980 samples were collected after 28 hr of pumping at 33 gpm (Lambert and Robinson, 1984), at which time ~55,000 gal of groundwater had been pumped from the well.
- The 1986 samples were collected after two weeks of pumping at ~seven gpm; more than 164,000 gal of water had been pumped before final sampling began (Uhland and Randall, 1986).
- Serial-sampling data from round two of the WQSP indicate that there is little or no difference between the round-one and round-two samples.

Any of the samples, from 1980 or from the WQSP, could be contaminated. Even though steady state was reached during the serial-sampling episodes, an apparent steady state could have been observed during the sampling of a large contamination plume.

At this time, the differences between SNL's 1980 samples and the WQSP samples cannot be explained. However, a future evaluation of all the existing data (including the minor and trace element data) plus additional data from the WQSP, coupled with a more detailed knowledge of the well's history, may lead to an understanding of these differences.

For SNL's 1980 sample, the UNC/Bendix data are recommended; for the WQSP round-one samples, the major solute data from UNC/Bendix and ITAS, as explained above, are considered reliable. However, all the data must be used with caution until the differences between SNL's 1980 samples and the WQSP samples are understood.

5.2.21 WIPP-26 Culebra (Table 91)

The Culebra at WIPP-26 was sampled by the USGS and SNL in 1980 and during round one of the WQSP in 1985. It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

1980 samples

The USGS laboratory data for their 1980 sample seem to be internally consistent although the CBE is rather large (-6.7%). The UNC/Bendix data for the 1980 SNL sample seem to be internally consistent.

1985 samples (WQSP round one)

UNC/Bendix, ITAS, and the EEG analyzed samples from the WQSP. All the data sets seem to be internally consistent. The UNC/Bendix and EEG data are in good agreement. The ITAS Cl^- and Ca values are higher and the $SO_4^=$ value is lower than those from the other laboratories. Because the UNC/Bendix and EEG Cl^- and X^{++}results agree with the field values, the UNC/Bendix and EEG major-solute results are considered more reliable.

Preliminary recommendations

The 1980 USGS sample apparently contained significantly more Cl^- than the 1980 SNL sample. However, this value may be in error, which would explain the slightly large negative CBE (-6.7%). The USGS K value is apparently low by a factor of 100; this is attributed to a laboratory error (see Section 4.1.3). The USGS sample was probably representative, but the use of the USGS data is not recommended because of the apparent errors in the Cl^- and K data.

The 1980 SNL and 1985 WQSP samples were thought to be representative of the groundwater at the time the samples were collected because the serial-sampling parameters had reached steady state in both cases. However, the 1985 samples contained more Cl^-, Na, K, and X^{++} than the 1980 samples.

- The 1980 samples were collected after 26 hours of pumping at ~34 gpm (Lambert and Robinson, 1984), at which time ~53000 gal of groundwater had been pumped from the well.
- The 1985 samples were collected after the well had been initially purged for 61 hr at 14.4 gpm and then pumped for eight days at ~53 gph; more than 60,000 gal of water had been pumped from the well before final sampling began (Uhland and Randall, 1986).
- During round two of the WQSP in March and April 1987, pumping continued for nine days at ~47 gph; ~9000 gal of water were removed from the well. Data from the last serial sample indicated that chloride was ~5800 mg/L (~1400 mg/L lower than in 1980 and ~3000 mg/L lower than in 1985), divalent cations were ~85 meq/L (~6 meq/L lower than in 1980 and ~15 meq/L lower than in 1985), and sulfate and alkalinity were about the same as they had been in earlier years.

Any of the samples could be contaminated. Even though steady state was apparently reached during all the serial-sampling episodes, steady state could have been observed during the sampling of a large contamination plume. At this time, the differences between SNL's 1980 sample and the WQSP samples cannot be explained.

However, a further evaluation of all the data (including the minor and trace element data) plus additional data from the WQSP, coupled with a more detailed knowledge of the well's history, may lead to an understanding of these differences.

For the 1980 SNL sample, the UNC/Bendix major-solute data are recommended. For the WQSP samples, the UNC/Bendix and the EEG major-solute results are both considered reliable.

However, because at this time the differences between the various sets of samples cannot be explained, all the data must be used with caution.

5.2.22 WIPP-27 Culebra (Table 92)

The Culebra at WIPP-27 was sampled by the USGS and SNL in 1980. The USGS laboratory data seem to be internally consistent. However, the K result appears to be low by a factor of ~10. This is attributed to a laboratory error (see Section 4.1.3). The UNC/Bendix results for the SNL sample also seem to be internally consistent. The two data sets are comparable, except for K, as explained above. Both samples are considered representative with respect to the major solutes, and both sets of major-solute data are considered reliable, except for the USGS K value.

5.2.23 WIPP-28 Culebra (Table 93)

The Culebra at WIPP-28 was sampled by the USGS and SNL in 1980. The USGS results seem to be internally consistent. The K value, however, is thought to be low by a factor of ~100. This is attributed to a laboratory error (see Section 4.1.3). The UNC/Bendix results for the SNL sample also seem to be internally consistent. The USGS sample contained significantly more Na and Cl^- and somewhat less Mg and $SO_4^=$ than the SNL sample. The representativeness of the USGS sample is doubted. The SNL sample is considered representative with respect to the major solutes, and the UNC/Bendix major-solute data are recommended. As was discussed in Section 3.3.2.2, the alkalinity was still dropping at the time of final sample collection, so a representative alkalinity value has not been obtained for the Culebra at WIPP-28.

5.2.24 WIPP-29 Culebra (Table 94)

The Culebra at WIPP-29 was sampled by the USGS and SNL in 1980 and during round one of the WQSP in 1985. It was sampled again during round two of the WQSP; the field and ITAS laboratory data are given in Randall et al. (1988).

<u>1980 samples</u>

The USGS laboratory data seem to be internally consistent as do the UNC/Bendix data for the 1980 SNL sample. The data agree well, except for K. The USGS K value is thought to be low by a factor of ~100; this is attributed to a laboratory error (see Section 4.1.3). Both the UNC/Bendix and the USGS major-solute data are considered reliable except for the USGS K value.

<u>1985 samples (WQSP round one)</u>

UNC/Bendix, ITAS, and the EEG analyzed samples from the WQSP. All the data sets seem to be internally consistent. For reasons that are not yet understood, the EEG Cl^-, Na, and Mg results are significantly lower than those of UNC/Bendix and ITAS; as a result, they are not recommended. The UNC/Bendix and ITAS results agree well for all the major solutes except Ca,

for which the ITAS value is ~60% higher. The UNC/Bendix Ca value is recommended because the Ca spike recovery for this sample was 105%; both the UNC/Bendix and ITAS data for the other major solutes are considered reliable.

Preliminary recommendations

The 1980 samples contained significantly less Cl^-, $SO_4^=$, Na, and K, and significantly more Ca than the 1985 samples. However, all the samples are considered representative of the water at the time of collection and the differences are attributed to real changes in the water quality at this location. The top of the Culebra at WIPP-29 lies only 12 feet below ground level and the water quality is almost certainly affected by the inflow of surface water runoff and/or potash mining activities elsewhere in Nash Draw. For the 1980 samples, the UNC/Bendix and USGS major-solute data are recommended (except for the USGS K value). For the 1985 samples, the UNC/Bendix and ITAS major-solute data are recommended (except for the ITAS Ca value).

5.2.25 WIPP-30 Culebra (Table 95)

The Culebra at WIPP-30 was sampled by the USGS and SNL in 1980. The USGS laboratory results seem to be internally consistent, as do the UNC/Bendix results for the SNL sample. However, the USGS sample contained significantly higher amounts of several solutes than the SNL sample. It is possible to account for this difference. The first SNL attempt at testing and sampling the Culebra at this site was abandoned because of unusual field geochemical results and hydrologic (drawdown) observations. The packer isolating the Culebra from the Rustler/Salado contact zone was removed from the well, found to be defective, and replaced (Lambert and Robinson, 1984). The test was repeated successfully. The USGS sample was collected when the defective packer was in use and was probably contaminated with Rustler/Salado water. The SNL sample is considered representative with respect to the major solutes, and the UNC/Bendix major-solute results are recommended.

5.2.26 Engle Well - Culebra (Table 96)

The Culebra at Engle Well was sampled by HGC in 1983 and during round one of the WQSP in 1985. It was sampled again during the private well sampling portion of the WQSP; the field and ITAS laboratory data are given in Randall et al. (1988).

1983 sample

Very few solute analyses were done on the 1983 sample; as a result, it is difficult to evaluate sample representativeness or the quality of the analytical data. However, the general agreement of the Cl^- data from UNC/Bendix and the KGS with the Cl^- data for the 1985 samples and the general agreement of data for several trace solutes with the data for the 1985 samples indicate there is no reason to doubt the representativeness of the 1983 samples.

1985 samples (WQSP round one)

UNC/Bendix and the EEG analyzed samples from the WQSP; ITAS did not determine major solutes in their sample. The UNC/Bendix and EEG data sets seem to be internally consistent. The two sets of data agree well, except that the EEG Cl^- value is significantly lower than the UNC/Bendix value, which agrees well with the field value. The UNC/Bendix Cl^- value is considered more reliable; for other major solutes, data from both laboratories are considered reliable.

Preliminary recommendations

As explained above, there is not enough information to evaluate the analyses of the 1983 samples. However, there is no reason to doubt the representativeness of the 1983 samples.

The WQSP samples are considered representative with respect to the major solutes. The UNC/Bendix and EEG major-solute data, with the exception of the EEG Cl^- value, are recommended.

5.3 Preliminary Evaluation of Data from the Magenta Dolomite

5.3.1 H-1 Magenta (Table 97)

The Magenta at H-1 was sampled by the USGS in 1976 and 1977. The USGS laboratory results for both samples seem to be internally consistent. Major solute contents for the two samples were comparable (but different); the Mg values differed by ~50% and the Cl^-, $SO_4^=$, Na, and Ca values differed by less than 20%. The K values differed by an order of magnitude. The observed differences between the major solutes could be caused by analytical variations; however, the samples might really have been different.

Because the well conditions and water production rates were different for the two sampling episodes, we cannot rule out the possibility that the samples were really different. In both cases, packers were used to isolate the Magenta from the lower stratigraphic zones. In June 1976, the well was open (not cased or screened) and after the zone was developed by swabbing, only ~13 gal of liquid were produced in 13.5 hr of monitoring (Mercer and Orr, 1979). In May 1977, the well had been cased and the casing was perforated in the water-producing zones. The Magenta was described as "fairly productive" (Mercer and Orr, 1979).

Because we cannot evaluate the representativeness of either sample, the data should be used with caution.

5.3.2 H-2 Magenta (Table 98)

The Magenta at H-2 (well H-2A) was sampled by the USGS in 1977. The USGS laboratory results seem to be internally consistent. Because we cannot evaluate the representativeness of this sample, which was collected by bailing or swabbing, the data should be used with caution.

5.3.3 H-3 Magenta (Table 99)

The Magenta at H-3 (well H-3B1) was sampled by the USGS in 1977 and 1979 and during round one of the WQSP in 1985. It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Uhland et al. (1987) and Randall et al. (1988).

1977 and 1979 samples

The USGS laboratory results for the 1977 sample seem to be internally consistent, as do SNL's laboratory results for the 1979 sample.

1985 samples (WQSP round one)

UNC/Bendix and the EEG analyzed WQSP samples; ITAS did not determine major solutes in their sample. The UNC/Bendix and EEG results seem to be internally consistent. But for reasons that are not understood, the EEG results for the major solutes are slightly but consistently lower than the UNC/Bendix results. For several of the major solutes, the differences are no more than can be attributed to analytical variation. However, because the EEG results are all ~10% lower than the UNC/Bendix results, rather than some being lower and some higher, and because the UNC/Bendix Cl^- and X^{++} results agree more closely with the field results, the UNC/Bendix major-solute results are tentatively considered more reliable.

Preliminary recommendations

The 1977 and 1979 samples contained comparable quantities of the major solutes. They also contained significantly higher amounts of Cl^-, Na, Mg, and $SO_4^=$ than the WQSP samples. The representativeness of the 1977 and 1979 samples is questioned.

The 1985 samples are considered representative with respect to the major solutes, and the UNC/Bendix major-solute data, as explained above, are recommended.

5.3.4 H-4 Magenta (Table 100)

The Magenta at H-4 was sampled by the USGS in 1978 (H-4A) and during round one of the WQSP in 1986 (H-4C). It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

1978 samples

The USGS laboratory results for their 1978 sample seem to be internally consistent.

1986 samples (WQSP round one)

UNC/Bendix and ITAS analyzed WQSP samples. Both sets of data seem to be internally consistent. However, the ITAS results are consistently higher than the UNC/Bendix results; in addition, the calculated TDS concentration is slightly higher than their observed ROI. Because the UNC/Bendix results for Cl^- and X^{++} values agree more closely with the field results, the UNC/Bendix major-solute data are tentatively considered more reliable.

Preliminary recommendations

The 1978 sample contained significantly less Ca and Cl^- than the 1986 samples. Some differences in the two tests are noted here:

- The 1978 sample was collected from well H-4A, which was cased to the top of the Magenta but open in the Magenta.
- The 1986 samples were collected from well H-4C, which was cased and perforated in the Magenta; a packer was used to isolate the tested interval from the Culebra.
- The 1978 sample was collected after the well, H-4A, had been bailed to remove standing water (Mercer et al., 1981).
- The 1986 samples were collected after ~700 gal of water had been pumped from the well, H-4C, over a 7-day period (Uhland et al., 1987).

Although we usually use the achievement of steady state for the field parameters as an indicator of representativeness, several factors make that criterion perhaps inappropriate for the samples from H-4C. For the following reasons, the possibility that the 1986 sample from H-4C was contaminated by reaction with the cement cannot be ruled out at this time:

- H-4C was sampled at a very low pumping rate of 4 gph, which resulted in a fairly small volume of water being purged before sampling.
- The H-4C sample contained higher amounts of Ca and Cl^- than the H-4A sample collected from an open interval. Note that calcium chloride is a common component of cement mixtures and that the sample was collected from a cased and cemented interval.

Even though steady state was apparently achieved during serial sampling, steady state could have been observed during the sampling of a contamination plume. The USGS major-solute data for their 1978 sample and the UNC/Bendix major-solute data for their 1986 sample are considered analytically satisfactory. However, because the representativeness of the 1986 sample is questioned and because the representativeness of the USGS sample cannot be evaluated, all the data must be used with caution. Data from later rounds of the WQSP may help resolve these problems.

5.3.5 H-5 Magenta (Table 101)

The Magenta at H-5 was sampled by the USGS in 1978 (H-5A) and during round one of the WQSP in 1986 (H-5C). It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Lyon (1989).

1978 samples

The USGS laboratory results seem to be internally consistent.

1986 samples (WQSP round one)

UNC/Bendix and ITAS analyzed WQSP samples. Both sets of data seem to be internally consistent. However, the ITAS results are consistently higher than the UNC/Bendix results. In addition, ITAS's calculated TDS concentration is ~25% higher than their ROI. Because the UNC/Bendix Cl^- and X^{++} values agree more closely with the field results, the UNC/Bendix major-solute data are considered more reliable.

Preliminary recommendations

The 1978 sample contained significantly less Ca and somewhat less Cl^- and $SO_4^=$ than the 1986 samples. Some differences in the two tests are noted here:

- The 1978 sample was collected from well H-5A, which was cased to the top of the Magenta but open in the Magenta (Dennehy and Mercer, 1982).
- The 1986 samples were collected from well H5C, which was cased and perforated in the Magenta; a packer was used to isolate the tested interval from the Culebra (Uhland et al., 1987).
- The 1978 sample was collected after the well, H-5A, had been bailed to remove standing water (Dennehy and Mercer, 1982).
- The 1986 samples were collected after ~6200 gal of water had been pumped from the well, H-5C, over a three-week period (Uhland et al., 1987).

Although we usually use the achievement of steady state for the field parameters as an indicator of representativeness, several factors make that criterion perhaps inappropriate for the samples from H-5C. For the following reason, the possibility that the 1986 samples from H-5C were contaminated by reaction with the cement cannot be ruled out at this time:

- The H-5C sample contained higher amounts of Ca and Cl^- than the H-5A sample from an open interval. Note that calcium chloride is a common component of cement mixtures and that the sample was collected from a cased and cemented interval.

Even though steady state was apparently achieved during serial sampling, steady state could have been observed during the sampling of a contamination plume.

The USGS major-solute data for their 1978 sample and the UNC/Bendix major-solute data for their 1986 sample are considered analytically satisfactory. However, because the

representativeness of the 1986 sample is questioned and because the representativeness of the USGS sample cannot be evaluated, all the data must be used with caution. Data from later rounds of the WQSP may help resolve these problems.

5.3.6 H-6 Magenta (Table102)

The Magenta at H-6 was sampled by the USGS in 1978 (H-6A) and during round one of the WQSP in 1986 (H-6C). It was sampled again during rounds two and three of the WQSP; the field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

1978 samples

The USGS laboratory results seem to be internally consistent.

1986 samples (WQSP round one)

UNC/Bendix and ITAS analyzed WQSP samples. The UNC/Bendix results seem to be internally consistent but the ITAS results have an unacceptably high CBE of +19%. The ITAS Na and K results are ~60% higher than the UNC/Bendix results. The high Na is probably the cause of the large positive CBE and the reason for the calculated TDS being larger than the observed ROI. The UNC/Bendix major-solute results are considered more reliable.

Preliminary recommendations

The 1978 sample contained significantly more Cl^-, Na, and K than the 1986 samples, as a result; its representativeness is doubted. The 1986 samples are considered more likely to be representative and, as explained above, the UNC/Bendix major-solute results are recommended.

5.3.7 H-8 Magenta (Table 103)

The Magenta at H-8 (well H-8A) was sampled by the USGS in 1980 and during round one of the WQSP in 1985. The USGS laboratory results appear to be internally consistent. ITAS analyzed the WQSP sample, and their results also seem to be internally consistent.

The 1980 sample had ~25% more calculated TDS than the WQSP sample; the individual major solutes ranged from 15% to 50% higher. During the 1985 sampling period, only 25 gal of water could be pumped from the well at ~40 gph. Because of the low productivity of the well, the representativeness of both samples is questioned. Therefore the data should be used with extreme caution.

5.3.8 H-9 Magenta (Table 104)

The Magenta at H-9 (well H-9A) was sampled by the USGS in 1980. The USGS laboratory results seem to be internally consistent. However, because the representativeness of this sample,

which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.3.9 H-10 Magenta (Table 105)

The Magenta at H-10 (well H-10A) was sampled by the USGS in 1980. The USGS laboratory results seem to be internally consistent. However, because the representativeness of this sample, which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.3.10 WIPP-25 Magenta (Table 106)

The Magenta at WIPP-25 was sampled by the USGS and SNL in 1980. The USGS laboratory data seem to be internally consistent, as do the UNC/Bendix data for the SNL sample. The USGS K value seems to be low by a factor of ~100, possibly because of a laboratory error (see Section 4.1.3).

Except for K, both sets of results are comparable. The USGS Na and Cl^- results are both slightly higher than the UNC/Bendix results. Although the difference could be attributed to normal analytical variation, because both Na and Cl^- are high by the same amount, ~10 meq/L, the possibility of slight contamination of the USGS sample cannot be ruled out. The SNL sample is considered representative with respect to the major solutes, and the UNC/Bendix major-solute results are recommended.

5.3.11 WIPP-27 Magenta (Table 107)

The Magenta at WIPP-27 was sampled by the USGS and SNL in 1980. The USGS laboratory data seem to be internally consistent, as do the UNC/Bendix analyses of the SNL sample. The two sets of analyses are comparable; $SO_4^=$ differs by ~15% and K differs by ~25%. These differences can be attributed to analytical variations and/or error, rather than to real differences between the samples.

The USGS sample was probably representative, and the SNL sample is considered representative with respect to the major solutes. The UNC/Bendix major-solute results may be preferred by some users, because the SNL sample collection procedures and UNC/Bendix analytical procedures are better documented than the USGS procedures.

5.3.12 WIPP-30 Magenta (Table 108)

The Magenta at WIPP-30 was sampled by the USGS and SNL in 1980. The USGS laboratory results seem to be internally consistent. However, as was explained in Section 3.3.2.3, SNL was unable to obtain a representative sample at this location.

Table 108 shows the USGS data and the field data from SNL's final serial sample. SNL's serial-sampling results for solutes that did not reach steady state are presented as upper limits.

To help evaluate the representativeness of the USGS sample, SNL's serial-sampling data for several parameters are shown in Table 109, along with the USGS laboratory data. Alkalinity is shown both as $HCO_3^- / CO_3^=$ and as total meq/L. Because the $HCO_3^- / CO_3^=$ ratio in a sample is a function of pH and because the determination of these two species involved titration to a fixed pH that was not necessarily the true equivalence point for each sample, the presentation of the data as total alkalinity in meq/L allows easier visualization of the variations in total alkalinity with time or other parameters, such as temperature.

The variations in the SNL field results occurred because of sample-collection circumstances. The depth to water in the well was measured with a steel tape sometime during the afternoon or evening of 4 December 1980 after serial sample three had been collected at 12:55 hr. Apparently this measurement dislodged some salts from the borehole casing and/or discharge pipe. These salts were then dissolved and flushed out of the well, the chlorides relatively rapidly and the sulfates more slowly. With a pumping rate of only 50 mL/min, the slow approach to steady state is not surprising.

SNL did not collect final samples and the SNL field data indicate that the USGS sample was probably not representative of the unperturbed groundwater either.

5.4 Preliminary Evaluation of Data from the Rustler/Salado Contact Zone

5.4.1 H-1 Rustler/Salado (Table 110)

The Rustler/Salado contact zone at H-1 was sampled by the USGS in 1977. The USGS laboratory results seem to be internally consistent. However, because the representativeness of the sample, which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.4.2 H-2 Rustler/Salado (Table 111)

The Rustler/Salado contact zone at H-2 (well H-2C) was sampled by the USGS in 1977. The USGS laboratory results seem to be internally consistent. However, because the representativeness of the sample, which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.4.3 H-3 Rustler/Salado (Table 112)

The Rustler/Salado contact zone at H-3 (well H-3B1) was sampled by the USGS in 1977. The USGS laboratory results seem to be internally consistent. However, because the

representativeness of the sample, which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.4.4 H-4 Rustler/Salado (Table 113)

The Rustler/Salado contact zone at H-4 (well H-4C) was sampled by the USGS in 1979. Samples were analyzed by the USGS and SNL. Both sets of laboratory data seem to be internally consistent and the analytical results are comparable, except for $SO_4^{=}$ and K. The SNL $SO_4^{=}$ result was a factor of two lower than the USGS result and the SNL K result was a factor of two higher than the USGS result. These differences are probably partly caused by analytical variation and/or error but could also partly be caused by sample instability or some other cause (for example, the samples could have been collected from different swabbing or bailing runs).

Because the reliability of the analyses cannot be evaluated, the results from both laboratories are tentatively considered equally reliable. However, because the representativeness of the samples cannot be evaluated, these data should be used with caution.

5.4.5 H-5 Rustler/Salado (Table 114)

The Rustler/Salado contact zone at H-5 (well H-5C) was sampled by the USGS in 1979. Samples were analyzed by the USGS and SNL. Both sets of laboratory data seem to be internally consistent but the SNL results are generally lower than the USGS results except for Na. This systematic difference may be caused mainly by sample instability, although analytical variation and/or error may also explain some of the differences. For example, the SNL sample could have lost some solutes as a result of precipitation, in which case the USGS results would be more accurate.

However, Dennehy and Mercer (1982) reported that these samples were collected before hydrologic testing because of the low productivity of the zone. The well was bailed dry, water from the Rustler/Salado contact zone was allowed to run into the well, and samples were collected with a stainless-steel sampling tool (Dennehy and Mercer, 1982). Under such conditions, if the samples sent to the two laboratories were from different sampling runs, then possibly the samples sent to the two laboratories were not identical. Dennehy and Mercer (1982) expressed concern about the quality of the samples and suggested that the data be used with discretion.

Because Dennehy and Mercer (1982) had reservations about the quality of the samples, the data must be used with extreme caution.

5.4.6 H-6 Rustler/Salado (Table 115)

The Rustler/Salado contact zone at H-6 (well H-6C) was sampled by the USGS in 1979. Samples were analyzed by the USGS and SNL. Both sets of laboratory results seem to be internally consistent; the analytical results are comparable, except that SNL's $SO_4^{=}$ and K results

are lower than the USGS results. These differences are probably partly caused by analytical variation and perhaps partly caused by sample instability or some other cause.

As the reliability of the analyses cannot be evaluated, both sets of data are tentatively considered equally reliable. However, because the representativeness of the samples cannot be evaluated, these data should be used with caution.

5.4.7 H-7 Rustler/Salado (Table 116)

The Rustler/Salado contact zone at H-7 (well H-7C) was sampled by the USGS in 1980. The USGS laboratory results seem to be internally consistent. However, because the representativeness of the sample, which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.4.8 H-8 Rustler/Salado (Table 117)

The Rustler/Salado contact zone at H-8 (well H-8C) was sampled by the USGS in 1980. The USGS laboratory results seem to be internally consistent. However, because the representativeness of the sample, which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.4.9 H-9 Rustler/Salado (Table 118)

The Rustler/Salado contact zone at H-9 (well H-9C) was sampled by the USGS in 1980. The USGS laboratory results seem to be internally consistent. However, because the representativeness of the sample, which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.4.10 H-10 Rustler/Salado (Table 119)

The Rustler/Salado contact zone at H-10 (well H-10C) was sampled by the USGS in 1980. The USGS laboratory results seem to be internally consistent. However, because the representativeness of the sample, which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.4.11 P-14 Rustler/Salado (Table 120)

The Rustler/Salado contact zone at P-14 was sampled by the USGS in 1977. The USGS laboratory results seem to be internally consistent. However, because the representativeness of the sample, which was collected by bailing or swabbing, cannot be evaluated, the data should be used with caution.

5.4.12 P-15 Rustler/Salado (Table 121)

The Rustler/Salado contact zone at P-15 was sampled by the USGS in 1979. Samples were analyzed by the USGS and SNL. Both sets of data seem to be internally consistent and the results are comparable; the differences may be attributed to analytical variations. If the samples were representative, use of both sets of data would be recommended. However, Lambert and Harvey (1987) indicated that the samples were probably contaminated with Culebra water from the same well. Therefore, the samples are not considered representative.

5.4.13 P-17 Rustler/Salado (Table 122)

The Rustler/Salado contact zone at P-17 was sampled by the USGS in 1979. Samples were analyzed by the USGS and SNL. Unfortunately, SNL's cation data have been lost. The USGS results seem to be internally consistent. The USGS and SNL Cl^- results were the same; the SNL $SO_4^=$ result was a factor of two lower than the USGS result. The $SO_4^=$ difference may be caused by analytical error, sample instability, or some other cause. The USGS data are considered more reliable. However, because the representativeness of the samples cannot be evaluated, the USGS data should be used with caution.

5.4.14 P-18 Rustler/Salado (Table 123)

The Rustler/Salado contact zone at P-18 was sampled by the USGS in 1979. Samples were analyzed by the USGS and SNL. The analytical results were comparable; the difference may be attributed to analytical variations. If these samples were representative, the use of both sets of data would be recommended. However, Lambert and Harvey (1987) doubted the representativeness of the samples because of the low productivity of the well. The samples are not considered representative.

5.4.15 WIPP-25 Rustler/Salado (Table 124)

The Rustler/Salado contact zone at WIPP-25 was sampled by the USGS and SNL in 1980. The USGS laboratory results for their sample seem to be internally consistent, as do the UNC/Bendix results for the SNL sample. However, the USGS sample contained significantly less Cl^-, Na, and K than the SNL sample. The representativeness of the USGS sample is questioned. The SNL sample is tentatively considered representative with respect to the major solutes, and the UNC/Bendix major-solute data are recommended.

5.4.16 WIPP-26 Rustler/Salado (Table 125)

The Rustler/Salado contact zone at WIPP-26 was sampled by the USGS and SNL in 1980. The USGS laboratory results for their sample seem to be internally consistent, as do the UNC/Bendix results for the SNL sample. However, the USGS sample contained significantly less Cl^- and Na and more Ca than the SNL sample. The representativeness of the USGS sample is

questioned. The SNL sample is tentatively considered representative with respect to the major solutes, and the UNC/Bendix major-solute data are recommended.

5.4.17 WIPP-27 Rustler/Salado (Table 126)

The Rustler/Salado contact zone in WIPP-27 was sampled by the USGS and SNL in 1980. The USGS laboratory results seem to be internally consistent. However, SNL was unable to collect a representative sample at this site (see Section 3.3.2.1). As SNL's final serial-sampling results showed significantly less Cl^- and more X^{++} than the USGS final sample, the representativeness of the USGS sample is doubted. A representative sample of water from the Rustler/Salado contact zone in WIPP-27 has probably not been collected.

5.4.18 WIPP-28 Rustler/Salado (Table 127)

The Rustler/Salado contact zone at WIPP-28 was sampled by the USGS and SNL in 1980. The USGS laboratory results for their sample seem to be internally consistent, as do the UNC/Bendix results for the SNL sample. However, the USGS sample contained significantly lower amounts of the major solutes, except Ca, than the SNL sample. The representativeness of the USGS sample is questioned. The SNL sample is tentatively considered representative with respect to the major solutes, and the UNC/Bendix major-solute data are recommended.

5.4.19 WIPP-29 Rustler/Salado (Table 128)

The Rustler/Salado contact zone at WIPP-29 was sampled by the USGS and SNL in 1980. The USGS laboratory results for their sample seem to be internally consistent, as do the UNC/Bendix results for the SNL sample. However, the USGS sample contained significantly lower amounts of the major solutes, except $SO_4^=$, than the SNL sample. The representativeness of the USGS sample is questioned. The SNL sample is tentatively considered representative with respect to the major solutes, and the UNC/Bendix major-solute data are recommended.

5.4.20 WIPP-30 Rustler/Salado (Table 129)

The Rustler/Salado contact zone at WIPP-30 was sampled by the USGS and SNL in 1980. The USGS laboratory results for their sample seem to be internally consistent, as do the UNC/Bendix results for the SNL sample. However, the USGS sample contained smaller amounts of the major solutes, except Na, than the SNL sample. Although most of the observed differences could be caused by analytical variation, the possibility that the USGS sample was not representative cannot be ruled out. The SNL sample is tentatively considered representative with respect to the major solutes, and the UNC/Bendix major-solute data are recommended.

5.5 Preliminary Evaluation of Data from the Dewey Lake Red Beds

5.5.1 Pocket Well Dewey Lake (Table 130)

Pocket Well was sampled by HGC in 1983 (see Section 3.5.2.6). The UNC/Bendix analytical results seem to be internally consistent. Two samples were sent to the KGS for halide analysis. The Cl^-, Br^-, and I^- contents of one sample were 1.6 times higher than in the other sample; this difference is not understood. The lower Cl^- value agrees with that obtained by UNC/Bendix. Except for the one apparently anomalously salty halide sample sent to the KGS, there is no reason to doubt the representativeness of the samples, which were collected after a five-day pumping test. However, because the sample-collection and analytical procedures are not very well documented, the data should be used with caution.

5.5.2 Ranch Well Dewey Lake (Table 131)

Ranch Well was sampled during round one of the WQSP in 1986. It was sampled again during the private well sampling portion of the WQSP; field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

Round-one samples were analyzed by UNC/Bendix and ITAS. Both sets of data seem to be internally consistent and are in reasonable agreement. The results from both laboratories are considered reliable. The samples are thought to be representative with respect to the major solutes, and the major-solute results from UNC/Bendix and ITAS are recommended.

5.5.3 Twin Wells/Pasture Well Dewey Lake (Table 132)

The Twin Wells/Pasture Well was sampled during round one of the WQSP in 1986. It was sampled again during the private well sampling portion of the WQSP; field and ITAS laboratory data are given in Lyon (1989).

Round-one samples were analyzed by UNC/Bendix, ITAS, and the EEG. The UNC/Bendix results seem internally consistent if the field alkalinity, rather than the laboratory value, is used to calculate the CBE. The EEG results also seem internally consistent; the field alkalinity must be used to calculate the CBE because the laboratory alkalinity was not reported. The ITAS results are not internally consistent; the CBE is -21% (even when alkalinity is included).

All results are comparable with two exceptions: the ITAS $SO_4^=$ value is a factor of four higher than the values reported by the other laboratories (and is probably the cause of the large negative CBE) and the EEG Ca value seems to be ~25% low. The results from all three laboratories are considered reliable with the exception of the ITAS $SO_4^=$ and EEG Ca values.

The samples are considered representative with respect to the major solutes. The major-solute results from all three laboratories are recommended, with the exceptions of the ITAS $SO_4^=$ and EEG Ca values.

5.5.4 Unger Well Dewey Lake (Table 133)

Unger Well was sampled by HGC in 1984 (see Section 3.5.2.7). It was sampled again during the private well sampling portion of the WQSP; field and ITAS laboratory data are given in Randall et al. (1988) and Lyon (1989).

The UNC/Bendix solute data for the 1984 sample seem to be internally consistent. The UNC/Bendix Cl^- result agrees with that obtained by the KGS in the sample sent for halide analysis. There is no reason to doubt the representativeness of the 1984 samples, which were collected after a lengthy pumping test. However, the data should be used with caution until they can be compared with the WQSP data.

5.6 Preliminary Evaluation of Data from Other Formations

5.6.1 DOE-2 Bell Canyon (Table 134)

The Hayes Sandstone member of the Bell Canyon Formation in DOE-2 was sampled by WQSP personnel in 1985. This location is not scheduled to be sampled again. Samples were analyzed by UNC/Bendix and the EEG; ITAS did not determine major solutes in their sample. The UNC/Bendix and EEG data sets seem to be internally consistent, but for reasons that are not understood, the EEG results are systematically lower that those of UNC/Bendix. Because the UNC/Bendix Cl^- and X^{++} results agree more closely with the field data, the UNC/Bendix results are tentatively considered more reliable. The samples are thought to be representative with respect to the major solutes, and the UNC/Bendix major-solute results are recommended.

5.6.2 WIPP-15 Alluvium (Table 135)

WIPP-15 was sampled by the USGS in 1979. Water from this well is thought to come from the alluvium (Lambert and Harvey, 1987). SNL analyzed the sample; the laboratory results appear to be internally consistent. However, because the representativeness of the sample cannot be evaluated, the data should be used with caution.

5.7 Summary

5.7.1 Representativeness of Samples

In general, samples are considered representative with respect to the major solutes if serial-sampling values for Cl^- and X^{++} reached steady state before the final samples were collected.

Representative samples have not been collected from certain locations, including the Culebra at H-2, the Magenta at WIPP-30, the Rustler/Salado at WIPP-27, and possibly several other locations where the only samples were collected by bailing or swabbing.

The representativeness of samples collected by bailing or swabbing must be considered doubtful, unless analyses of later samples are in close agreement with the analyses of the bailed or swabbed sample or until another method of verifying sample representativeness is developed.

At this time we do not understand the variations observed in samples collected at different times from the Culebra at WIPP-25 and WIPP-26 and from the Magenta at H-4 and H-5.

5.7.2 Reliability of Analyses

Given only a single set of laboratory analyses for a location, the analytical results are considered adequate if they seem to be internally consistent, but this does not mean that the sample was necessarily representative. Also, despite apparent internal consistency, some values may be in error. For example, many USGS potassium values are apparently in error by factors of ~100, although the small CBEs indicate apparent internal consistency. Thus, the tentative designation of "adequate" for a single set of results is subject to change if other data become available.

The UNC/Bendix analytical results are generally considered the most reliable. They show good precision, good spike recovery, small CBEs, and good agreement with the field results.

The EEG analyses are thought to be of high quality, as they show small CBE and usually good agreement with the field results. However, results for some samples vary systematically from both the field and the UNC/Bendix results. The cause of the variations has not yet been thoroughly investigated.

Similarly, much of the ITAS analytical work is thought to be of good quality. However, the results for some samples showed large CBEs and/or rather large differences for some solutes between the ITAS results and the results from the field and the UNC/Bendix and EEG laboratories. The differences noted between the ITAS results and the results from the other laboratories and the field are not all understood. But since the time this report was started, some of the differences have been investigated by personnel from the MOC and ITAS. Some analytical procedures used by ITAS were changed during round two of the WQSP, and the ITAS major-solute results from rounds two and three (Uhland et al., 1987; Randall et al., 1988; Lyon, 1989) are tentatively thought to be reliable.

All minor and trace solute data must be used with extreme caution until the sample representativeness and quality of analyses for these analytes can be evaluated.

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Table 1. List of Wells and Zones Sampled by the WQSP, HGC, SNL, and/or the USGS from 1976 to 1986 (WIPP wells are listed first, alphabetically, followed by the stock wells.)

Well Name[1]	Abbrev[2]	Synonyms[3]	Zones[4]	Refs[5]
DOE-1	DOE-1		Cul	b,w
DOE-2	DOE-2	DOE-II	Cul,BC	j,w
FR-10	FR-10	H-13,RF-10[6]	Cul	--
H-1	H-1		Mag,Cul,RS	i,l,t,w
H-2A	H-2A		Mag,Cul	g,i,l,t,w
H-2B1	H-2B1	H-2B[7]	Cul	i,l,t,w
H-2C	H-2C		Cul,RS	i,l,t,w
H-3B1	H-3B1	H-3,H-3A,H-3B[8]	Mag,Cul,RS	i,l,t,w
H-3B2	H-3B2		Cul	g,w
H-3B3	H-3B3		Cul	g,w
H-4A	H-4A		Mag	i,k,t,w
H-4B	H-4B		Cul	i,k,t,w
H-4C	H-4C		Mag,Cul,RS	i,k,t,w
H-5A	H-5A		Mag	d,i,t,w
H-5B	H-5B		Cul	d,i,t,w
H-5C	H-5C		Mag,Cul,RS	d,i,t,w
H-6A	H-6A		Mag	c,i,t,w
H-6B	H-6B		Cul	c,i,t,w
H-6C	H-6C		Mag,Cul,RS	c,i,t,w
H-7B1	H-7B1	H-7B[9]	Cul	e,i,t,w
H-7C	H-7C		RS	e,i,t,w
H-8A	H-8A		Mag	i,t,u,w
H-8B	H-8B		Cul	i,t,u,w
H-8C	H-8C		RS	i,t,u,w
H-9A	H-9A		Mag	f,g,i,t,w
H-9B	H-9B		Cul	f,i,t,w
H-9C	H-9C		RS	f,i,t,w
H-10A	H-10A		Mag	i,t,v,w
H-10B	H-10B		Cul	i,t,v,w
H-10C	H-10C		RS	i,t,v,w
H-11B3	H-11B3		Cul	g,w
H-12	H-12		Cul	g,w
P-14	P-14		Cul,RS	h,i,l,t,w
P-15	P-15		Cul,RS	h,i,l,t,w
P-17	P-17		Cul,RS	h,i,l,t,w
P-18	P-18		Cul,RS	h,i,l,t,w
WIPP-15	W-15		Alluvium	i,s,t
WIPP-25	W-25		Mag,Cul,RS	i,m,t,w
WIPP-26	W-26		Cul,RS	i,n,t,w
WIPP-27	W-27		Mag,Cul,RS	i,o,t,w

Table 1. List of Wells and Zones Sampled by the WQSP, HGC, SNL,and/or the USGS from 1976 to 1986 (continued)

Well Name[1]	Abbrev[2]	Synonyms[3]	Zones[4]	Refs[5]
WIPP-28	W-28		Cul,RS	i,p,t,w
WIPP-29	W-29		Cul,RS	i,q,t,w
WIPP-30	W-30		Mag,Cul,RS	i,r,t,w
Engle Well	ENGLE	Ingle[10]	Cul	a,w
Pocket Well	POCKET	Walker[11]	DL	a,w,x
Ranch Well	RANCH	Ranch Headqtrs[12]	DL	a,w,x
Twin Wells - Pasture	TWIN-P	see footnote[13]	DL	w
Unger Well	UNGER	Inger[14]	DL	a,w

1. Well names used in this report (see Section 1.3.1).
2. Abbreviations used in some data tables in this report.
3. Synonyms or other names that have been used in published reports or in unpublished field notes and/or memoranda.
4. Stratigraphic zones sampled:
   BC - Bell Canyon Formation
   Cul - Culebra Dolomite
   DL - Dewey Lake Red Beds
   Mag - Magenta Dolomite
   RS - Rustler/Salado contact zone
5. References containing details about well locations and histories. Complete citations are in Section 6.
   a. Cooper and Glanzman, 1971
   b. D'Appolonia, 1982 = Freeland, 1982
   c. Dennehy, 1982
   d. Dennehy and Mercer, 1982
   e. Drellack and Wells, 1982a
   f. Drellack and Wells, 1982b
   g. Hydro Geo Chem, 1985
   h. Jones, 1978
   i. Mercer, 1983
   j. Mercer et al., 1987
   k. Mercer et al., 1981
   l. Mercer and Orr, 1979
   m. SNL and USGS, 1979a
   n. SNL and USGS, 1979b
   o. SNL and USGS, 1979c
   p. SNL and USGS, 1979d
   q. SNL and USGS, 1979e
   r. SNL and USGS, 1980
   s. SNL and UNM, 1981
   t. Seward, 1982
   u. Wells and Drellack, 1982
   v. Wells and Drellack, 1983
   w. Winstanley and Carrasco, 1986
   x. Cooley, 1973
6. Well was originally designated H-13 and is referred to by this name in field notes and in several laboratory reports. "RF-10" appears to be a typographical error that was propagated through several requests for analysis and laboratory reports.
7. H-2 was originally a three-well hydropad, with the wells designated H-2A, H-2B, and H-2C. An additional well was drilled and completed in the Culebra in 1983 and was designated H-2B2. The original "B" well is now usually designated H-2B1.
8. H-3 was originally a single-well hydropad, with the well designated H-3. Two additional wells were drilled in 1983 and 1984 and were designated H-3B2 and H-3B3. The original well is now usually designated H-3B1 but has appeared in some documents as H-3A or H-3B.

Table 1. List of Wells and Zones Sampled by the WQSP, HGC, SNL and/or the USGS from 1976 to 1986 (continued)

9. H-7 was originally a three-well hydropad, with the wells designated H-7A, H-7B, and H-7C. An additional well was drilled in 1983 and designated H-7B2. The original H-7B well is now usually designated H-7B1.

10. Engle Well was called "Ingle" well by Cooper and Glanzman (1971; location 24.31.4.430) and is called Engles Windmill on the Big Sinks Quadrangle map (USGS 7½-minute topographic series).

11. Pocket Well was called "Walker" well by Cooper and Glanzman (1971; location 23.31.29.113) and is shown as an unnamed windmill on the Los Medaños Quadrangle map (USGS 7½-min. topographic series).

12. Ranch Well was called "Ranch Headquarters" well by Cooper and Glanzman (1971; location 23.31.6.444).

13. Two wells are located on Twin Wells Ranch (NW¼ of T24S, R31E, S17; Big Sinks Quadrangle, USGS 7½-min. topographic series). The Twin Wells - House well corresponds to the "Ranch Headquarters" well of Cooper and Glanzman (1971; location 24.31.17.111); the Twin Wells - Pasture well is not mentioned in Cooper and Glanzman (1971). Both wells are included in the database of Winstanley and Carrasco (1986).

14. Unger Well was misspelled as "Inger" well in a series of field notes, requests for analysis, and laboratory reports. It was called "Unger" well by Cooper and Glanzman (1971; location 23.31.17.310) and is shown as an unnamed windmill on the Los Medaños Quadrangle map (USGS 7½-min. topographic series).

Table 2. List of Tests in Which Samples Were Collected and Analyzed for Solutes
(Wells are grouped first by stratigraphic zone --in the order Culebra, Magenta, Rustler/Salado contact zone, Dewey Lake, Bell Canyon, and alluvium -- and then by hydropad, with the WIPP wells first, alphabetically, followed by the stock wells.)

Well Abbrev[1]	Strat. Zone[2]	Date	Agency[3]	Average Pumping Rate	Approx. Vol. Pumped[4]	Refs[5]
DOE-1	Cul	Apr 83	HGC	30 gph (0.5 gpm)	>4000 gal	c,q
DOE-1	Cul	Apr 85	WQSP-R1	500 gph (8.3 gpm)	135000 gal	o,q
DOE-2	Cul	Mar 85	WQSP-R1	380 gph (6.3 gpm)	178000 gal	i,o,q
FR-10	Cul	Oct 83	HGC	pump pulse test	~200 gal	
H-1	Cul	Jun 76	USGS	bail or swab	--	h,k,q
H-1	Cul	Mar 77	USGS	bail or swab	--	k,q
H-2B1	Cul	Feb 77	USGS	bail or swab	--	h,k,q
H-2C	Cul	Mar 77	USGS	bail or swab	--	k,q
H-2C	Cul	Dec 80	SNL	recirc. tracer test	--	c,d,q
H-2A	Cul	Apr 86	WQSP-R1	23 gph	9700 gal	o,q
H-3B1	Cul	Mar 77	USGS	bail or swab	--	h,k,q
H-3B3	Cul	Jun 84	HGC	180 gph (3 gpm)	---	q
H-3B3	Cul	Feb 85	WQSP-R1	180 gph (3 gpm)	16000 gal	o,q
H-3B2	Cul	Dec 85	WQSP-R1	290 gph (4.8 gpm)	---	p,q,r
H-4B	Cul	Dec 78	USGS	bail or swab	--	h,j,q
H-4B	Cul	May 81	SNL	15 gph	~3000 gal	c,q
H-4C	Cul	Aug 84	HGC	30 gph	---	e,q
H-4B	Cul	Jul 85	WQSP-R1	20 gph	3600 gal	o,q
H-5B	Cul	Dec 78	USGS	bail or swab	--	b,h,q
H-5B	Cul	Jun 81	SNL	12 gph	~1000 gal	c,q
H-5C	Cul	Oct 81	SNL	7.5 gph	~1400 gal	c,q
H-5B	Cul	Aug 85	WQSP-R1	8 gph	1100 gal	o,q
H-6B	Cul	Dec 78	USGS	bail or swab	--	a,h,q
H-6B	Cul	May 81	SNL	1400 gph (23 gpm)	~33000 gal	c,q
H-6C	Cul	May 81	SNL	1100 gph (19 gpm)	~150000 gal	c,q
H-6B	Cul	Sep 85	WQSP-R1	330 gph (5.5 gpm)	80000 gal	o,q
H-7B1	Cul	Mar 80	USGS	bail or swab	--	h,l,q
H-7B1	Cul	Mar 86	WQSP-R1	270 gph (4.5 gpm)	39000 gal	o,q
H-8B	Cul	Feb 80	USGS	bail or swab	--	h,l,q
H-8B	Cul	Jan 86	WQSP-R1	40 gph	11000 gal	o,q
H-9B	Cul	Feb 80	USGS	bail or swab	--	h,l,q
H-9B	Cul	Oct 83	HGC	600 gph (10 gpm)	>500 gal	f,q
H-9B	Cul	Nov 85	WQSP-R1	38 gph	8400 gal	o,q
H-10B	Cul	Mar 80	USGS	bail or swab	--	h,l,q
H-11B3	Cul	Jun 85	WQSP-R1	330 gph (5.5 gpm)	109000 gal	o,q

Table 2. List of Tests in Which Samples Were Collected and Analyzed for Solutes (continued)

Well Abbrev[1]	Strat. Zone[2]	Date	Agency[3]	Average Pumping Rate	Approx. Vol. Pumped[4]	Refs[5]
H-12	Cul	Jan 84	HGC	8.4 gph	~800 gal	f,q
H-12	Cul	Jan 84	HGC	13.5 gph	~700 gal	q
H-12	Cul	Aug 85	WQSP-R1	17 gph	2400 gal	o,q
P-14	Cul	Mar 77	USGS	bail or swab	--	h,k,q
P-14	Cul	Feb 86	WQSP-R1	33 gph	6500 gal	o,q
P-15	Cul	May 77	USGS	bail or swab	--	h,k,q
P-15	Cul	Apr 79	USGS	bail or swab	--	h,q
P-17	Cul	May 77	USGS	bail or swab	--	h,k,q
P-17	Cul	Mar 86	WQSP-R1	30 gph (0.5 gpm)	8700 gal	o,q
P-18	Cul	May 77	USGS	bail or swab	--	h,k,q
W-25	Cul	Aug 80	USGS	bail or swab	--	h,m,q
W-25	Cul	Aug 80	SNL	2000 gph (33 gpm)	55000 gal	g,q
W-25	Cul	Feb 86	WQSP-R1	430 gph (7.1 gpm)	164000 gal	o,q
W-26	Cul	Aug 80	USGS	bail or swab	--	h,m,q
W-26	Cul	Aug 80	SNL	2000 gph (34 gpm)	53000 gal	g,q
W-26	Cul	Nov 85	WQSP-R1	52 gph[6]	61000 gal	o,q
W-27	Cul	Aug 80	USGS	bail or swab	--	h,m,q
W-27	Cul	Sep 80	SNL	1500 gph (25 gpm)	30000 gal	g,q
W-28	Cul	Aug 80	USGS	bail or swab	--	h,m,q
W-28	Cul	Sep 80	SNL	1000 gph (17 gpm)	46000 gal	g,q
W-29	Cul	Aug 80	USGS	bail or swab	--	h,m,q
W-29	Cul	Aug 80	SNL	2200 gph (37 gpm)	98000 gal	g,q
W-29	Cul	Dec 85	WQSP-R1	60 gph[7]	138000 gal	o,q
W-30	Cul	Aug 80	USGS	bail or swab	--	h,m,q
W-30	Cul	Sep 80	SNL	12 gph[8]	1000 gal	g,q
ENGLE	Cul	Nov 83	HGC	590 gph (9.8 gpm)	~70000 gal	q
ENGLE	Cul	Mar 85	WQSP-R1	50 gph (0.8 gpm)	7500 gal	o,q
H-1	Mag	Jun 76	USGS	bail or swab	--	h,k,q
H-1	Mag	May 77	USGS	bail or swab	--	h,k,q
H-2A	Mag	Feb 77	USGS	bail or swab	--	h,k,q
H-3B1	Mag	May 77	USGS	bail or swab	--	h,k,q
H-3B1	Mag	May 79	USGS	bail or swab	--	h,q
H-3B1	Mag	Jul 85	WQSP-R1	14 gph	3800 gal	o,q
H-4A	Mag	Dec 78	USGS	bail or swab	--	h,j,q
H-4C	Mag	Nov 86	WQSP-R1	4 gph	700 gal	p,q
H-5A	Mag	Dec 78	USGS	bail or swab	--	b,h,q
H-5C	Mag	Oct 86	WQSP-R1	13 gph	5800 gal	p,q
H-6A	Mag	Dec 78	USGS	bail or swab	--	a,h,q
H-6C	Mag	Oct 86	WQSP-R1	24 gph	7000 gal	p,q

Table 2. List of Tests in Which Samples Were Collected and Analyzed for Solutes (continued)

Well Abbrev[1]	Strat. Zone[2]	Date	Agency[3]	Average Pumping Rate	Approx. Vol. Pumped[4]	Refs[5]
H-8A	Mag	Feb 80	USGS	bail or swab	--	h,l,q
H-8A	Mag	Oct 85	WQSP-R1	40 gph	25 gal	o,q
H-9A	Mag	Feb 80	USGS	bail or swab	--	h,l,q
H-10A	Mag	Mar 80	USGS	bail or swab	--	h,l,q
W-25	Mag	Sep 80	USGS	bail or swab	--	h,m,q
W-25	Mag	Sep 80	SNL	2000 gph (34 gpm)	51000 gal	g,q
W-27	Mag	Sep 80	USGS	bail or swab	--	h,m,q
W-27	Mag	Sep 80	SNL	560 gph (9.4 gpm)	15000 gal	g,q
W-30	Mag	Sep 80	USGS	bail or swab	--	h,m,q
W-30	Mag	Dec 80	SNL	<100 mL/min[9]		g,q
H-1	RS	Feb 77	USGS	bail or swab	--	h,k,q
H-2C	RS	Feb 77	USGS	bail or swab	--	h,k,q
H-3B1	RS	Feb 77	USGS	bail or swab	--	h,k,q
H-4C	RS	Mar 79	USGS	bail or swab	--	h,j,q
H-5C	RS	May 79	USGS	bail or swab	--	b,h,q
H-6C	RS	Apr 79	USGS	bail or swab	--	a,h,q
H-7C	RS	Mar 80	USGS	bail or swab	--	a,l,q
H-8C	RS	Sep 80	USGS	bail or swab	--	h,l,q
H-9C	RS	May 80	USGS	bail or swab	--	h,l,q
H-10C	RS	May 80	USGS	bail or swab	--	h,l,q
P-14	RS	Feb 77	USGS	bail or swab	--	h,k,q
P-15	RS	Apr 79	USGS	bail or swab	--	h,q
P-17	RS	May 79	USGS	bail or swab	--	h,q
P-18	RS	May 79	USGS	bail or swab	--	h,q
W-25	RS	Mar 80	USGS	bail or swab	--	h,m,q
W-25	RS	Jul 80	SNL	70 gph (1.1 gpm)	1800 gal	g,q
W-26	RS	Mar 80	USGS	bail or swab	--	h,m,q
W-26	RS	Jul 80	SNL	25 gph (0.42 gpm)	900 gal	g,q
W-27	RS	May 80	USGS	bail or swab	--	h,m,q
W-27	RS	Aug 80	SNL	4.2 gph[10]	100 gal	g,q
W-28	RS	Mar 80	USGS	bail or swab	--	h,m,q
W-28	RS	Jul 80	SNL	190 gph (3.1 gpm)	7600 gal	g,q
W-29	RS	Mar 80	USGS	bail or swab	--	h,m,q
W-29	RS	Jul 80	SNL	90 gph (1.5 gpm)	4100 gal	g,q
W-30	RS	Mar 80	USGS	bail or swab	--	h,m,q
W-30	RS	Jul 80	SNL	13 gph (0.22 gpm)	590 gal	g,q

Table 2. List of Tests in Which Samples Were Collected and Analyzed for Solutes (continued)

Well Abbrev[1]	Strat. Zone[2]	Date	Agency[3]	Average Pumping Rate	Approx. Vol. Pumped[4]	Refs[5]
POCKET	DL	Nov 83	HGC	510 gph (8.6 gpm)	>40000 gal	q
RANCH	DL	Jun 86	WQSP-R1	160 gph (2.7 gpm)	20000 gal	p,q
TWIN-P	DL	Jan 86	WQSP-R1	33 gph	5000 gal	o,q
UNGER	DL	Jan 84	HGC	570 gph (9.6 gpm)	~17000 gal	q
DOE-2	BC	Jul 85	WQSP-R1	250 gal per swab	>10000 gal	i,o,q
W-15	Alluvium	Mar 79	USGS	bail or swab	--	n

1. Abbreviations of well names are are explained in Table 1.

2. Stratigraphic zone sampled:
   BC - Bell Canyon Formation
   Cul - Culebra Dolomite
   DL - Dewey Lake Red Beds
   Mag - Magenta Dolomite
   RS - Rustler/Salado contact zone

3. Agency or program responsible for sample collection:
   HGC - Hydro Geo Chem, Inc., Tucson, AZ
   SNL - Sandia National Laboratories, Albuquerque, NM
   USGS - United States Geological Survey
   WQSP-R1 - Round One of the Water Quality Sampling Program

4. Approximate volume of water removed from the well before final samples were collected.

5. References containing information about hydrologic testing, equipment, well configuration during testing, and so forth. Complete citations are given in Section 6.

   a. Dennehy, 1982
   b. Dennehy and Mercer, 1982
   c. Hydro Geo Chem, 1985
   d. Hydro Geo Chem, 1986
   f. Intera and HGC, 1985
   g. Lambert and Robinson, 1984
   h. Mercer, 1983
   i. Mercer et al., 1987
   j. Mercer et al., 1981
   k. Mercer and Orr, 1979
   l. Richey, 1986
   m. Richey, 1987
   n. SNL and UNM, 1981
   o. Uhland and Randall, 1986
   p. Uhland et al., 1987
   q. Winstanley and Carrasco, 1986

6. Before serial sampling began, the well was purged at a pumping rate of 870 gph; 54500 gal were pumped from the well. For sampling, the pumping rate was reduced to 52 gph.

7. Before serial sampling, this well was purged for 63 hr at 33 gpm. For sampling, the pumping rate was reduced to 60 gph.

8. At the beginning of the test, the pumping rate was ~0.3 gpm; by the end of the test it was ~0.1 gpm. The average pumping rate was ~0.2 gpm (12 gph).

9. At the beginning of the test, the pumping rate was ~100 mL/min; the rate decreased to ~50 mL/min by the end of the test.

10. The pumping rate was initially ~0.13 gpm and decreased to ~0.02 gpm during the test. The average pumping rate was ~0.07 gpm (4.2 gph).

Table 3. List of Samples for Which Data Are Included in This Report
(Samples are ordered by stratigraphic zone (Cul, Mag, RS, DL, BC, alluvium), then by hydropad (WIPP wells precede stock wells), and then by test.)

Well Abbrev[1]	Strat. Zone[2]	Collection Date(s)[3]	Agency[4]	Lab[5]	Sample ID[6]
DOE-1	Cul	04/13/83-04/21/83	HGC	FLD	D1.C483F
DOE-1	Cul	04/19/83	HGC	KCS	D1.C483KC
DOE-1	Cul	04/12/85 - 04/25/85	WQSP-R1	FLD	D1.C485F
DOE-1	Cul	04/24,25/85	WQSP-R1	BFEC	D1.C485B
DOE-1	Cul	04/24,25/85	WQSP-R1	EEG	D1.C485E
DOE-1	Cul	04/24/85	WQSP-R1	ITAS	D1.C485Ia
DOE-1	Cul	04/25/85	WQSP-R1	ITAS	D1.C485Ib
DOE-2	Cul	02/20/85 - 03/12/85	WQSP-R1	FLD	D2.C385F
DOE-2	Cul	03/11,12/85	WQSP-R1	BFEC	D2.C385B
DOE-2	Cul	03/11,12/85	WQSP-R1	EEG	D2.C385E
DOE-2	Cul	03/11,12/85	WQSP-R1	ITAS	D2.C385I
FR-10	Cul	10/06/83	HGC	FLD	FR10.C1083F
FR-10	Cul	10/06/83	HGC	H-B	FR10.C1083HB
FR-10	Cul	10/06/83	HGC	KCS	FR10.C1083KC
FR-10	Cul	10/06/83	HGC	KGS	FR10.C1083K
H-1	Cul	06/02/76	USGS	USGS	H01.C676G
H-1	Cul	03/17/77	USGS	USGS	H01.C377G
H-2B1	Cul	02/22/77	USGS	USGS	H02B1.C277G
H-2C	Cul	03/16/77	USGS	USGS	H02C.C377G
H-2C	Cul	12/10/80	SNL	FLD	H02C.C1280F
H-2A	Cul	04/04/86 - 04/21/86	WQSP-R1	FLD	H02A.C486F
H-2A	Cul	04/21/86	WQSP-R1	BFEC	H02A.C486B
H-2A	Cul	04/21/86	WQSP-R1	ITAS	H02A.C486I
H-3B1	Cul	03/17/77	USGS	USGS	H03B1.C377G
H-3B3	Cul	06/10/84-06/11/84	HGC	FLD	H03B3.C684F
H-3B3	Cul	06/11/84	HGC	BFEC	H03B3.C684B
H-3B3	Cul	06/11/84	HGC	UA	H03B3.C684UA
H-3B3	Cul	01/29/85 - 02/04/85	WQSP-R1	FLD	H03B3.C285F
H-3B3	Cul	02/04/85	WQSP-R1	BFEC	H03B3.C285B
H-3B3	Cul	02/04/85	WQSP-R1	EEG	H03B3.C285E
H-3B3	Cul	02/04/85	WQSP-R1	ITAS	H03B3.C285I
H-3B3	Cul	02/04/85	WQSP-R1	UA	H03B3.C285UA
H-3B2	Cul	12/16/85	WQSP	ITAS	H03B2.C1285I
H-4B	Cul	12/14/78	USGS	USGS	H04B.C1278G
H-4B	Cul	05/14/81 - 05/29/81	SNL	FLD	H04B.C581F
H-4B	Cul	05/29/81	SNL	BFEC	H04B.C581B
H-4C	Cul	08/09/84-08/10/84	HGC	FLD	H04C.C884F
H-4C	Cul	08/10/84	HGC	BFEC	H04C.C884B

Table 3. List of Samples for Which Data Are Included in This Report (continued)

Well Abbrev[1]	Strat. Zone[2]	Collection Date(s)[3]	Agency[4]	Lab[5]	Sample ID[6]
H-4B	Cul	07/08/85 - 07/25/85	WQSP-R1	FLD	H04B.C785F
H-4B	Cul	07/20/85	WQSP-R1	BFEC	H04B.C785B
H-4B	Cul	07/25/85	WQSP-R1	EEG	H04B.C785E
H-4B	Cul	07/20/85	WQSP-R1	ITAS	H04B.C785I
H-5B	Cul	12/19/78	USGS	USGS	H05B.C1278G
H-5B	Cul	05/27/81 - 06/02/81	SNL	FLD	H05B.C681F
H-5B	Cul	06/01/81	SNL	BFEC	H05B.C681B
H-5C	Cul	10/07/81 - 10/15/81	SNL	FLD	H05C.C1081F
H-5C	Cul	10/15/81	SNL	BFEC	H05C.C1081B
H-5B	Cul	08/22/85 - 08/30/85	WQSP-R1	FLD	H05B.C885F
H-5B	Cul	08/26,27/85	WQSP-R1	BFEC	H05B.C885B
H-5B	Cul	08/26/85	WQSP-R1	EEG	H05B.C885E
H-5B	Cul	08/26/85	WQSP-R1	ITAS	H05B.C885I
H-6B	Cul	12/20/78	USGS	USGS	H06B.C1278G
H-6B	Cul	05/01/81 - 05/02/81	SNL	FLD	H06B.C581F
H-6B	Cul	05/02/81	SNL	BFEC	H06B.C581B
H-6C	Cul	05/12/81 - 05/27/81	SNL	FLD	H06C.C581F
H-6B	Cul	09/04/85 - 09/16/85	WQSP-R1	FLD	H06B.C985F
H-6B	Cul	09/15/85	WQSP-R1	BFEC	H06B.C985B
H-6B	Cul	09/15/85	WQSP-R1	EEG	H06B.C985E
H-6B	Cul	09/15/85	WQSP-R1	ITAS	H06B.C985I
H-7B1	Cul	03/20/80	USGS	USGS	H07B1.C380G
H-7B1	Cul	03/20/86 - 03/27/86	WQSP-R1	FLD	H07B1.C386F
H-7B1	Cul	03/26/86	WQSP-R1	BFEC	H07B1.C386B
H-7B1	Cul	03/27/86	WQSP-R1	ITAS	H07B1.C386I
H-8B	Cul	02/11/80	USGS	USGS	H08B.C280G
H-8B	Cul	01/09/86 - 01/23/86	WQSP-R1	FLD	H08B.C186F
H-8B	Cul	01/22/86	WQSP-R1	BFEC	H08B.C186B
H-8B	Cul	01/22/86	WQSP-R1	EEG	H08B.C186E
H-8B	Cul	01/21-23/86	WQSP-R1	ITAS	H08B.C186I
H-9B	Cul	02/05/80	USGS	USGS	H09B.C280G
H-9B	Cul	10/07/83	HGC	FLD	H09B.C1083F
H-9B	Cul	10/07/83	HGC	H-B	H09B.C1083HB
H-9B	Cul	10/07/83	HGC	KCS	H09B.C1083KC
H-9B	Cul	10/07/83	HGC	KGS	H09B.C1083K
H-9B	Cul	10/30/85 - 11/14/85	WQSP-R1	FLD	H09B.C1185F
H-9B	Cul	11/14/85	WQSP-R1	BFEC	H09B.C1185B
H-9B	Cul	11/14/85	WQSP-R1	EEG	H09B.C1185E
H-9B	Cul	11/14/85	WQSP-R1	ITAS	H09B.C1185I
H-10B	Cul	03/21/80	USGS	USGS	H10B.C380G

Table 3. List of Samples for Which Data Are Included in This Report (continued)

Well Abbrev[1]	Strat. Zone[2]	Collection Date(s)[3]	Agency[4]	Lab[5]	Sample ID[6]
H-11B3	Cul	05/13/85 - 06/04/85	WQSP-R1	FLD	H11B3.C685F
H-11B3	Cul	06/03,04/85	WQSP-R1	BFEC	H11B3.C685B
H-11B3	Cul	06/03,04/85	WQSP-R1	EEG	H11B3.C685E
H-11B3	Cul	06/03/85	WQSP-R1	ITAS	H11B3.C685I
H-12	Cul	01/07/84-01/12/84	HGC	FLD	H12.C184F
H-12	Cul	01/11/84	HGC	H-B	H12.C184HBa
H-12	Cul	01/11/84	HGC	KGS	H12.C184Ka
H-12	Cul	01/11/84	HGC	UA	H12.C184UAa
H-12	Cul	01/25/84	HGC	H-B	H12.C184HBb
H-12	Cul	01/25/84	HGC	KGS	H12.C184Kb
H-12	Cul	08/01/85 - 08/09/85	WQSP-R1	FLD	H12.C885F
H-12	Cul	08/08/85	WQSP-R1	BFEC	H12.C885B
H-12	Cul	08/09/85	WQSP-R1	EEG	H12.C885E
H-12	Cul	08/09/85	WQSP-R1	ITAS	H12.C885I
P-14	Cul	03/14/77	USGS	USGS	P14.C377G
P-14	Cul	02/18/86 - 02/27/86	WQSP-R1	FLD	P14.C286F
P-14	Cul	02/26/86	WQSP-R1	BFEC	P14.C286B
P-14	Cul	02/26/86	WQSP-R1	EEG	P14.C286E
P-14	Cul	02/26,27/86	WQSP-R1	ITAS	P14.C286I
P-15	Cul	05/10/77	USGS	USGS	P15.C577G
P-15	Cul	04/11/79	USGS	SNL	P15.C479S
P-17	Cul	05/10/77	USGS	USGS	P17.C577G
P-17	Cul	03/04/86 - 03/17/86	WQSP-R1	FLD	P17.C386F
P-17	Cul	03/17/86	WQSP-R1	BFEC	P17.C386B
P-17	Cul	03/17/86	WQSP-R1	EEG	P17.C386E
P-17	Cul	03/17/86	WQSP-R1	ITAS	P17.C386I
P-18	Cul	05/10/77	USGS	USGS	P18.C577G
W-25	Cul	08/14/80	USGS	USGS	W25.C880G
W-25	Cul	08/19/80 - 08/20/80	SNL	FLD	W25.C880F
W-25	Cul	08/20/80	SNL	BFEC	W25.C880B
W-25	Cul	01/31/86 - 02/13/86	WQSP-R1	FLD	W25.C286F
W-25	Cul	02/12/86	WQSP-R1	BFEC	W25.C286B
W-25	Cul	02/12/86	WQSP-R1	ITAS	W25.C286I
W-26	Cul	08/18/80	USGS	USGS	W26.C880G
W-26	Cul	08/23/80 - 08/24/80	SNL	FLD	W26.C880F
W-26	Cul	08/24/80	SNL	BFEC	W26.C880B
W-26	Cul	08/24/80	SNL	KCS	W26.C880KC
W-26	Cul	11/19/85 - 11/26/85	WQSP-R1	FLD	W26.C1185F
W-26	Cul	11/25/85	WQSP-R1	BFEC	W26.C1185B
W-26	Cul	11/25/85	WQSP-R1	EEG	W26.C1185E
W-26	Cul	11/25/85	WQSP-R1	ITAS	W26.C1185I

Table 3. List of Samples for Which Data Are Included in This Report (continued)

Well Abbrev[1]	Strat. Zone[2]	Collection Date(s)[3]	Agency[4]	Lab[5]	Sample ID[6]
W-27	Cul	08/22/80	USGS	USGS	W27.C880G
W-27	Cul	09/02/80 - 09/05/80	SNL	FLD	W27.C980F
W-27	Cul	09/03/80	SNL	BFEC	W27.C980B
W-28	Cul	08/21/80	USGS	USGS	W28.C880G
W-28	Cul	09/09/80 - 09/12/80	SNL	FLD	W28.C980F
W-28	Cul	09/11/80	SNL	BFEC	W28.C980B
W-28	Cul	09/11/80	SNL	KCS	W28.C980KC
W-29	Cul	08/20/80	USGS	USGS	W29.C880G
W-29	Cul	08/26/80 - 08/28/80	SNL	FLD	W29.C880F
W-29	Cul	08/28/80	SNL	BFEC	W29.C880B
W-29	Cul	08/28/80	SNL	KCS	W29.C880KC
W-29	Cul	12/05/85 - 12/15/85	WQSP-R1	FLD	W29.C1285F
W-29	Cul	12/14/85	WQSP-R1	BFEC	W29.C1285B
W-29	Cul	12/14/85	WQSP-R1	EEG	W29.C1285E
W-29	Cul	12/14/85	WQSP-R1	ITAS	W29.C1285I
W-30	Cul	08/13/80	USGS	USGS	W30.C880G
W-30	Cul	09/02/80 - 09/06/80	SNL	FLD	W30.C980F
W-30	Cul	09/06/80	SNL	BFEC	W30.C980B
W-30	Cul	09/06/80	SNL	KCS	W30.C980KC
ENGLE	Cul	11/04/83-11/10/83	HGC	FLD	XENG.C1183F
ENGLE	Cul	11/10/83	HGC	H-B	XENG.C1183HB
ENGLE	Cul	11/10/83	HGC	KGS	XENG.C1183K
ENGLE	Cul	11/10/83	HGC	UA	XENG.C1183UA
ENGLE	Cul	02/26/85 - 03/05/85	WQSP-R1	FLD	XENG.C385F
ENGLE	Cul	03/05/85	WQSP-R1	BFEC	XENG.C385B
ENGLE	Cul	03/04,05/85	WQSP-R1	EEG	XENG.C385E
ENGLE	Cul	03/04,05/85	WQSP-R1	ITAS	XENG.C385I
H-1	Mag	06/04/76	USGS	USGS	H01.M676G
H-1	Mag	05/10/77	USGS	USGS	H01.M577G
H-2A	Mag	02/22/77	USGS	USGS	H02A.M277G
H-3B1	Mag	05/10/77	USGS	USGS	H03B1.M577G
H-3B1	Mag	05/10/79	USGS	SNL	H03B1.M579S
H-3B1	Mag	06/17/85 - 07/02/85	WQSP-R1	FLD	H03B1.M785F
H-3B1	Mag	07/01/85	WQSP-R1	BFEC	H03B1.M785B
H-3B1	Mag	07/01/85	WQSP-R1	EEG	H03B1.M785E
H-3B1	Mag	07/01/85	WQSP-R1	ITAS	H03B1.M785I
H-4A	Mag	12/14/78	USGS	USGS	H04A.M1278G
H-4C	Mag	10/30/86 - 11/04/86	WQSP-R1	FLD	H04C.M1186F
H-4C	Mag	11/04/86	WQSP-R1	BFEC	H04C.M1186B
H-4C	Mag	11/04/86	WQSP-R1	ITAS	H04C.M1186I

Table 3. List of Samples for Which Data Are Included in This Report (continued)

Well Abbrev[1]	Strat. Zone[2]	Collection Date(s)[3]	Agency[4]	Lab[5]	Sample ID[6]
H-5A	Mag	12/14/78	USGS	USGS	H05A.M1278G
H-5C	Mag	10/07/86 - 10/24/86	WQSP-R1	FLD	H05C.M1086F
H-5C	Mag	10/24/86	WQSP-R1	BFEC	H05C.M1086B
H-5C	Mag	10/24/86	WQSP-R1	ITAS	H05C.M1086I
H-6A	Mag	12/20/78	USGS	USGS	H06A.M1278G
H-6C	Mag	09/22/86 - 10/01/86	WQSP-R1	FLD	H06C.M1086F
H-6C	Mag	10/01/86	WQSP-R1	BFEC	H06C.M1086B
H-6C	Mag	10/01/86	WQSP-R1	ITAS	H06C.M1086I
H-8A	Mag	02/12/80	USGS	USGS	H08A.M280G
H-8A	Mag	10/21/85	WQSP-R1	ITAS	H08A.M1085I
H-9A	Mag	02/05/80	USGS	USGS	H09A.M280G
H-10A	Mag	03/21/80	USGS	USGS	H10A.M380G
W-25	Mag	09/04/80	USGS	USGS	W25.M980G
W-25	Mag	09/16/80 - 09/18/80	SNL	FLD	W25.M980F
W-25	Mag	09/17/80	SNL	BFEC	W25.M980B
W-27	Mag	09/04/80	USGS	USGS	W27.M980G
W-27	Mag	09/24/80 - 09/25/80	SNL	FLD	W27.M980F
W-27	Mag	09/25/80	SNL	BFEC	W27.M980B
W-30	Mag	09/20/80	USGS	USGS	W30.M980G
W-30	Mag	12/02/80 - 12/10/80	SNL	FLD	W30.M1280F
H-1	RS	02/23/77	USGS	USGS	H01.R277G
H-2C	RS	02/23/77	USGS	USGS	H02C.R277G
H-3B1	RS	02/23/77	USGS	USGS	H03B1.R277G
H-4C	RS	03/16/79	USGS	SNL	H04C.R379S
H-4C	RS	03/16/79	USGS	USGS	H04C.R379G
H-5C	RS	05/16/79	USGS	SNL	H05C.R579S
H-5C	RS	05/16/79	USGS	USGS	H05C.R579G
H-6C	RS	04/09/79	USGS	SNL	H06C.R479S
H-6C	RS	04/09/79	USGS	USGS	H06C.R479G
H-7C	RS	03/20/80	USGS	USGS	H07C.R380G
H-8C	RS	09/06/80	USGS	USGS	H08C.R980G
H-9C	RS	05/20/80	USGS	USGS	H09C.R580G
H-10C	RS	05/19/80	USGS	USGS	H10C.R580G
P-14	RS	02/24/77	USGS	USGS	P14.R277G

Table 3. List of Samples for Which Data Are Included in This Report (continued)

Well Abbrev[1]	Strat. Zone[2]	Collection Date(s)[3]	Agency[4]	Lab[5]	Sample ID[6]
P-15	RS	04/03/79	USGS	SNL	P15.R479S
P-15	RS	04/03/79	USGS	USGS	P15.R479G
P-17	RS	05/11/79	USGS	SNL	P17.R579S
P-17	RS	05/11/79	USGS	USGS	P17.R579G
P-18	RS	05/11/79	USGS	SNL	P18.R579S
P-18	RS	05/11/79	USGS	USGS	P18.R579G
W-25	RS	03/19/80	USGS	USGS	W25.R380G
W-25	RS	07/16/80 - 07/17/80	SNL	FLD	W25.R780F
W-25	RS	07/17/80	SNL	BFEC	W25.R780B
W-26	RS	03/18/80	USGS	USGS	W26.R380G
W-26	RS	07/22/80 - 07/23/80	SNL	FLD	W26.R780F
W-26	RS	07/23/80	SNL	BFEC	W26.R780B
W-27	RS	05/21/80	USGS	USGS	W27.R580G
W-27	RS	08/05/80 - 08/07/80	SNL	FLD	W27.R780F
W-28	RS	03/20/80	USGS	USGS	W28.R380G
W-28	RS	07/30/80 - 07/31/80	SNL	FLD	W28.R780F
W-28	RS	07/31/80	SNL	BFEC	W28.R780B
W-29	RS	03/18/80	USGS	USGS	W29.R380G
W-29	RS	07/22/80 - 07/24/80	SNL	FLD	W29.R780F
W-29	RS	07/24/80	SNL	BFEC	W29.R780B
W-30	RS	03/19/80	USGS	USGS	W30.R380G
W-30	RS	07/16/80 - 07/17/80	SNL	FLD	W30.R780F
W-30	RS	07/17/80	SNL	BFEC	W30.R780B
POCKET	DL	10/27/83-11/02/83	HGC	FLD	XPOC.D1183F
POCKET	DL	11/02/83	HGC	H-B	XPOC.D1183HB
POCKET	DL	11/02/83	HGC	KGS	XPOC.D1183Ka
POCKET	DL	11/02/83	HGC	KGS	XPOC.D1183Kb
POCKET	DL	11/02/83	HGC	UA	XPOC.D1183UA
RANCH	DL	06/13/86 - 06/18/86	WQSP-R1	FLD	XRAN.D686F
RANCH	DL	06/18/86	WQSP-R1	BFEC	XRAN.D686B
RANCH	DL	06/18/86	WQSP-R1	ITAS	XRAN.D686I
TWIN-P	DL	01/24/86 - 02/02/86	WQSP-R1	FLD	XTWP.D186F
TWIN-P	DL	01/30/86	WQSP-R1	BFEC	XTWP.D186B
TWIN-P	DL	01/31/86	WQSP-R1	EEG	XTWP.D186E
TWIN-P	DL	01/30,31/86	WQSP-R1	ITAS	XTWP.D186I
UNGER	DL	01/26/84	HGC	H-B	XUNG.D184HB
UNGER	DL	01/26/84	HGC	KGS	XUNG.D184K
UNGER	DL	01/26/84	HGC	UA	XUNG.D184UA

Table 3. List of Samples for Which Data Are Included in This Report (continued)

Well Abbrev[1]	Strat. Zone[2]	Collection Date(s)[3]	Agency[4]	Lab[5]	Sample ID[6]
DOE-2	BC	07/20/85 - 07/23/85	WQSP-R1	FLD	D2.B785F
DOE-2	BC	07/23/85	WQSP-R1	BFEC	D2.B785B
DOE-2	BC	07/23/85	WQSP-R1	EEG	D2.B785E
DOE-2	BC	07/23/85	WQSP-R1	ITAS	D2.B785I
W-15	Alluvium	03/12/79	USGS	SNL	W15.Q379S

1. Abbreviations of well names are explained in Table 1.
2. Stratigraphic zones sampled:
   BC - Bell Canyon Formation
   Cul - Culebra Dolomite
   DL - Dewey Lake Red Beds
   Mag - Magenta Dolomite
   RS - Rustler/Salado contact zone
3. Date(s) on which final samples were collected or range of dates during which serial samples were collected.
4. Agency responsible for sample collection:
   HGC - Hydro Geo Chem, Inc., Tucson, AZ
   SNL - Sandia National Laboratories, Albuquerque, NM
   USGS - United States Geological Survey
   WQSP-R1 - Round One of the Water Quality Sampling Program
5. Laboratory that did analyses:
   BFEC - Bendix Field Engineering Corp., Grand Junction, CO (now UNC Technical Services; called UNC/Bendix in the text)
   EEG - New Mexico Bureau of Mines & Mineral Resources, Socorro, NM
   FLD - Field measurements, either steady-state values or the best available values
   H-B - Bendix Field Engineering Corp., Grand Junction, CO
   ITAS - IT Analytical Services, Murraysville, PA
   KCS - KC Services
   KGS - Kansas Geological Survey
   SNL - Sandia National Laboratories, Albuquerque, NM
   UA - University of Arizona, Laboratory of Isotope Geochemistry
   USGS - United States Geological Survey, Central Laboratories
6. Sample identification code used for cross-referencing to other data tables. The codes contain the following: a well abbreviation; a period; a zone abbreviation (C = Culebra, and so forth.); the month and year of collection; a letter code indicating the laboratory; optionally, a lower-case suffix to distinguish either more than one sample sent to the same lab or more than one sample collected in the same month.

Table 4. Data from Serial Samples Collected from the Culebra at H-4B in May 1981

Date	Collection Time: Start - End	Temp (°C)	Specific Gravity	pH	Eh (volts)	Specific Conductance (μS/cm)	Alkalinity HCO_3^- (mg/L)	$SO_4^=$ (mg/L)
05/14/81	17:50 - 17:55	21.0	1.015	8.30	-0.057	32000	69.7	~5500
05/15/81	08:25 - 08:30	20.0	1.010	8.14	0.024	25000	71.0	~6400
05/15/81	15:50 - 15:55	23.0	1.010	8.09	0.080	29500	71.0	~3900
05/16/81	06:00 - 06:05	19.5	1.010	8.08	0.114	23700	71.3	~4800
05/27/81	13:50 - 13:55	25.0	1.010	8.03	0.173	30000	71.3	~5500
05/28/81	10:20 - 10:25	22.0	1.010	8.00	0.123	26500	71.9	~5900
05/29/81	10:10 - 10:15	22.0	1.010	8.00	0.158	25500	71.0	~6300

First test: pumping started on 05/14/81 at 09:00. Average pumping rate was 20 gph.
Second test: pumping started on 05/21/81 at 12:30. Average pumping rate was 15 gph.

Table 5. Data from Serial Samples Collected from the Culebra at H-5B in May/June 1981

Date	Collection Time: Start - End	Temp (°C)	Specific Gravity	pH	Eh (volts)	Specific Conductance (μS/cm)	Alkalinity HCO_3^- (mg/L)	$SO_4^=$ (mg/L)
05/29/81	12:00 - 12:05	23.5	1.100	7.90	0.052	170000	84.4	~8700
05/31/81	09:40 - 09:45	22.0	1.100	7.90	0.052	140000	83.1	~8000
06/01/81	10:00 - 10:05	22.5	1.100	7.90	0.044	130000	81.2	~8500
06/02/81	08:30 - 08:35	21.5	1.100	7.90	0.045	150000	79.9	~8500

Pumping started on 05/27/81 at 12:30 and stopped during the evening of 05/29/81. Pumping was restarted on 05/30/81 at 11:30. Average pumping rate was 12 gph.

Table 6. Data from Serial Samples Collected from the Culebra at H-5C in Oct. 1981

Date	Collection Times: HCO_3^- Sample	Other Samples Start - End	Temp (°C)	Specific Gravity	pH	Eh (volts)	Specific Conductance (µS/cm)	Alkalinity HCO_3^- (mg/L)
10/12/81	14:50	14:55 - 15:00	24.0		7.90	0.052	140000	90.3
10/13/81	11:55	12:00 - 12:05	25.0	1.110	7.92	0.051	150000	87.1
10/14/81	10:05	10:10 - 10:15	24.0	1.102	7.91	0.062	160000	86.4
10/15/81	10:35	10:40 - 10:45	23.5		7.89	0.032	140000	85.5

Pumping started on 10/07/81 at 09:35. Average pumping rate was 7.5 gph.

Table 7. Data from Serial Samples Collected from the Culebra at H-6B in May 1981

Date	Collection Time:	Temp (°C)	Specific Gravity	pH	Eh (volts)	Specific Conductance (µS/cm)	Alkalinity HCO_3^- (mg/L)	$SO_4^=$ (mg/L)
05/01/81	16:30	23.0	1.040	7.00	0.242	73000	97.5	~3500
05/02/81	05:20	22.0	1.040	7.00	0.243	70000	96.3	~3900

Pumping started on 05/01/81 at 10:20. Average pumping rate was 23 gpm.

Table 8. Data from Serial Samples Collected from the Culebra at H-6C in May 1981

Date	Collection times: HCO_3^- Sample	Other Samples	Temp (°C)	Specific Gravity	pH	Eh (volts)	Specific Conductance (µS/cm)	Alkalinity HCO_3^- (mg/L)	$SO_4^=$ (mg/L)
05/13/81	10:25	10:25	23.0	1.040	7.10	0.280	80000	95.3	~4000
05/27/81	13:00	11:20	23.5	1.040	7.20	0.277	80000	94.3	~3800

Pumping started on 05/12/81 at 16:05. Generator failed on 05/14/81 at 01:10. Average pumping rate was 19 gpm. Pumping was restarted on 05/21/81 at 10:45. Average pumping rate was 17 gpm.

Table 9. Data from Serial Samples Collected from the Culebra at H-3B3 in June 1984

Collection Date	Collection Time	Temp (°C)	Specific Gravity	pH	Specific Conductance (µS/cm)
06/10/84	16:59	25.8	1.034	7.40	73700
06/11/84	09:30	25.6	1.034	7.41	68900
06/11/84	15:00	25.6	1.035	7.46	74800

Table 10. Data from Serial Samples Collected from the Culebra at H-4C in August 1984

Collection Date	Collection Time	Temp (°C)	Specific Gravity	pH	Specific Conductance (µS/cm)	Alkalinity HCO_3^- (mg/L)
08/09/84	11:53	23	1.012	7.70	25800	
08/09/84	22:00	21	1.012	7.90	24300	
08/10/84	12:12	21.5	1.010	8.55	24500	
08/10/84	15:45	21.5	1.01	7.80	24500	75

Table 11. Steady-State Field Results for Serial-Sampling Parameters Determined in Nash Draw in 1980[1]

Well	Zone	Serial-Sampling Dates (start - stop)	Temp Range (°C)	pH	Spec. Grav.	Alk. $CO_3^{=}$ (mg/L)	Alk. HCO_3^{-} (mg/L)	Cl^- (mg/L)	X^{++} (meq/L)	Ca (mg/L)	$SO_4^{=}$ (mg/L)	Total Fe (mg/L)
W-25	RS	07/16/80 - 07/17/80	22-23	7.4	na	0	130	190000	290	na	na	na
W-25	Cul	08/19/80 - 08/20/80	22-23	6.9	1.01	0	210	5200	66	910	~3000	~0.6
W-25	Mag	09/16/80 - 09/18/80	21-23	6.9	1.004	0	180	4900	66	920	~3000	~0.6
W-26	RS	07/22/80 - 07/23/80	23-25	7.7	na	0	270	110000	190	na	na	na
W-26	Cul	08/23/80 - 08/24/80	21-23	6.9	1.005	0	140	6900	91	1300	~3000	~0.3
W-27	RS[2]	08/05/80 - 08/07/80	22-31	(~7.1)	(~1.07)	(~0)	(~70)	(~58000)	(~220)	na	(~10000)	na
W-27	Cul	09/02/80 - 09/05/80	21-25	6.4	1.09	0	120	77000	320	3300	~4000	~0.4
W-27	Mag	09/24/80 - 09/25/80	21-22	6.4	1.09	0	210	84000	330	3600	~3000	~2
W-28	RS	07/30/80 - 07/31/80	23-25	7.0	1.18	0	170	150000	300	na	~20000	~0.1
W-28	Cul	09/09/80 - 09/12/80	22-23	6.5	1.03	0	<350[3]	24000	100	1200	~4000	~0.8
W-29	RS	07/22/80 - 07/24/80	20-22	7.2	na	0	200	57000	230	na	~10000	na
W-29	Cul	08/26/80 - 08/28/80	20-21	6.1	1.16	0	210	130000	480	1100	~10000	~0.8
W-30	RS	07/16/80 - 07/17/80	22-27	7.5	na	0	620	180000	260	(~900)	na	na
W-30	Cul	09/02/80 - 09/06/80	21-25	8.8	1.02	17	40	15000	97	1200	~4000	~0.05
W-30	Mag[4]	12/02/80 - 12/10/80	4-20	(~8.6)	(<1.01)	(~10)	(~50)	(<4000)	(<44)	(<620)	(<4000)	~0.1

1. Key: na=not analyzed; RS = Rustler/Salado contact zone; Cul = Culebra Dolomite; Mag = Magenta Dolomite; abbreviations of well names are explained in Table 1.
2. Representative sample not collected from WIPP-27 Rustler/Salado. Field values are presented as approximations (~).
3. Alkalinity at WIPP-28 Culebra was still decreasing when test terminated. Value is presented as an upper limit.
4. Representative sample not collected from WIPP-30 Magenta. Solute concentrations were decreasing when test terminated, so values are given as upper limits.

Table 12. Steady-State Field Results for Serial-Sampling Parameters Determined During Hydrologic Tests in 1980 and 1981[1]

Well	Zone	Serial-Sampling Dates (start - stop)	Temp. Range (°C)	pH	Specific Gravity	Alk. HCO_3^- (mg/L)	$SO_4^=$ (mg/L)
H-2C	Cul	12/10/80	~19	7.9	1.002	na	na
H-4B	Cul	05/14/81 - 05/29/81	19-25	8.0	1.01	71	~6000
H-5B	Cul	05/27/81 - 06/02/81	21-24	7.9	1.10	80	~8000
H-5C	Cul	10/07/81 - 10/15/81	23-25	7.9	1.10	86	na
H-6B	Cul	05/01/81 - 05/02/81	22-23	7.0	1.04	96	~4000
H-6C	Cul	05/12/81 - 05/27/81	23-24	7.2	1.04	94	~4000

1. Key: na = not analyzed; Cul = Culebra Dolomite.

Table 13. Steady-State or Best Available Field Results for Serial-Sampling Parameters Determined During Hydrologic Tests in 1983 and 1984[1]

Well	Zone	Serial-Sampling Dates (start - stop)	Temp. Range (°C)	Specific Gravity	pH	Specific Conductance (µS/cm)	Alk.[2] HCO_3^- (mg/L)
DOE-1	Cul	04/13/83-04/21/83	20-22	1.090	7.6	125000	~65-70
ENGLE	Cul	11/04/83-11/10/83	22-24		7.3	3600	~230
FR-10	Cul	10/06/83	21-23	1.000	7.4	3200	~260
H-9B	Cul	10/07/83	24	1.000	7.9	3600	~240
H-12	Cul	01/07/84-01/12/84		1.090	7.9		
POCKET	DL	10/27/83-11/02/83	19-21	1.000	7.7	3800	~140

1. Key: Cul = Culebra Dolomite; DL = Dewey Lake Red Beds; abbreviations of well names are explained in Table 1.
2. Values highly uncertain. See discussion in Section 3.5.2.

Table 14. Steady-State Field Results for Serial-Sampling Parameters Determined During Tracer Tests in June and August 1984[1]

Well	Zone	Serial-Sampling Dates (start - stop)	Temp. Range (°C)	Specific Gravity	pH
H-3B3	Cul	06/10/84 - 06/11/84	25-26	1.03	7.4
H-4C	Cul	08/09/84 - 08/10/84	21-23	1.01	7.8

1. Key: Cul = Culebra Dolomite

Table 15. Steady-State Field Results for Serial-Sampling Parameters Determined During Round One of the WQSP in 1985 and 1986[1]

Well	Zone	Serial-Sampling Dates (start - stop)	Temp. Range (°C)	pH	Specific Gravity	Alk. $CO_3^{=}$ (mg/L)	Alk. HCO_3^{-} (mg/L)	Cl^- (mg/L)	X^{++} (meq/L)	Total Fe (mg/L)
DOE-2	BC	07/20/85 - 07/23/85	na	6.8	na	na	na	90000	400	na
DOE-1	Cul	04/12/85 - 04/25/85	22-24	7.1	na	0	45	73000	210	0.4
DOE-2	Cul	02/20/85 - 03/12/85	20-24	7.0	na	0	67	32000	190	<0.02
ENGLE	Cul	02/26/85 - 03/05/85	20-24	7.4	na	0	110	220	42	0.5
H-2A	Cul	04/04/86 - 04/21/86	21-23	8.0	1.009	0	57	<5200[2]	53	1.
H-3B3	Cul	01/29/85 - 02/04/85	21-22	7.4	na	0	52	28000	170	0.2
H-4B	Cul	07/08/85 - 07/25/85	21-22	7.7	1.015	0	69	7500	71	1.
H-5B	Cul	08/22/85 - 08/30/85	22-23	7.4	1.105	0	50	84000	260	3.
H-6B	Cul	09/04/85 - 09/16/85	21-23	6.9	1.042	0	94	32000	190	0.2
H-7B1	Cul	03/20/86 - 03/27/86	21-23	7.3	1.001	0	120	310	46	0.1
H-8B	Cul	01/09/86 - 01/23/86	19-23	7.3	1.002	0	96	33	42	0.09
H-9B	Cul	10/30/85 - 11/14/85	20-24	7.4	1.002	0	110	190	41	0.1
H-11B3	Cul	05/13/85 - 06/04/85	21-27	7.2	1.090	0	54	67000	190	0.2
H-12	Cul	08/01/85 - 08/09/85	23-24	7.2	1.096	0	53	80000	240	1.
P-14	Cul	02/18/86 - 02/27/86	21-23	6.8	1.019	0	110	15000	260	2.
P-17	Cul	03/04/86 - 03/17/86	21-22	7.5	1.065	0	64	48000	220	5.
W-25	Cul	01/31/86 - 02/13/86	20-22	7.2	1.010	0	130	6200	85	0.5
W-26	Cul	11/19/85 - 11/26/85	20-22	7.1	1.012	0	120	8500	100	0.1
W-29	Cul	12/05/85 - 12/15/85	19-22	5.9	1.216	0	160	180000	610	1.
TWIN-P	DL	01/24/86 - 02/02/86	20-22	7.8	0.998	0	230	45	5.9	0.05
RANCH	DL	06/13/86 - 06/18/86	22-23	7.0	1.002	0	220	400	38	0.1
H-3B1	Mag	06/17/85 - 07/02/85	22-25	8.0	1.006	0	47	3400	74	0.7
H-4C	Mag	10/30/86 - 11/04/86	20-23	8.4	1.019	7	70	8400	70	0.7
H-5C	Mag	10/07/86 - 10/24/86	20-23	8.0	1.006	0	56	1100	43	1.
H-6C	Mag	09/22/86 - 10/01/86	21-23	7.7	1.003	0	51	420	41	0.4

1. Key: na = not analyzed; Cul = Culebra Dolomite; Mag = Magenta Dolomite; DL = Dewey Lake Red Beds; BC = Bell Canyon Formation; abbreviations of well names are explained in Table 1.
2. At H-2A Culebra, Cl^- was still slowly decreasing when the test was terminated. The value is given as an upper limit.

Table 16. Results of Analyses of Solutes in Samples Collected by the USGS and Analyzed by the Analytical Chemistry Division, SNL[1]

Well	Zone	Date Collected	Density (g/mL)	Calc'd TDS (mg/L)	CBE[2] (%)	Alk. $CO_3^{=}$ (mg/L)	Alk. HCO_3^{-} (mg/L)	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)
W-15	Alv	03/12/79	0.999	1920	1.0	92	1130	109	32	480	20	20	42
H-3B1	Mag	05/10/79	1.019	29000	1.1	0	52	14300	3580	7810	1360	1120	730
H-4C	RS	03/16/79	1.208	315200	-0.2	0	<10	202000	730	64400	14500	8560	25400
H-5C	RS	05/16/79	1.258	372300	-0.4	0	200	262000	1430	14200	16100	1780	76400
H-6C	RS	04/09/79	1.207	312600	-1.9	0	<10	201000	1450	79400	6670	4170	20200
P-15	RS	04/03/79	1.045	67600	-0.6	0	95	38000	3350	23700	1350	800	320
P-15	Cul	04/11/79	1.060	89600	-0.8	23	150	47100	7430	26000	6610	780	1510
P-17	RS	05/11/79	1.194	--	--	0	740	186000	540	lost	lost	lost	lost
P-18	RS	05/11/79	1.221	325200	-0.7	0	400	217000	610	45600	11700	10200	39800

1. Key: Alv = alluvium; Cul = Culebra Dolomite; Mag = Magenta Dolomite; RS = Rustler/Salado contact zone; SNL = Sandia National Laboratories; abbreviations of well names are explained in Table 1.
2. CBE = charge-balance error

Table 17. Results of Solute Analyses by Bendix for HGC[1]

Well	Zone	Collection Date	CBE[2] (%)	Calc'd TDS (mg/L)	Cl^- (mg/L)	$SO_4^=$ (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)
ENGLE	Cul	11/10/83	--	--	230	1100	na	na	na	na
FR-10	Cul	10/06/83	--	--	na	na	520	150	77	8.5
H-9B	Cul	10/07/83	-5.4	2290	180	1500	400	94	110	5.0
H-12	Cul (a)	01/11/84	-1.3	143700	85000	4000	1400	1300	51000	970
H-12	Cul (b)	01/25/84	-0.8	149100	84000	8400	1300	1300	53000	1000
POCKET	DL	11/02/83	3.8	1880	210	1100	380	96	95	2.4
UNGER	DL	01/26/84	-2.9	2840	260	1800	530	130	120	3.2

Well	Zone	Collection Date	Si (mg/L)	Li (mg/L)	Fe (mg/L)	Mn (mg/L)	Br^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
ENGLE	Cul	11/10/83	9	na	na	na	na	na	2
FR-10	Cul	10/06/83	na	0.51	0.06	0.04	na	na	na
H-9B	Cul	10/07/83	13	0.13	0.08	0.02	na	na	<1
H-12	Cul (a)	01/11/84	5.0	0.25	0.55	0.10	70	0.33	<1
H-12	Cul (b)	01/25/84	5.0	0.29	1.1	0.14	76	0.34	<1
POCKET	DL	11/02/83	12	0.06	0.14	0.02	na	na	8
UNGER	DL	01/26/84	1	0.05	<0.05	0.03	15	0.06	11

1. Key: Cul = Culebra Dolomite; DL = Dewey Lake Red Beds; HGC = Hydro Geo Chem; abbreviations of well names are explained in Table 1, na = not analyzed.
2. CBE = charge-balance error

Table 18. Results of Halide Analyses by the KGS[1]

Well	Zone	Collection Date	Cl^- (mg/L)	Br^- (mg/L)	I^- (mg/L)	Alk. HCO_3^- (mg/L)
ENGLE	Cul	11/10/83	163	0.47	0.008	98
FR-10	Cul	10/06/83	49.5	0.21	0.009	na
H-9B	Cul	10/07/83	206	0.43	0.109	na
H-12	Cul (a	01/25/84	80100	77	0.290	na
H-12	Cul (b	01/11/84	86500	72	0.250	na
POCKET	DL (a	11/02/83	340	0.71	0.019	120
POCKET	DL (b	11/02/83	214	0.46	0.012	95
UNGER	DL	01/26/84	268	0.56	0.010	130

1. Key: na = not analyzed; Cul = Culebra Dolomite; DL = Dewey Lake Red Beds; KGS = Kansas Geological Survey; abbreviations of well names are explained in Table 1.

Table 19. Results of Chlorine-37 Analyses by KCS and the UA[1]

Well	Zone	Collection Date	Cl^- (mg/L)	$\delta^{37}Cl$ (per mil relative to SMOC[2])	Lab
DOE-1	Cul	04/19/83	94100	-0.38	KCS
ENGLE	Cul	10/11/83		-0.73	UA
FR-10	Cul	10/06/83	100	1.32	KCS
H-3B3	Cul	06/11/84		0.06	UA
H-3B3	Cul	02/04/85		-0.55	UA
H-9B	Cul	10/07/83	255	1.35	KCS
H-12	Cul	01/11/84		0.30	UA
W-26	Cul	08/24/80	8240	-0.50	KCS
W-28	Cul	09/11/80	21600	-0.50	KCS
W-29	Cul	08/28/80	201000	-0.45	KCS
W-30	Cul	09/06/80	18700	-1.03	KCS
POCKET	DL	11/11/83		0.25	UA
UNGER	DL	01/26/84		-0.47	UA

1. Key: Cul = Culebra Dolomite; DL = Dewey Lake Red Beds; KCS = KC Services; UA = University of Arizona, Laboratory of Isotope Geochemistry; abbreviations of well names are explained in Table 1.
2. SMOC = standard mean ocean chloride

Table 20. Results of Solute Analyses by UNC/Bendix: WIPP-25 Culebra[1]

Sample ID: W25.C880B Collection date: 8/20/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	average (mg/L)	RPD (%)
Ca	910	900	905	1.1
Mg	260	260	260	0
K	74.0	73.0	73.5	1.4
Na	3120	3190	3160	2.2
Cl^-	5200	5300	5250	1.9
$SO_4^=$	2460	2530	2500	2.8
Alk-$CaCO_3$			na	
B	1.52	1.52	1.52	0
Cs			na	
Fe			na	
Li	0.20	0.20	0.20	0
Mn			na	
Si (SiO_2)	33.6	35.0	34.3	4.1
Sr	12.0	12.1	12.0	0.8
Br^-	2.6	2.5	2.6	3.9
F^-			na	
I^-			na	
NO_3^-			na	

1. Key: na = not analyzed; RPD = relative percent difference.

Table 21. Results of Solute Analyses by UNC/Bendix: WIPP-26 Culebra[1]

Sample ID: W26.C880B

Collection date: 08/24/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	average (mg/L)	RPD (%)
Ca	1240	1230	1240	0.8
Mg	360	350	355	2.8
K	170	170	170	0
Na	3590	3660	3620	1.9
Cl^-	7300	7100	7200	2.8
$SO_4^=$	2470	2490	2480	0.8
Alk-$CaCO_3$			na	
B	1.42	1.48	1.45	4.1
Cs				
Fe			na	
Li	0.23	0.25	0.24	8.3
Mn			na	
Si (SiO_2)	33.3	33.5	33.4	0.6
Sr	16.5	17.2	16.8	4.1
Br^-	3.2	3.2	3.20	0
F^-			na	
I^-			na	
NO_3^-			na	

1. Key: na = not analyzed; RPD = relative percent difference.

Table 22. Results of Solute Analyses by UNC/Bendix: WIPP-27 Culebra[1]

Sample ID: W27.C980B

Collection date: 09/03/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	3210	3210		3210		0
Mg	1920	1890		1900		1.6
K	8010	8120		8060		1.4
Na	39400	38900		39200		1.3
Cl^-	79000	78000		78500		1.3
$SO_4^=$	3800	3860		3830		1.6
Alk-$CaCO_3$				na		
B	2.20	2.40		2.30		8.7
Cs				na		
Fe				na		
Li	0.340	0.320		0.33		6.1
Mn				na		
Si (SiO_2)	23.1	22.0		22.6		4.9
Sr	50.9	50.9		50.9		0
Br^-	30.0	26.0	29.0	28.3	7.3	
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 23. Results of Solute Analyses by UNC/Bendix: WIPP-28 Culebra[1]

Sample ID: W28.C980B

Collection date: 09/11/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1150	1210	1170	1200	1180	2.3	
Mg	550	560			555		1.8
K	490	480			485		2.1
Na	15200	15300			15200		0.7
Cl^-	24800	24700			24800		0.4
$SO_4^=$	4460	4300			4380		3.7
Alk-$CaCO_3$					na		
B	5.76	5.90			5.83		2.4
Cs					na		
Fe					na		
Li	0.300	0.310			0.300		3.3
Mn					na		
Si (SiO_2)	36.3	36.2			36.2		0.3
Sr	15.4	15.6			15.5		1.3
Br^-	7.00	7.50			7.20		6.7
F^-					na		
I^-					na		
NO_3^-					na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 24. Results of Solute Analyses by UNC/Bendix: WIPP-29 Culebra[1]

Sample ID: W29.C880B

Collection date: 08/28/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	950	950		950		0
Mg	5450	5500		5480		0.9
K	15600	15500		15600		0.6
Na	71100	71700		71400		0.8
Cl^-	140000	137000		138000		2.2
$SO_4^=$	14200	13900		14000		2.1
Alk-$CaCO_3$				na		
B	4.20	4.60		4.40		9.1
Cs				na		
Fe				na		
Li	0.800	0.750		0.780		6.5
Mn				na		
Si (SiO_2)	21.6	22.4		22.0		3.6
Sr	29.0	28.6		28.8		1.4
Br^-	47.0	41.0	47.0	45.0	7.7	
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 25. Results of Solute Analyses by UNC/Bendix: WIPP-30 Culebra[1]

Sample ID: W30.C980B

Collection date: 09/06/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1140	1150		1140		0.9
Mg	460	460		460		0
K	250	260		255		3.9
Na	8520	8620		8570		1.2
Cl^-	14800	14500		14600		2.0
$SO_4^=$	4050	4190		4120		3.4
Alk-$CaCO_3$				na		
B	6.18	6.00		6.09		3.0
Cs				na		
Fe				na		
Li	0.27	0.27		0.270		0
Mn				na		
Si (SiO_2)	6.90	6.30	6.30	6.50	5.3	
Sr	17.8	18.0		17.9		1.1
Br^-	11.0	10.0		10.5		9.5
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 26. Results of Solute Analyses by UNC/Bendix: WIPP-25 Magenta[1]

Sample ID: W25.M980B Collection date: 09/17/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	average (mg/L)	RPD (%)
Ca	900	910	905	1.1
Mg	260	260	260	0
K	72.0	71.0	71.5	1.4
Na	2920	2900	2910	0.7
Cl^-	5300	5200	5250	1.9
$SO_4^=$	2470	2510	2490	1.6
Alk-$CaCO_3$			na	
B	1.58	1.50	1.54	5.2
Cs			na	
Fe			na	
Li	0.20	0.20	0.200	0
Mn			na	
Si (SiO_2)	33.3	33.5	33.4	0.6
Sr	11.9	12.1	12.0	1.7
Br^-	2.40	2.60	2.50	8.0
F^-			na	
I^-			na	
NO_3^-			na	

1. Key: na = not analyzed; RPD = relative percent difference.

Table 27. Results of Solute Analyses by UNC/Bendix: WIPP-27 Magenta[1]

Sample ID: W27.M980B Collection date: 09/25/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	3680	3640			3660		1.1
Mg	2110	2090			2100		0.9
K	8060	8120			8090		0.7
Na	44400	42600	42500	43400	43200	2.0	
Cl^-	86500	84000			85200		2.9
$SO_4^=$	3330	3490			3410		4.7
Alk-$CaCO_3$					na		
B	2.15	2.45	2.30	2.38	2.32	5.5	
Cs					na		
Fe					na		
Li	0.34	0.34			0.340		0
Mn					na		
Si (SiO_2)	30.3	29.7			30.0		2.0
Sr	58.9	58.2			58.6		1.2
Br^-	30.0	26.0	29.0		28.3	7.3	
F^-					na		
I^-					na		
NO_3^-					na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 28. Results of Solute Analyses by UNC/Bendix: WIPP-25 Rustler/Salado[1]

Sample ID: W25.R780B Collection date: 07/17/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	average (mg/L)	RPD (%)
Ca	560	560	560	0
Mg	3230	3300	3260	2.1
K	3310	3350	3330	1.2
Na	123400	122200	122800	1.0
Cl^-	194000	190000	192000	2.1
$SO_4^=$	12600	12100	12400	4.0
Alk-$CaCO_3$			na	
B	41.4	40.4	40.9	2.4
Cs			na	
Fe			na	
Li	1.55	1.60	1.58	3.2
Mn			na	
Si (SiO_2)	4.0	3.9	4.00	2.6
Sr	11.2	11.4	11.3	1.2
Br^-	49.0	53.0	51.0	7.8
F^-			na	
I^-			na	
NO_3^-			na	

1. Key: na = not analyzed; RPD = relative percent difference.

Table 29. Results of Solute Analyses by UNC/Bendix: WIPP-26 Rustler/Salado[1]

Sample ID: W26.R780B Collection date: 07/23/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1410	1420		1420		0.7
Mg	1670	1650		1660		1.2
K	1200	1190		1200		0.8
Na	68200	69100		68600		1.3
Cl^-	110000	107000		108000		2.7
$SO_4^=$	7390	7560		7480		2.3
Alk-$CaCO_3$				na		
B	31.6	32.1		31.8		1.6
Cs				na		
Fe				na		
Li	1.15	1.15		1.15		0
Mn				na		
Si (SiO_2)	6.2	6.3		6.20		1.7
Sr	27.0	27.0		27.0		0
Br^-	20.0	18.0	20.0	19.3	6.0	
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 30. Results of Solute Analyses by UNC/Bendix: WIPP-28 Rustler/Salado[1]

Sample ID: W28.R780B Collection date: 07/31/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	average (mg/L)	RPD (%)
Ca	610	600	605	1.7
Mg	3400	3400	3400	0
K	4290	4310	4300	0.5
Na	98000	96200	97100	1.8
Cl^-	157000	153000	155000	2.6
$SO_4^=$	16700	16700	16700	0
Alk-$CaCO_3$			na	
B	45.6	46.9	46.2	2.8
Cs			na	
Fe			na	
Li	1.85	1.80	1.82	2.7
Mn			na	
Si (SiO_2)	7.70	7.80	7.80	1.3
Sr	11.6	11.5	11.6	0.8
Br^-	30.0	28.0	29.0	3.4
F^-			na	
I^-			na	
NO_3^-			na	

1. Key: na = not analyzed; RPD = relative percent difference.

Table 31. Results of Solute Analyses by UNC/Bendix: WIPP-29 Rustler/Salado[1]

Sample ID: W29.R780B Collection date: 07/24/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1030	1100	1060	1120	1080	3.7	
Mg	2310	2330			2320		0.9
K	1490	1460			1480		2.0
Na	36200	36000			36100		0.6
Cl^-	57500	58500			58000		1.7
$SO_4^=$	12100	12000			12000		0.8
Alk-$CaCO_3$					na		
B	19.6	20.2			19.9		3.0
Cs					na		
Fe					na		
Li	1.36	1.32			1.34		1.5
Mn					na		
Si (SiO_2)	14.9	15.1			15.0		1.3
Sr	21.0	20.9			21.0		0.5
Br^-	12.0	13.0			12.5		8.0
F^-					na		
I^-					na		
NO_3^-					na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 32. Results of Solute Analyses by UNC/Bendix: WIPP-30 Rustler/Salado[1]

Sample ID: W30.R780B Collection date: 07/17/80

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	average (mg/L)	RPD (%)
Ca	960	950	955	1.1
Mg	2760	2780	2770	0.7
K	2170	2190	2180	0.9
Na	121400	119900	120600	1.2
Cl^-	195000	190000	192000	2.6
$SO_4^=$	7440	7340	7390	1.4
Alk-$CaCO_3$			na	
B	82.5	80.7	81.6	2.2
Cs			na	
Fe			na	
Li	0.70	0.75	0.720	6.8
Mn			na	
Si (SiO_2)	5.5	5.5	5.50	0
Sr	18.2	18.6	18.4	2.2
Br^-	79.0	77.0	78.0	2.6
F^-			na	
I^-			na	
NO_3^-			na	

1. Key: na = not analyzed; RPD = relative percent difference.

Table 33. Results of Solute Analyses by UNC/Bendix: H-4B Culebra[1]

Sample ID: H04B.C581B Collection date: 05/29/81

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	average (mg/L)	RPD (%)
Ca	710	690	700	2.8
Mg	450	460	455	2.2
K	210	220	215	4.6
Na	6150	6020	6080	2.1
Cl^-	8050	7900	7980	1.9
$SO_4^=$	6290	6170	6230	1.9
Alk-$CaCO_3$			na	
B	18.2	17.6	17.9	3.3
Cs			na	
Fe			na	
Li	0.39	0.39	0.390	0
Mn			na	
Si (SiO_2)	11.1	10.9	11.0	1.8
Sr	13.9	14.2	14.0	2.1
Br^-	43.0	40.0	41.5	7.2
F^-			na	
I^-			na	
NO_3^-			na	

1. Key: na = not analyzed; RPD = relative percent difference.

Table 34. Results of Solute Analyses by UNC/Bendix: H-5B Culebra[1]

Sample ID: H05B.C681B

Collection date: 06/01/81

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1680	1740		1710		3.5
Mg	2140	2130		2140		0.5
K	1300	1280		1290		1.6
Na	52900	51800		52400		2.1
Cl^-	90000	89000		89500		1.1
$SO_4^=$	7310	7420		7360		1.5
Alk-$CaCO_3$				na		
B	33.4	33.0		33.2		1.2
Cs				na		
Fe				na		
Li	0.78	0.76		0.770		2.6
Mn				na		
Si (SiO_2)	5.9	6.3	6.5	6.20	4.9	
Sr	31.6	31.6		31.6		0
Br^-	65.0	60.0		62.5		8.0
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 35. Results of Solute Analyses by UNC/Bendix: H-5C Culebra[1]

Sample ID: H05C.C1081B

Collection date: 10/15/81

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1710	1730		1720		1.2
Mg	2160	2140		2150		0.9
K	1290	1300		1300		0.8
Na	52400	52200		52300		0.4
Cl^-	90000	89000		89500		1.1
$SO_4^=$	7670	7470		7570		2.6
Alk-$CaCO_3$				na		
B	35.7	34.8		35.2		2.6
Cs				na		
Fe				na		
Li	0.78	0.76		0.770		2.6
Mn				na		
Si (SiO_2)	5.50	5.90	6.10	5.80	5.3	
Sr	31.4	31.2		31.3		0.6
Br^-	65.0	63.0		64.0		3.1
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 36. Results of Solute Analyses by UNC/Bendix: H-6B Culebra[1]

Sample ID: H06B.C581B Collection date: 05/02/81

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	2180	2120		2150		2.8
Mg	1070	1080		1080		0.9
K	450	450		450		0
Na	18600	18600		18600		0
Cl^-	33000	33000		33000		0
$SO_4^=$	4020	3940		3980		2.0
Alk-$CaCO_3$				na		
B	10.9	10.9		10.9		0
Cs				na		
Fe				na		
Li	0.44	0.44		0.440		0
Mn				na		
Si (SiO_2)	20.1	20.5	21.0	20.5	2.2	
Sr	32.1	31.8		32.0		0.9
Br^-	35.0	33.0	35.0	34.3		3.4
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 37. Results of Solute Analyses by UNC/Bendix: H-3B3 Culebra[1]

Sample ID: H03B3.C684B Collection date: 06/11/84

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)
Ca	1560	1530	1560	1550	1.1
Mg	827	816	845	829	1.8
K	509	488	487	495	2.6
Na	17800	17300	17200	17400	1.8
Cl^-	29900	28800	29900	29500	2.2
$SO_4^=$	5160	5170	5060	5130	1.2
Alk-$CaCO_3$	43.3	43.2	43.6	43.4	0.5
B	29.8	29.7	30.5	30.0	1.5
Cs	<0.007	<0.007	<0.007	<0.007	
Fe	0.55	0.57	0.60	0.573	4.4
Li	0.51	0.53	0.55	0.530	3.8
Mn	0.13	0.14	0.13	0.133	4.5
Si (SiO_2)	9.88	10.02	9.44	9.78	3.1
Sr	23.4	22.2	22.3	22.6	2.9
Br^-	28.7	28.8	28.8	28.8	0.3
F^-	2.10	2.07	2.10	2.09	1.0
I^-	0.125	0.132	0.141	0.133	6.0
NO_3^-				na	

1. Key: na = not analyzed; RPD = relative percent difference.

Table 38. Results of Solute Analyses by UNC/Bendix: H-4C Culebra[1]

Sample ID: H04C.C884B Collection date: 08/10/84

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)
Ca	705	690	700		698	1.1
Mg	505	500	510		505	1.0
K	222	221	224		222	0.7
Na	6140	6180	6120		6150	0.5
Cl^-	7900	7950	8000		7950	0.6
$SO_4^=$	5780	5490	5840		5700	3.3
Alk-$CaCO_3$					na	
B	19.8	20.0	19.6		19.8	1.0
Cs	<0.003	<0.003	<0.002		<0.002	
Fe	2.24	2.16	2.10		2.17	3.2
Li	0.51	0.49	0.48		0.490	3.1
Mn	0.192	0.204	0.199		0.198	3.0
Si (SiO_2)	12.5	13.5			13.0	7.0
Sr	18.0	17.7	17.7		17.8	1.0
Br^-	52.5	47.7	46.0	44.6	47.7	7.2
F^-	2.21	2.05	2.12		2.13	3.8
I^-	0.226				0.226	
NO_3^-					na	

1. Key: na = not analyzed; RSD = relative standard deviation.

Table 39. Results of Solute Analyses by UNC/Bendix: DOE-1 Culebra[1]

Sample ID: D1.C485B Collection date: 04/24,25/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1740	1720		1730		1.2
Mg	1580	1640		1610		3.7
K	1120	1080		1100		3.6
Na	46000	45600		45800		0.9
Cl^-	73600	73600		73600		0
$SO_4^=$	7470	7230		7350		3.3
Alk-$CaCO_3$	35	35		35.0		0
B	35.2	38.1		36.6		7.9
Cs				na		
Fe	0.272	0.294	0.276	0.281	4.2	
Li	0.65	0.62		0.635		4.7
Mn				na		
Si (SiO_2)	8.3	8.6		8.45		3.6
Sr	26.0	26.4		26.2		1.5
Br^-	56.1	56.0		56.0		0.2
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 40. Results of Solute Analyses by UNC/Bendix: DOE-2 Culebra[1]

Sample ID: D2.C385B Collection date: 03/11,12/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)
Ca	1970	1960	1940		1960	0.8
Mg	1060	1050	1060		1060	0.5
K	406	409	414		410	1.0
Na	18400	18300	18500		18400	0.5
Cl^-	34700	34700	34500		34600	0.3
$SO_4^=$	4000	4010	3840		3950	2.4
Alk-$CaCO_3$	53.6	53.6	53.6		53.6	0
B	15.6	16.0	15.2		15.6	2.6
Cs	<0.007	<0.007	<0.007		<0.007	
Fe	0.0384	0.0360	0.0344		0.0363	5.5
Li	0.46	0.48	0.48		0.470	2.5
Mn	0.298	0.294	0.295		0.296	0.7
Si (SiO_2)	17.0	16.7	18.5		17.4	5.5
Sr	37.8	37.2	38.0		37.7	1.1
Br^-	34.6	35.2	31.6	32.5	33.5	5.1
F^-	1.69	1.69	1.70		1.69	0.3
I^-	0.243	0.206	0.226		0.225	8.2
NO_3^-					na	

1. Key: na = not analyzed; RSD = relative standard deviation.

Table 41. Results of Solute Analyses by UNC/Bendix: H-2A Culebra[1]

Sample ID: H02A.C486B Collection date: 04/21/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	750	736		743		1.9
Mg	170	160	170	167	3.4	
K	93.0	94		93.5		1.1
Na	3500	3620	3600	3570	1.8	
Cl^-	5350	5270		5310		1.5
$SO_4^=$	2970	3010	2950	2980	1.0	
Alk-$CaCO_3$	46.0	43.5	42.5	44.0	4.1	
B	10.4	10.5		10.4		1.0
Cs	<0.01			<0.01		
Fe	1.04	1.11		1.08		6.5
Li	0.22	0.23		0.225		4.5
Mn	0.054	0.056		0.0550		3.6
Si (SiO_2)	12.4	12.8		12.6		3.2
Sr	9.52	9.56		9.54		0.4
Br^-	5.7	5.5		5.60		3.6
F^-	2.20	2.28		2.24		3.6
I^-	0.077	0.086	0.081	0.0813	5.6	
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 42. Results of Solute Analyses by UNC/Bendix: H-3B3 Culebra[1]

Sample ID: H03B3.C285B Collection date: 02/04/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)
Ca	1470	1460	1470		1470	0.4
Mg	790	760	800		783	2.7
K	420	428	426		425	1.0
Na	18000	17900	18100		18000	0.6
Cl^-	30000	30300	30500		30300	0.8
$SO_4^=$	4990	4670	4810		4820	3.3
Alk-$CaCO_3$	40.4	40.0	40.4		40.3	0.6
B	26.4	26.6	26.0		26.3	1.2
Cs	<0.007	<0.007	<0.007		<0.007	
Fe	0.207	0.197	0.197		0.200	2.9
Li	0.40	0.39	0.41		0.400	2.5
Mn	0.114	0.117	0.119		0.117	2.2
Si (SiO_2)	11.7	11.2	11.0		11.3	3.2
Sr	30.6	29.9	31.0		30.5	1.8
Br^-	24.3	27.5	24.4	26.9	25.8	6.4
F^-	1.97	1.90	1.96		1.94	1.9
I^-	0.129	0.138	0.146		0.138	6.2
NO_3^-					na	

1. Key: na = not analyzed; RSD = relative standard deviation.

Table 43. Results of Solute Analyses by UNC/Bendix: H-4B Culebra[1]

Sample ID: H04B.C785B Collection date: 07/20/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	698	684		691		2.0
Mg	422	432	428	427	1.2	
K	210	210		210		0
Na	5830	5870		5850		0.7
Cl^-	7480	7490		7480		0.1
$SO_4^=$	5650	5400		5520		4.5
Alk-$CaCO_3$	55	54		54		1.9
B	13.0	15.2		14.1		15.6
Cs				na		
Fe	0.32	0.324	0.322	0.322	0.6	
Li	0.39	0.40		0.395		2.6
Mn	0.104	0.109		0.106		4.7
Si (SiO_2)	14.4	14.2		14.3		1.4
Sr	14.4	14.2		14.3		1.4
Br^-	42.5	42.7		42.6		0.5
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 44. Results of Solute Analyses by UNC/Bendix: H-5B Culebra[1]

Sample ID: H05B.C885B

Collection date: 08/26,27/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1680	1720		1700		2.4
Mg	2160	2280	2070	2170	5.1	
K	1360	1340		1350		1.5
Na	53800	54500		54100		1.3
Cl^-	85600	85100		85400		0.6
$SO_4^=$	7880	7800		7840		1.0
Alk-$CaCO_3$	35	34		34.0		2.9
B	33.0	34.4		33.7		3.3
Cs	<0.01	<0.01		<0.01		
Fe	2.80	2.93		2.86		4.5
Li	0.80	0.82		0.810		2.5
Mn	0.282	0.306		0.294		8.2
Si (SiO_2)	7.1	7.1		7.10		0
Sr	30.0	28.6		29.3		4.8
Br^-	48.9	48.4		48.6		1.0
F^-	2.0	1.9		1.95		5.1
I^-	0.197	0.185		0.191		3.1
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 45. Results of Solute Analyses by UNC/Bendix: H-6B Culebra[1]

Sample ID: H06B.C985B

Collection date: 09/15/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	2050	2040		2040		0.5
Mg	1040	1040		1040		0
K	376	374		375		0.5
Na	17900	18000		18000		0.6
Cl^-	32110	32560		32330		1.4
$SO_4^=$	3550	3630	3530	3570	1.5	
Alk-$CaCO_3$	67.5	70.0		68.8		3.6
B	10.4	10.5		10.4		1.0
Cs	<0.01			<0.01		
Fe	0.093	0.096		0.0945		3.2
Li	0.46	0.44		0.450		4.4
Mn	0.133	0.124		0.128		7.0
Si (SiO_2)	17.6	18.0		17.8		2.2
Sr	29.9	31.0		30.4		3.6
Br^-	33.0	35.0		34.0		2.9
F^-	1.90	1.91	1.90	1.90	0.3	
I^-	0.100	0.090	0.097	0.0957	5.3	
IO_3^-	0.10			0.10		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 46. Results of Solute Analyses by UNC/Bendix: H-7B Culebra[1]

Sample ID: H07B.C386B

Collection date: 03/26/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	586	588		587		0.3
Mg	130	130		130		0
K	7.00	7.00		7.00		0
Na	208	206		207		1.0
Cl^-	325	317	317	320	1.4	
$SO_4^=$	1840	1910	1810	1850	2.8	
Alk-$CaCO_3$	97.5	99.0		98.2		1.5
B	0.75	0.76		0.755		1.3
Cs	<0.01			<0.01		
Fe	0.055	0.057		0.0560		3.6
Li	0.10	0.10		0.100		0
Mn	0.051	0.050		0.0505		2.0
Si (SiO_2)	47.5	47.1		47.3		0.8
Sr	8.84	8.18		8.51		7.7
Br^-	0.58	0.56		0.570		3.5
F^-	1.51	1.51		1.51		0
I^-	0.053	0.052		0.0525		1.9
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 47. Results of Solute Analyses by UNC/Bendix: H-8B Culebra[1]

Sample ID: H08B.C186B

Collection date: 01/22/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	556	540		548		2.9
Mg	160	150	160	157	3.7	
K	3.84	3.82		3.83		0.5
Na	54.4	55.8		55.1		2.5
Cl^-	30.4	30.4	30.6	30.5	0.4	
$SO_4^=$	1870	2050	1920	1950	4.8	
Alk-$CaCO_3$	75.0	72.5		73.7		3.4
B	0.48	0.49		0.485		2.1
Cs	<0.01			<0.01		
Fe	0.033	0.037	0.039	0.0363	8.5	
Li	0.12	0.11		0.115		9.1
Mn	0.022	0.020		0.0210		9.5
Si (SiO_2)	28.6	29.8		29.2		4.1
Sr	7.04	6.80		6.92		3.5
Br^-	0.075	0.100	0.080	0.0850	15.6	
F^-	2.53	2.38		2.46		6.1
I^-	0.150	0.140		0.145		6.9
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 48. Results of Solute Analyses by UNC/Bendix: H-9B Culebra[1]

Sample ID: H09B.C1185B

Collection date: 11/14/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	596	584		590		2.0
Mg	140	130	140	137	4.2	
K	6.90	6.80		6.85		0.7
Na	145	147		146		0.7
Cl^-	194	193		194		0.5
$SO_4^=$	1900	1970	1840	1900	3.4	
Alk-$CaCO_3$	87.0	87.5		87.2		0.6
B	0.64	0.62		0.630		3.2
Cs	<0.01			<0.01		
Fe	0.030	0.033		0.0315		9.7
Li	0.18	0.17		0.175		5.9
Mn	0.016	0.014	0.016	0.0153	7.7	
Si (SiO_2)	27.1	26.8		27.0		1.1
Sr	7.53	7.47		7.50		0.8
Br^-	0.23	0.25		0.240		4.2
F^-	3.38	3.29	3.25	3.31	2.0	
I^-	0.11	0.11		0.110		0
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 49. Results of Solute Analyses by UNC/Bendix: H-11B3 Culebra[1]

Sample ID: H11B3.C685B

Collection date: 06/03,04/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1700	1700		1700		0
Mg	1300	1350		1320		3.5
K	970	920	940	943	2.7	
Na	40300	40600		40400		0.7
Cl^-	65800	66100		65900		0.4
$SO_4^=$	7360	7000		7180		5.0
Alk-$CaCO_3$				na		
B	29.8	33.6		31.7		12
Cs				na		
Fe	0.134	0.143	0.133	0.137	4.0	
Li	0.62	0.61		0.615		3.3
Mn	0.215	0.231		0.223		7.2
Si (SiO_2)				na		
Sr	25.2	24.2		24.7		4.0
Br^-	46.0	48.9		47.4		6.1
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 50. Results of Solute Analyses by UNC/Bendix: H-12 Culebra[1]

Sample ID: H12.C885B

Collection date: 08/08/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1770	1790	1730	1760	1.7	
Mg	1960	1990		1980		1.5
K	1310	1240	1260	1270	2.8	
Na	49600	48900		49200		1.4
Cl^-	78900	79200		79000		0.2
$SO_4^=$	7400	7030		7210		5.1
Alk-$CaCO_3$	40	41		40.0		2.5
B	37.6	41.1		39.3		8.9
Cs				na		
Fe	0.220	0.240	0.214	0.225	6.1	
Li	1.1	1.2		1.15		8.7
Mn	0.085	0.090	0.087	0.0873	2.9	
Si (SiO_2)	7.3	7.2		7.25		1.4
Sr	30.6	30.2	31.0	30.6	1.3	
Br^-	73.5	78.5		76.0		6.6
F^-				na		
I^-				na		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 51. Results of Solute Analyses by UNC/Bendix: P-14 Culebra[1]

Sample ID: P14.C286B

Collection date: 02/26/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	3550	3480		3520		2.0
Mg	840	840		840		0
K	38.0	37.8		37.9		0.5
Na	4240	4440	4400	4360	2.4	
Cl^-	14570	14370		14470		1.4
$SO_4^=$	1550	1670	1540	1590	4.5	
Alk-$CaCO_3$	80	80		80.0		0
B	0.72	0.72		0.720		0
Cs	<0.01			<0.01		
Fe	1.91	2.09		2.00		9.0
Li	0.27	0.28		0.275		3.7
Mn	0.183	0.184		0.184		0.5
Si (SiO_2)	29.2	30.4		29.8		4.0
Sr	52.1	49.6		50.8		4.9
Br^-	70.0	74.0		72.0		5.5
F^-	1.66	1.72		1.69		3.6
I^-	0.42	0.41		0.415		2.4
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 52. Results of Solute Analyses by UNC/Bendix: P-17 Culebra[1]

Sample ID: P17.C386B

Collection date: 03/17/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1640	1600		1620		2.5
Mg	1440	1480		1460		2.7
K	780	784		782		0.5
Na	28200	28400		28300		0.7
Cl^-	48260	48190		48220		0.1
$SO_4^=$	6020	5990	6040	6020	0.4	
Alk-$CaCO_3$	43.5	42.5		43.0		2.3
B	37.4	37.6		37.5		0.5
Cs	<0.01			<0.01		
Fe	4.04	4.00		4.02		1.0
Li	0.87	0.87		0.870		0
Mn	0.864	0.880		0.872		1.8
Si (SiO_2)	8.7	8.3		8.50		4.7
Sr	27.9	29.9	29.6	29.1	3.7	
Br^-	71.0	72.0		71.5		1.4
F^-	1.79	1.95		1.87		8.6
I^-	0.18	0.17		0.175		5.7
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 53. Results of Solute Analyses by UNC/Bendix: WIPP-25 Culebra[1]

Sample ID: W25.C286B Collection date: 02/12/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1140	1130		1140		0.9
Mg	320	310		315		3.2
K	102	101		102		1.0
Na	3140	3220		3180		2.5
Cl^-	6380	6260		6320		1.9
$SO_4^=$	2440	2350	2350	2380	2.2	
Alk-$CaCO_3$	100	102		101		2.0
B	1.63	1.71		1.67		2.4
Cs	<0.01			<0.01		
Fe	0.47	0.54	0.50	0.503	7.0	
Li	0.22	0.22		0.220		0
Mn	0.108	0.108		0.108		0
Si (SiO_2)	32.0	33.2		32.6		3.7
Sr	16.6	16.5		16.6		0.6
Br^-	3.40	3.30		3.35		3.0
F^-	1.67	1.70		1.68		1.2
I^-	0.038	0.043	0.045	0.0420	8.6	
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 54. Results of Solute Analyses by UNC/Bendix: WIPP-26 Culebra[1]

Sample ID: W26.C1185B Collection date: 11/25/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1360	1330		1340		2.2
Mg	380	380		380		0
K	344	342		343		0.3
Na	4160	4280		4220		2.8
Cl^-	8870	8670		8770		2.3
$SO_4^=$	2430	2470	2350	2420	2.5	
Alk-$CaCO_3$	98	93	97	96.0	2.7	
B	1.66	1.64		1.65		1.2
Cs	<0.01			<0.01		
Fe	0.024	0.027	0.028	0.0263	8.0	
Li	0.23	0.23		0.230		0
Mn	<0.01			<0.01		
Si (SiO_2)	33.8	35.7		34.8		3.5
Sr	19.5	19.5		19.5		0
Br^-	3.8	4.0		3.90		2.6
F^-	1.86	1.68	1.64	1.73	6.8	
I^-	0.069	0.070		0.0695		1.4
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 55. Results of Solute Analyses by UNC/Bendix: WIPP-29 Culebra[1]

Sample ID: W29.C1285B Collection date: 12/14/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	420	406		413		3.4
Mg	6600	6400		6500		3.1
K	23800	22800	23400	23300	2.2	
Na	92400	96400	96000	94900	2.3	
Cl^-	179700	177900		178800		1.0
$SO_4^=$	19700	20300	20100	20000	1.5	
Alk-$CaCO_3$	123	127		125		3.2
B	5.14	5.20		5.17		1.2
Cs	<0.01			<0.01		
Fe	1.08	1.14		1.11		9.0
Li	0.70	0.70		0.700		0
Mn	1.74	1.72		1.73		1.2
Si (SiO_2)	14.9	14.3		14.6		4.1
Sr	12.9	12.6		12.8		2.4
Br^-	62.0	60.0		61.0		3.3
F^-	4.79	4.40		4.60		8.5
I^-	0.39	0.38		0.385		2.6
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 56. Results of Solute Analyses by UNC/Bendix: Engle Well - Culebra[1]

Sample ID: XENG.C385B

Collection date: 03/05/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)
Ca	590	580	595		588	1.3
Mg	152	149	154		152	1.7
K	5.60	5.56	5.64		5.60	0.7
Na	198	199	202		200	1.0
Cl^-	228	230	235		231	1.6
$SO_4^=$	1950	2040	1970		1990	2.4
Alk-$CaCO_3$	86.5	87.0	87.0		86.8	0.3
B	0.98	0.96	0.96		0.970	1.2
Cs	<0.001	<0.001	<0.001		<0.001	
Fe	0.595	0.588	0.575		0.586	1.7
Li	0.18	0.16	0.17		0.170	5.9
Mn	0.0590	0.0630	0.0575		0.0598	4.7
Si (SiO_2)	30.5	28.2	28.5		29.1	4.3
Sr	8.40	8.20	8.48		8.36	1.7
Br^-	0.310	0.240	0.290	0.230	0.270	14.3
F^-	2.81	2.80	2.79		2.80	0.3
I^-	0.110	0.121	0.117		0.116	4.8
NO_3^-					na	

1. Key: na = not analyzed; RSD = relative standard deviation.

Table 57. Results of Solute Analyses by UNC/Bendix: H-3B1 Magenta[1]

Sample ID: H03B1.M785B

Collection date: 07/01/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	1010	1000			1000		1.0
Mg	290	294			292		1.4
K	35.0	34.0			34.5		2.9
Na	1570	1510	1490	1510	1520	2.3	
Cl^-	3360	3360			3360		0
$SO_4^=$	2340	2290			2310		2.2
Alk-$CaCO_3$	35	35			35.0		0
B	2.0	2.1			2.05		4.9
Cs	<0.01	<0.01			<0.01		
Fe	0.108	0.110	0.103		0.107	3.4	
Li	0.31	0.33			0.320		6.2
Mn	0.0264	0.0288			0.0276		8.7
Si (SiO_2)	10.7	10.3			10.5		3.8
Sr	17.4	17.2			17.3		1.2
Br^-	5.9	5.8			5.85		1.7
F^-	2.50	2.36			2.43		5.7
I^-	1.21	1.20			1.20		0.8
NO_3^-					na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 58. Results of Solute Analyses by UNC/Bendix: H-4C Magenta[1]

Sample ID: H04C.M1186 Collection date: 11/04/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	646	656		651		1.5
Mg	410	412		411		0.5
K	85.0	85.2		85.1		0.2
Na	7075	7150		7112		1.0
Cl^-	8463	8458		8460		0.1
$SO_4^=$	7190	7060	7050	7100	1.1	
Alk-$CaCO_3$	61.0	60.5		60.8		0.8
B	11.3	11.7		11.5		3.5
Cs	<0.01			<0.01		
Fe	0.72	0.70		0.710		2.8
Li	0.46	0.45		0.460		2.2
Mn	0.29	0.29		0.290		0
Si (SiO_2)	8.98	9.53	8.67	9.06	4.8	
Sr	11.8	12.3		12.0		4.1
Br^-	5.92	5.90		5.91		0.3
F^-	2.34	2.52		2.43		7.4
I^-	0.303	0.325		0.314		7.0
IO_3^-	<0.01			<0.01		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 59. Results of Solute Analyses by UNC/Bendix: H-5C Magenta[1]

Sample ID: H05C.M1086 Collection date: 10/24/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	548	552			550		0.7
Mg	174	172			173		1.2
K	33.4	33.7			33.6		0.9
Na	1500	1460			1480		2.7
Cl^-	1073	1071			1072		0.2
$SO_4^=$	3610	3630	3620		3620	0.3	
Alk-$CaCO_3$	41	41			41.0		0
B	10.6	10.6			10.6		0.4
Cs	<0.01				<0.01		
Fe	1.52	1.55			1.54		2.0
Li	0.20	0.20			0.200		0
Mn	0.020	0.020			0.0200		0
Si (SiO_2)	10.4	10.8			10.6		3.8
Sr	10.3	10.6			10.4		2.4
Br^-	2.59	2.76	2.74	2.79	2.72	3.3	
F^-	2.36	2.56			2.46		8.1
I^-	0.313	0.303			0.308		3.2
IO_3^-	<0.01				<0.01		
NO_3^-					na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 60. Results of Solute Analyses by UNC/Bendix: H-6C Magenta[1]

Sample ID: H06C.M1086

Collection date: 10/01/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	rep 4 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	542	550			546		1.5
Mg	160	160			160		0
K	16.7	16.7			16.6		0.6
Na	632	652			642		3.1
Cl^-	426	430			428		0.9
$SO_4^=$	2720	2680	2700		2700	0.7	
Alk-$CaCO_3$	38.5	39.0			38.8		1.3
B	2.12	2.20			2.16		3.9
Cs	<0.01				<0.01		
Fe	0.26	0.26			0.260		0
Li	0.21	0.21			0.210		0
Mn	0.010	0.010			0.0100		0
Si (SiO_2)	11.7	11.0	10.4		11.1	5.0	
Sr	9.74	9.85			9.80		1.1
Br^-	1.08	1.09	1.08	1.11	1.09	1.3	
F^-	1.45	1.57			1.51		7.9
I^-	0.088	0.083			0.0860		5.9
IO_3^-	<0.01				<0.01		
NO_3^-					na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 61. Results of Solute Analyses by UNC/Bendix: Ranch Well - Dewey Lake[1]

Sample ID: XRAN.D686 Collection date: 06/18/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	418	422		420		1.0
Mg	204	201		202		1.5
K	3.94	4.06		4.00		3.0
Na	200	199		200		0.5
Cl^-	416	419		418		0.7
$SO_4^=$	1100	1090	1110	1100	0.9	
Alk-$CaCO_3$	142	141		142		0.7
B	0.10	0.10		0.100		0
Cs	<0.010			<0.01		
Fe	0.024	0.024		0.0240		0
Li	0.12	0.12		0.120		0
Mn				<0.01		
Si (SiO_2)	51.6	53.4	50.2	51.7	3.1	
Sr	5.83	6.05		5.94		3.7
Br^-	2.34	2.31		2.32		1.3
F^-	0.79	0.85		0.82		7.3
I^-	0.128	0.130		0.129		1.6
IO_3^-	0.150			0.150		
NO_3^-	525	523		524		0.4

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 62. Results of Solute Analyses by UNC/Bendix: Twin Wells/Pasture Well - Dewey Lake[1]

Sample ID: XTWP.D186B

Collection date: 01/30/86

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	81.0	79.8		80.4		1.5
Mg	22.0	23.0		22.5		4.4
K	3.84	3.86		3.85		0.5
Na	25.0	25.8		25.4		3.1
Cl^-	44.6	44.4	43.2	44.1	1.7	
$SO_4^=$	74.4	75.5	75.4	75.1	0.8	
Alk-$CaCO_3$	120	128	122	123	3.4	
B	0.13	0.13		0.130		0
Cs	<0.01			<0.01		
Fe	<0.01			<0.01		
Li	<0.05			<0.05		
Mn	<0.01			<0.01		
Si (SiO_2)	46.3	47.5		46.9		2.8
Sr	1.07	1.06		1.06		1.0
Br^-	0.17	0.17		0.170		0
F^-	0.58	0.59		0.58		1.7
I^-	<0.01			<0.01		
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 63. Results of Solute Analyses by UNC/Bendix: DOE-2 Bell Canyon[1]

Sample ID: D2.B785B

Collection date: 07/23/85

Analyte	rep 1 (mg/L)	rep 2 (mg/L)	rep 3 (mg/L)	average (mg/L)	RSD (%)	RPD (%)
Ca	5860	5840	6040	5910	1.9	
Mg	1320	1350	1310	1330	1.6	
K	900	870		885		3.4
Na	49900	49300		49600		1.2
Cl^-	89900	89200	89900	89700	0.4	
$SO_4^=$	2130	1970	1950	2020	4.9	
Alk-$CaCO_3$	40	38		39.0		5.1
B	52.0	55.7		53.8		6.9
Cs	<0.01	<0.01		<0.01		
Fe	10.8	11.0	10.7	10.8	1.4	
Li	5.7	6.0		5.85		5.2
Mn	2.74	2.94		2.84		7.0
Si (SiO_2)	2.58	2.46		2.52		4.8
Sr	145	146		146		0.7
Br^-	239	270	244	251	6.6	
F^-	1.14	1.10		1.12		3.6
I^-	6.33	6.46		6.39		2.0
NO_3^-				na		

1. Key: na = not analyzed; RSD = relative standard deviation; RPD = relative percent difference.

Table 64. Summary of Results of Laboratory Analyses by UNC/Bendix For SNL[1]

Well	Zone	Collection Date(s)	Sample ID	Table[2]	Chg Bal Error (%)	TDS-Calc'd (mg/L)
DOE-1	Cul	04/24,25/85	D1.C485B	39	0.2	13120
DOE-2	Cul	03/11,12/85	D2.C385B	40	-3.2	6040
H-2A	Cul	04/21/86	H02A.C486B	41	-1.1	1290
H-3B3	Cul	06/11/84	H03B3.C684B	37	-1.4	5500
H-3B3	Cul	02/04/85	H03B3.C285B	42	-1.4	5580
H-4B	Cul	05/29/81	H04B.C581B	33	-1.9	2170
H-4C	Cul	08/10/84	H04C.C884B	38	1.0	2120
H-4B	Cul	07/20/85	H04B.C785B	43	0.4	2020
H-5B	Cul	06/01/81	H05B.C681B	34	-2.1	15440
H-5C	Cul	10/15/81	H05C.C1081B	35	-2.2	15450
H-5B	Cul	08/26,27/85	H05B.C885B	44	1.5	15260
H-6B	Cul	05/02/81	H06B.C581B	36	0.2	5930
H-6B	Cul	09/15/85	H06B.C985B	45	-0.5	5740
H-7B	Cul	03/26/86	H07B1.C386B	46	-0.4	322
H-8B	Cul	01/22/86	H08B.C186B	47	-0.3	283
H-9B	Cul	11/14/85	H09B.C1185B	48	0.5	308
H-11B3	Cul	06/03,04/85	H11B3.C685B	49	-0.9	11740
H-12	Cul	08/08/85	H12.C885B	50	0.9	14050
P-14	Cul	02/26/86	P14.C286B	51	-0.9	2490
P-17	Cul	03/17/86	P17.C386B	52	-1.2	8650
W-25	Cul	08/20/80	W25.C880B	20	1.4	1210
W-25	Cul	02/12/86	W25.C286B	53	-1.4	1360
W-26	Cul	08/24/80	W26.C880B	21	-0.4	1510
W-26	Cul	11/25/85	W26.C1185B	54	-1.6	1760
W-27	Cul	09/03/80	W27.C980B	22	-1.5	13470
W-28	Cul	09/11/80	W28.C980B	23	-0.9	4660
W-29	Cul	08/28/80	W29.C880B	24	-2.3	24540
W-29	Cul	12/14/85	W29.C1285B	55	-1.8	32410
W-30	Cul	09/06/80	W30.C980B	25	-2.5	2910
ENGLE	Cul	03/05/85	XENG.C385B	56	1.0	327
H-3B1	Mag	07/01/85	H03B1.M785B	57	-1.0	856
H-4C	Mag	11/04/86	H04C.M1186B	58	-1.4	2390
H-5C	Mag	10/24/86	H05C.M1086B	59	0.2	698
H-6C	Mag	10/01/86	H06C.M1086B	60	-0.3	454
W-25	Mag	09/17/80	W25.M980B	26	-1.3	1190
W-27	Mag	09/25/80	W27.M980B	27	-0.7	14570
W-25	RS	07/17/80	W25.R780B	28	0.4	33440
W-26	RS	07/23/80	W26.R780B	29	0.3	18840
W-28	RS	07/31/80	W28.R780B	30	-0.9	27710
W-29	RS	07/24/80	W29.R780B	31	-1.0	11100
W-30	RS	07/17/80	W30.R780B	32	0.1	32590
RANCH	DL	06/18/86	XRAN.D686B	61	0.3	252
TWIN-P	DL	01/30/86	XTWP.D186B	62	9.2[3]	40
DOE-2	BC	07/23/85	D2.B785B	63	0.2	14950

Table 64. Summary of Results of Laboratory Analyses by UNC/Bendix (continued)

Well	Zone	Date	Alk $CO_3^{=}$ (mg/L)	Alk HCO_3^{-} (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl^{-} (mg/L)	$SO_4^{=}$ (mg/L)
DOE-1	Cul	04/85	0	43	1730	1610	45800	1100	73600	7350
DOE-2	Cul	03/85	0	65	1960	1060	18400	410	34600	3950
H-2A	Cul	04/86	0	54	743	167	3570	93.5	5310	2980
H-3B3	Cul	06/84	0	53	1550	829	17400	495	29500	5130
H-3B3	Cul	02/85	0	49	1470	783	18000	425	30300	4820
H-4B	Cul	05/81	na	na	700	455	6080	215	7980	6230
H-4C	Cul	08/84	na	na	698	505	6150	222	7950	5700
H-4B	Cul	07/85	0	66	691	427	5850	210	7480	5520
H-5B	Cul	06/81	na	na	1710	2140	52400	1290	89500	7360
H-5C	Cul	10/81	na	na	1720	2150	52300	1300	89500	7570
H-5B	Cul	08/85	0	41	1700	2170	54100	1350	85400	7840
H-6B	Cul	05/81	na	na	2150	1080	18600	450	33000	3980
H-6B	Cul	09/85	0	84	2040	1040	18000	375	32300	3570
H-7B1	Cul	03/86	0	120	587	130	207	7.00	320	1850
H-8B	Cul	01/86	0	90	548	157	55.1	3.83	30.5	1950
H-9B	Cul	11/85	0	110	590	137	146	6.85	194	1900
H-11B3	Cul	06/85	na	na	1700	1320	40400	943	65900	7180
H-12	Cul	08/85	0	49	1760	1980	49200	1270	79000	7210
P-14	Cul	02/86	0	98	3520	840	4360	37.9	14500	1590
P-17	Cul	03/86	0	52	1620	1460	28300	782	48200	6020
W-25	Cul	08/80	na	na	905	260	3160	73.5	5250	2500
W-25	Cul	02/86	0	120	1140	315	3180	102	6320	2380
W-26	Cul	08/80	na	na	1240	355	3620	170	7200	2480
W-26	Cul	11/85	0	120	1340	380	4220	343	8770	2420
W-27	Cul	09/80	na	na	3210	1900	39200	8060	78500	3830
W-28	Cul	09/80	na	na	1180	555	15200	485	24800	4380
W-29	Cul	08/80	na	na	950	5480	71400	15600	138000	14000
W-29	Cul	12/85	0	150	413	6500	94900	23300	179000	20000
W-30	Cul	09/80	na	na	1140	460	8570	255	14600	4120
ENGLE	Cul	03/85	0	110	588	152	200	5.60	231	1990
H-3B1	Mag	07/85	0	43	1000	292	1520	34.5	3360	2310
H-4C	Mag	11/86	0	74	651	411	7112	85.1	8460	7100
H-5C	Mag	10/86	0	50	550	173	1480	33.6	1070	3620
H-6C	Mag	10/86	0	47	546	160	642	16.6	428	2700
W-25	Mag	09/80	na	na	905	260	2910	71.5	5250	2490
W-27	Mag	09/80	na	na	3660	2100	43200	8090	85200	3410
W-25	RS	07/80	na	na	560	3260	122800	3330	192000	12400
W-26	RS	07/80	na	na	1420	1660	68600	1200	108000	7480
W-28	RS	07/80	na	na	605	3400	97100	4300	155000	16700
W-29	RS	07/80	na	na	1080	2320	36100	1480	58000	12000
W-30	RS	07/80	na	na	955	2770	120600	2180	192000	7390
RANCH	DL	06/86	0	170	420	202	200	4.00	418	1100
TWIN-P	DL	01/86	0	150	80.4	22.5	25.4	3.85	44.1	75.1
DOE-2	BC	07/85	0	48	5910	1330	49600	885	89700	2020

Table 64. Summary of Results of Laboratory Analyses by UNC/Bendix (continued)

Well	Zone	Date	B (mg/L)	Cs (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Si (mg/L as SiO_2)	Sr (mg/L)
DOE-1	Cul	04/85	37.	na	0.28	0.64	na	8.4	26.
DOE-2	Cul	03/85	16.	<0.007	0.036	0.47	0.30	17.	38.
H-2A	Cul	04/86	10.	<0.01	1.1	0.22	0.055	13.	9.5
H-3B3	Cul	06/84	30.	<0.007	0.57	0.53	0.13	9.8	23.
H-3B3	Cul	02/85	26.	<0.007	0.20	0.40	0.12	11.	30.
H-4B	Cul	05/81	18.	na	na	0.39	na	11.	14.
H-4C	Cul	08/84	20.	<0.002	2.2	0.49	0.20	13.	18.
H-4B	Cul	07/85	14.	na	0.32	0.40	0.11	14.	14.
H-5B	Cul	06/81	33.	na	na	0.77	na	6.2	32.
H-5C	Cul	10/81	35.	na	na	0.77	na	5.8	31.
H-5B	Cul	08/85	34.	<0.01	2.9	0.81	0.29	7.1	29.
H-6B	Cul	05/81	11.	na	na	0.44	na	20.	32.
H-6B	Cul	09/85	10.	<0.01	0.094	0.45	0.13	18.	30.
H-7B1	Cul	03/86	0.76	<0.01	0.056	0.10	0.050	47.	8.5
H-8B	Cul	01/86	0.48	<0.01	0.036	0.12	0.021	29.	6.9
H-9B	Cul	11/85	0.63	<0.01	0.032	0.18	0.015	27.	7.5
H-11B3	Cul	06/85	32.	na	0.14	0.62	0.22	na	25.
H-12	Cul	08/85	39.	na	0.22	1.2	0.087	7.2	31.
P-14	Cul	02/86	0.72	<0.01	2.0	0.28	0.18	30.	51.
P-17	Cul	03/86	38.	<0.01	4.0	0.87	0.87	8.5	29.
W-25	Cul	08/80	1.5	na	na	0.20	na	34.	12.
W-25	Cul	02/86	1.7	<0.01	0.50	0.22	0.11	33.	17.
W-26	Cul	08/80	1.4	na	na	0.24	na	33.	17.
W-26	Cul	11/85	1.6	<0.01	0.026	0.23	<0.01	35.	20.
W-27	Cul	09/80	2.3	na	na	0.33	na	23.	51.
W-28	Cul	09/80	5.8	na	na	0.30	na	36.	16.
W-29	Cul	08/80	4.4	na	na	0.78	na	22.	29.
W-29	Cul	12/85	5.2	<0.01	1.1	0.70	1.7	15.	13.
W-30	Cul	09/80	6.1	na	na	0.27	na	6.5	18.
ENGLE	Cul	03/85	0.97	<0.001	0.59	0.17	0.060	29.	8.4
H-3B1	Mag	07/85	2.0	<0.01	0.11	0.32	0.028	10.	17.
H-4C	Mag	11/86	12.	<0.01	0.71	0.46	0.29	9.1	12.
H-5C	Mag	10/86	11.	<0.01	1.5	0.20	0.020	11.	10.
H-6C	Mag	10/86	2.2	<0.01	0.26	0.21	0.010	11.	9.8
W-25	Mag	09/80	1.5	na	na	0.20	na	33.	12.
W-27	Mag	09/80	2.3	na	na	0.34	na	30.	59.
W-25	RS	07/80	41.	na	na	1.6	na	4.0	11.
W-26	RS	07/80	32.	na	na	1.2	na	6.2	27.
W-28	RS	07/80	46.	na	na	1.8	na	7.8	12.
W-29	RS	07/80	20.	na	na	1.3	na	15.	21.
W-30	RS	07/80	82.	na	na	0.72	na	5.5	18.
RANCH	DL	06/86	0.10	<0.01	0.024	0.12	<0.01	52.	5.9
TWIN-P	DL	01/86	0.13	<0.01	<0.01	<0.05	<0.01	47.	1.1
DOE-2	BC	07/85	54.	<0.01	11.	5.8	2.8	2.5	150.

Table 64. Summary of Results of Laboratory Analyses by UNC/Bendix (continued)

Well	Zone	Date	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	IO_3^- (mg/L)	NO_3^- (mg/L)
DOE-1	Cul	04/85	56	na	na	na	na
DOE-2	Cul	03/85	34	1.7	0.22	na	na
H-2A	Cul	04/86	5.6	2.2	0.081	na	na
H-3B3	Cul	06/84	29	2.1	0.13	na	na
H-3B3	Cul	02/85	26	1.9	0.14	na	na
H-4B	Cul	05/81	42	na	na	na	na
H-4C	Cul	08/84	48	2.1	0.23	na	na
H-4B	Cul	07/85	43	na	na	na	na
H-5B	Cul	06/81	62	na	na	na	na
H-5C	Cul	10/81	64	na	na	na	na
H-5B	Cul	08/85	49	2.0	0.19	na	na
H-6B	Cul	05/81	34	na	na	na	na
H-6B	Cul	09/85	34	1.9	0.096	0.10	na
H-7B1	Cul	03/86	0.57	1.5	0.052	na	na
H-8B	Cul	01/86	0.085	2.5	0.14	na	na
H-9B	Cul	11/85	0.24	3.3	0.11	na	na
H-11B3	Cul	06/85	47	na	na	na	na
H-12	Cul	08/85	76	na	na	na	na
P-14	Cul	02/86	72	1.7	0.42	na	na
P-17	Cul	03/86	72	1.9	0.18	na	na
W-25	Cul	08/80	2.6	na	na	na	na
W-25	Cul	02/86	3.4	1.7	0.042	na	na
W-26	Cul	08/80	3.2	na	na	na	na
W-26	Cul	11/85	3.9	1.7	0.070	na	na
W-27	Cul	09/80	28	na	na	na	na
W-28	Cul	09/80	7.2	na	na	na	na
W-29	Cul	08/80	45	na	na	na	na
W-29	Cul	12/85	61	4.6	0.38	na	na
W-30	Cul	09/80	10	na	na	na	na
ENGLE	Cul	03/85	0.27	2.8	0.12	na	na
H-3B1	Mag	07/85	5.8	2.4	1.2	na	na
H-4C	Mag	11/86	5.9	2.4	0.31	<0.01	na
H-5C	Mag	10/86	2.7	2.5	0.31	<0.01	na
H-6C	Mag	10/86	1.1	1.5	0.086	<0.01	na
W-25	Mag	09/80	2.5	na	na	na	na
W-27	Mag	09/80	28	na	na	na	na
W-25	RS	07/80	51	na	na	na	na
W-26	RS	07/80	19	na	na	na	na
W-28	RS	07/80	29	na	na	na	na
W-29	RS	07/80	12	na	na	na	na
W-30	RS	07/80	78	na	na	na	na
RANCH	DL	06/86	2.3	0.82	0.13	0.15	520
TWIN-P	DL	01/86	0.17	0.58	<0.01	na	na
DOE-2	BC	07/85	250	1.1	6.4	na	na

1. Key: na = not analyzed; Cul = Culebra; Mag = Magenta; RS = Rustler/Salado; DL = Dewey Lake; BC = Bell Canyon; well abbreviations are explained in Table 1.
2. Table with replicate data and estimates of analytical precision.
3. CBE is -1.0% if field alkalinity used rather than laboratory value.

Table 65. Analytical Methods Used by UNC/Bendix (1984-1986)[1]

SAMPLE ID[2]	Ca	Mg	Na	K	Alk.	Cl^-	$SO_4^=$
D1.C485B	ICP	ICP	AAS	AAS	Titrn	Titrn	IC
D2.C385B	AAS	AAS	AAS	AAS	Titrn	ISE	IC
H02A.C486B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
H03B3.C684B	ICP	ICP	ICP	ICP	Titrn	ISE	IC
H03B3.C285B	AAS	AAS	AAS	AAS	Titrn	ISE	IC
H04B.C581B	AAS	AAS	AAS	AAS	--	ISE	IC
H04C.C884B	AAS	AAS	AAS	AAS	--	ISE	IC
H04B.C785B	ICP	ICP	AAS	AAS	Titrn	Titrn	IC
H05B.C681B	AAS	AAS	AAS	AAS	--	ISE	IC
H05C.C1081B	AAS	AAS	AAS	AAS	--	ISE	IC
H05B.C885B	ICP	ICP	AAS	AAS	Titrn	Titrn	IC
H06B.C581B	AAS	AAS	AAS	AAS	--	ISE	IC
H06B.C985B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
H07B1.C386B	AAS	AAS	AAS	AAS	Titrn	ISE	IC
H08B.C186B	AAS	AAS	AAS	AAS	Titrn	ISE	IC
H09B.C1185B	AAS	AAS	AAS	AAS	Titrn	ISE	IC
H11B3.C685B	ICP	ICP	AAS	AAS	--	Titrn	IC
H12.C885B	ICP	ICP	AAS	AAS	Titrn	Titrn	IC
P14.C286B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
P17.C386B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
W25.C880B	AAS	AAS	AAS	AAS	--	ISE	IC
W25.C286B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
W26.C880B	AAS	AAS	AAS	AAS	--	ISE	IC
W26.C1185B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
W27.C980B	AAS	AAS	AAS	AAS	--	ISE	IC
W28.C980B	AAS	AAS	AAS	AAS	--	ISE	IC
W29.C880B	AAS	AAS	AAS	AAS	--	ISE	IC
W29.C1285B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
W30.C980B	AAS	AAS	AAS	AAS	--	ISE	IC
XENG.C385B	AAS	AAS	AAS	AAS	Titrn	ISE	IC
H03B1.M785B	ICP	ICP	AAS	AAS	Titrn	Titrn	IC
H04C.M1186B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
H05C.M1086B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
H06C.M1086B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
W25.M980B	AAS	AAS	AAS	AAS	--	ISE	IC
W27.M980B	AAS	AAS	AAS	AAS	--	ISE	IC
W25.R780B	AAS	AAS	AAS	AAS	--	ISE	IC
W26.R780B	AAS	AAS	AAS	AAS	--	ISE	IC
W28.R780B	AAS	AAS	AAS	AAS	--	ISE	IC
W29.R780B	AAS	AAS	AAS	AAS	--	ISE	IC
W30.R780B	AAS	AAS	AAS	AAS	--	ISE	IC
XRAN.D686B	AAS	AAS	AAS	AAS	Titrn	Titrn	IC
XTWP.D186B	AAS	AAS	AAS	AAS	Titrn	ISE	IC
D2.B785B	ICP	ICP	AAS	AAS	Titrn	Titrn	IC

Table 65. Analytical Methods Used by UNC/Bendix (1984-1986) (continued)

SAMPLE ID	Br^-	F^-	I^-	NO_3^-	B	Cs	Fe	Li	Mn	SiO_2	Sr
D1.C485B	DPP	--	--	--	ICP	--	GFAAS	AAS	--	UV/VI	ICP
D2.C385B	DPP	ISE	DPP	--	ICP	GFAAS	GFAAS	AAS	GFAAS	UV/VI	AAS
H02A.C486B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
H03B3.C684B	XRF	ISE	DPP	--	ICP	GFAAS	AAS	ICP	AAS	UV/VI	ICP
H03B3.C285B	DPP	ISE	DPP	--	ICP	GFAAS	GFAAS	AAS	GFAAS	UV/VI	AAS
H04B.C581B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
H04C.C884B	DPP	ISE	DPP	--	ICP	GFAAS	GFAAS	AAS	GFAAS	UV/VI	AAS
H04B.C785B	DPP	--	--	--	ICP	--	GFAAS	AAS	GFAAS	UV/VI	ICP
H05B.C681B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
H05C.C1081B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
H05B.C885B	DPP	ISE	DPP	--	ICP	GFAAS	GFAAS	AAS	GFAAS	UV/VI	ICP
H06B.C581B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
H06B.C985B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
H07B1.C386B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
H08B.C186B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
H09B.C1185B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
H11B3.C685B	DPP	--	--	--	ICP	--	GFAAS	AAS	GFAAS	--	ICP
H12.C885B	DPP	--	--	--	ICP	--	GFAAS	AAS	GFAAS	UV/VI	ICP
P14.C286B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
P17.C386B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
W25.C880B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W25.C286B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
W26.C880B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W26.C1185B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
W27.C980B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W28.C980B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W29.C880B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W29.C1285B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
W30.C980B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
XENG.C385B	DPP	ISE	DPP	--	ICP	GFAAS	GFAAS	AAS	GFAAS	UV/VI	AAS
H03B1.M785B	DPP	ISE	DPP	--	ICP	GFAAS	GFAAS	AAS	GFAAS	UV/VI	ICP
H04C.M1186B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	ICP	ICP
H05C.M1086B	UV/VIS	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	ICP	ICP
H06C.M1086B	UV/VIS	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	ICP	ICP
W25.M980B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W27.M980B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W25.R780B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W26.R780B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W28.R780B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W29.R780B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
W30.R780B	DPP	--	--	--	ICP	--	--	AAS	--	UV/VI	AAS
XRAN.D686B	DPP	ISE	DPP	IC	ICP	GFAAS	AAS	AAS	AAS	ICP	ICP
XTWP.D186B	DPP	ISE	DPP	--	ICP	GFAAS	AAS	AAS	AAS	UV/VI	ICP
D2.B785B	DPP	ISE	DPP	--	ICP	GFAAS	GFAAS	AAS	GFAAS	UV/VI	ICP

1. Abbreviations of analytical methods are explained in the text.
2. See Table 64 for well names, zones, and collection dates corresponding to Sample IDs.

Table 66. Spike Recovery Data from UNC/Bendix[1]

SAMPLE ID[2]	Ca	Mg	Na	K	Alk	Cl^-	$SO_4^=$
D1.C485B	96	98	99	104	na	na	na
D2.C385B	104	103	102	100	na	na	106
H02A.C486B	na	na	na	na	na	na	na
H03B3.C684B	101	102	102	96	na	99	98
H03B3.C285B	100	102	101	99	na	na	100
H04B.C581B	na	98	na	na	--	na	na
H04C.C884B	102	99	101	98	--	na	109
H04B.C785B	99	98	na	na	na	99	na
H05B.C681B	na	na	na	96	--	na	na
H05C.C1081B	na	na	99	na	--	94	na
H05B.C885B	98	96	na	101	na	101	na
H06B.C581B	na	na	na	na	--	na	na
H06B.C985B	101	96	100	101	na	102	99
H07B1.C386B	na	na	na	na	na	na	na
H08B.C186B	107	102	100	102	na	98	95
H09B.C1185B	101	100	100	101	na	97	96
H11B3.C685B	93	93	na	97	--	na	na
H12.C885B	96	99	na	na	na	na	na
P14.C286B	na	na	na	na	na	na	na
P17.C386B	na	na	na	na	na	na	na
W25.C880B	na	na	na	na	--	na	na
W25.C286B	104	102	98	101	na	102	92
W26.C880B	na	na	na	na	--	96	na
W26.C1185B	na	na	na	na	na	na	na
W27.C980B	na	na	na	na	--	na	na
W28.C980B	na	104	na	na	--	na	na
W29.C880B	105	na	na	na	--	na	na
W29.C1285B	105	97	102	100	na	101	98
W30.C980B	na	na	na	na	--	98	na
XENG.C385B	100	99	102	99	na	na	103
H03B1.M785B	99	102	102	na	na	99	na
H04C.M1186B	na	na	na	na	na	na	na
H05C.M1086B	na	na	na	na	na	na	na
H06C.M1086B	99	102	101	95	na	100	103
W25.M980B	na	na	96	na	--	na	na
W27.M980B	na	na	96	na	--	na	na
W25.R780B	105	103	na	105	--	na	na
W26.R780B	na	na	na	na	--	na	na
W28.R780B	99	na	na	104	--	na	na
W29.R780B	na	na	na	na	--	98	na
W30.R780B	na	na	na	na	--	na	na
XRAN.D686B	98	100	99	98	na	100	101
XTWP.D186B	na	na	na	na	na	na	na
D2.B785B	93	100	97	na	na	na	na

Table 66. Spike Recovery Data from UNC/Bendix (continued)

SAMPLE ID	Br^-	F^-	I^-	NO_3^-	B	Cs	Fe	Li	Mn	SiO_2	Sr
D1.C485B	MA	--	--	--	96	--	93	96	--	MA	92
D2.C385B	MA	MA	MA	--	103	MA	92	100	100	MA	104
H02A.C486B	MA	MA	MA	--	na	na	na	na	na	na	na
H03B3.C684B	MA	MA	98	--	102	MA	MA	101	MA	99	95
H03B3.C285B	MA	MA	MA	--	105	MA	95	99	94	MA	104
H04B.C581B	MA	--	--	--	na	--	--	na	--	na	na
H04C.C884B	MA	MA	MA	--	102	MA	94	100	95	MA	101
H04B.C785B	MA	--	--	--	99	--	na	101	na	MA	97
H05B.C681B	MA	--	--	--	na	--	--	98	--	na	96
H05C.C1081B	MA	--	--	--	na	--	--	na	--	na	na
H05B.C885B	MA	MA	MA	--	97	MA	na	100	na	MA	96
H06B.C581B	MA	--	--	--	na	--	--	na	--	92	na
H06B.C985B	MA	MA	MA	--	104	98	90	100	91	103	98
H07B1.C386B	MA	MA	MA	--	na	na	na	na	na	na	na
H08B.C186B	MA	MA	MA	--	101	101	98	100	92	102	100
H09B.C1185B	MA	MA	MA	--	102	105	95	98	89	92	96
H11B3.C685B	MA	--	--	--	97	--	na	101	99	--	93
H12.C885B	MA	--	--	--	96	--	na	95	94	MA	93
P14.C286B	MA	MA	MA	--	na	na	na	na	na	na	na
P17.C386B	MA	MA	MA	--	na	na	na	na	na	na	na
W25.C880B	MA	--	--	--	na	--	--	na	--	na	95
W25.C286B	MA	MA	MA	--	103	105	100	96	93	107	98
W26.C880B	MA	--	--	--	na	--	--	na	--	na	na
W26.C1185B	MA	MA	MA	--	na	na	na	na	na	na	na
W27.C980B	MA	--	--	--	102	--	--	96	--	96	na
W28.C980B	MA	--	--	--	96	--	--	na	--	na	96
W29.C1285B	MA	MA	MA	--	99	100	100	100	110	92	95
W29.C880B	MA	--	--	--	na	--	--	na	--	na	na
W30.C980B	MA	--	--	--	na	--	--	na	--	na	na
XENG.C385B	MA	MA	MA	--	104	MA	100	103	98	MA	101
H03B1.M785B	MA	MA	MA	--	95	MA	na	103	na	MA	98
H04C.M1186B	MA	MA	MA	--	na	107	na	na	na	na	na
H05C.M1086B	117	MA	MA	--	na	106	na	na	na	102	na
H06C.M1086B	112	MA	MA	--	99	107	95	101	100	na	100
W25.M980B	MA	--	--	--	na	--	--	na	--	na	na
W27.M980B	MA	--	--	--	na	--	--	na	--	na	na
W25.R780B	MA	--	--	--	na	--	--	97	--	na	na
W26.R780B	MA	--	--	--	105	--	--	na	--	na	na
W28.R780B	MA	--	--	--	na	--	--	na	--	96	na
W29.R780B	MA	--	--	--	na	--	--	na	--	na	na
W30.R780B	MA	--	--	--	101	--	--	na	--	96	na
XRAN.D686B	MA	MA	MA	na	96	98	102	102	96	100	99
XTWP.D186B	MA	MA	MA	--	na	na	na	na	na	na	na
D2.B785B	MA	MA	MA	--	98	MA	na	94	na	MA	107

1. Spike recoveries are reported in percent (%). Key: na = spiked sample not analyzed; MA = method of additions used; -- = analyte not determined in this sample.
2. See Table 64 for well names, zones, and collection dates corresponding to Sample IDs.

Table 67. Results from UNC/Bendix: Analyses of Acid Blanks

Well	Zone	Date	Fe (mg/L)	Mn (mg/L)	Cs (mg/L)	Ca (mg/L)	Mg (mg/L)	K (mg/L)	Na (mg/L)	B (mg/L)	Li (mg/L)	Sr (mg/L)
DOE-1	Cul	04/85	<0.01									
H-5B	Cul	08/85	<0.01	<0.01								
H-7B1	Cul	03/86	<0.01	<0.01		<1	<1	<1	<1	<0.01	<0.05	<0.1
H-8B	Cul	01/86	<0.01	<0.01		<1	<1	<1	<1	<0.01	<0.05	<0.1
H-9B	Cul	11/85	<0.01	<0.01		<1	<1	<1	<1	<0.01	<0.05	<0.1
H-11B3	Cul	06/85	<0.01									
H-12	Cul	08/85	<0.01	<0.01								
H-3B1	Mag	07/85	<0.01		<0.01							
H-4C	Mag	11/86	<0.01	<0.01		<1	<1	<1	<1	<0.01	<0.05	<0.01
RANCH	DL	06/86	<0.01	<0.01		<1	<1	<1	<1	<0.01	<0.05	<0.01
TWIN-P	DL	01/86	<0.01	<0.05		<1	<1	<1	<1	<0.01	<0.05	<0.1
DOE-2	BC	07/85	<0.01	<0.01								

Table 68. Results of Field and Laboratory Analyses by the USGS[1] - Part A-Samples from the Culebra Dolomite (continued)

Sample ID	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl^- (mg/L)	$SO_4^=$ (mg/L)	F^- (mg/L)	B (mg/L)	SiO_2 (mg/L)
H01.C676G	780	280	9400	190	12000	7400	5.1	2.4	2.7
H01.C377G	820	1800	29000	5600	49000	11000	0.8	18	.6
H02B1.C277G	690	160	2100	91	2800	3000	2.0	9.5	1.7
H02C.C377G	680	120	3600	120	4700	3200	1.6	10	3.5
H03B1.C377G	1500	670	19000	630	29600	5700	0.5	20	1.2
H04B.C1278G	180	430	5800	180	7500	4000	1.9	19	5.2
H05B.C1278G	360	1900	53000	1400	86000	810	1.4	36	2.1
H06B.C1278G	1200	970	18000	500	28000	3800	1.5	9.5	8.5
H07B1.C380G	590	130	210	1.4	350	1900	1.4	0.78	39
H08B.C280G	570	170	82	4.7	57	2000	2.4	0.58	19
H09B.C280G	580	150	210	1400	320	2000	3.0	0.78	26
H10B.C380G	1600	1000	21000	520	36000	5600	1.3	13	1.5
P14.C377G	3100	760	7600	600	20000	1400	0.9	0.70	33
P15.C577G	770	63	6900	1700	11000	3200	1.2	4.7	1.6
P17.C577G	1700	1600	30000	120	54000	5000	1.5	1.7	1.0
P18.C577G	5600	16000	9200	6200	80000	980	1.2	100	1.0
W25.C880G	920	250	5100	0.9	8300	2400	1.4	1.9	29
W26.C880G	1200	340	3600	2.0	8200	2300	1.5	1.8	20
W27.C880G	3100	2000	39000	714	77000	3900	0.5	1.9	13
W28.C880G	1200	470	21000	4.0	30000	3200	1.1	5.4	28
W29.C880G	810	5700	79000	150	140000	13000	0.7	45	11
W30.C880G	1100	870	37000	888	64000	5050	0.5	64	2.9

Table 68. Results of Field and Laboratory Analyses by the USGS[1] - Part B - Samples from the Magenta Dolomite (continued)

Well	Zone	Date	Sample ID	Density (g/mL @ 20 C)	pH	TDS (ROI @ 105 C) (mg/L)	TDS (Calc'd) (mg/L)	CBE (%)	Alk. $CaCO_3$ (mg/L)	Alk. $CO_3^{=}$ (mg/L)	Alk. HCO_3^{-} (mg/L)
H-1	Mag	06/04/76	H01.M676G	na	7.4	18900	18900	1.3	75	0	92
H-1	Mag	05/10/77	H01.M577G	na	7.2	na	22200	2.8	76	0	93
H-2A	Mag	02/22/77	H02A.M277G	na	8.6	12000	10300	2.3	61	0	74
H-3B1	Mag	05/10/77	H03B1.M577G	na	8.0	32000	29700	1.6	42	0	51
H-4A	Mag	12/14/78	H04A.M1278G	na	8.0	22300	22300	-1.0	52	0	63
H-5A	Mag	12/14/78	H05A.M1278G	na	7.8	na	6090	0.2	41	0	50
H-6A	Mag	12/20/78	H06A.M1278G	na	7.3	na	5780	-1.6	42	0	51
H-8A	Mag	02/12/80	H08A.M280G	1.006	9.3	9410	8970	3.1	26	--	--
H-9A	Mag	02/05/80	H09A.M280G	1.003	8.5	5460	5000	-0.4	35	--	--
H-10A	Mag	03/21/80	H10A.M380G	1.175	7.1	270000	261300	-2.0	na	na	na
W-25	Mag	09/04/80	W25.M980G	1.010	7.5	18700	11800	0.7	150	0	180
W-27	Mag	09/04/80	W27.M980G	na	6.5	173000	146500	0.3	180	0	220
W-30	Mag	09/20/80	W30.M980G	na	8.8	19000	18400	-3.3	62	--	--

Sample ID	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)	F^- (mg/L)	B (mg/L)	SiO_2 (mg/L)
H01.M676G	890	270	5700	70	8000	3900	2.8	2.2	1.3
H01.M577G	1000	460	6200	840	10000	3600	2.0	3.3	1.7
H02A.M277G	820	170	2700	81	4100	2400	na	0.22	6.0
H03B1.M577G	1200	480	9300	250	15000	3400	1.8	13	6.4
H04A.M1278G	210	410	7000	130	7500	7000	2.5	13	6.4
H05A.M1278G	240	170	1500	53	880	3200	2.8	11	9.0
H06A.M1278G	520	160	1100	46	1200	2700	1.4	2.5	7.7
H08A.M280G	870	17	2400	84	3500	2100	0.7	3.1	0.9
H09A.M280G	550	170	800	28	750	2700	1.8	2.6	3.3
H10A.M380G	2500	2600	93000	510	160000	2700	1.3	3.9	1.9
W25.M980G	910	240	3100	0.8	5600	1900	1.5	1.9	25
W27.M980G	3600	2000	43000	10000	85000	2900	0.4	0.23	13
W30.M980G	690	170	5500	190	8700	3200	1.9	12	0.7

Table 68. Results of Field and Laboratory Analyses by the USGS[1] -Part C - Samples from the Rustler/Salado contact zone (continued)

Well	Zone	Date	Sample ID	Density (g/mL @ 20 C)	pH	TDS (ROI @ 105 C) (mg/L)	TDS (Calc'd) (mg/L)	CBE (%)	Alk-$CaCO_3$ (mg/L)	Alk-$CO_3^{=}$ (mg/L)	Alk-HCO_3^{-} (mg/L)
H-1	RS	02/23/77	H01.R277G	na	7.9	480000	327200	0.3	550	0	680
H-2C	RS	02/23/77	H02C.R277G	na	5.9	450000	310800	-0.6	160	0	200
H-3B1	RS	02/23/77	H03B1.R277G	na	7.6	327000	326800	-0.6	380	0	470
H-4C	RS	03/16/79	H04C.R379G	na	na	322000	321300	-2.1	1	0	1
H-5C	RS	05/16/79	H05C.R579G	na	na	412000	411400	-1.6	180	0	300
H-6C	RS	04/09/79	H06C.R479G	na	na	316000	315200	-0.7	1	0	1
H-7C	RS	03/20/80	H07C.R380G	1.048	6.8	79800	69600	-2.2	35	0	43
H-8C	RS	09/06/80	H08C.R980G	na	7.6	130000	123600	0.7	21	0	26
H-9C	RS	05/20/80	H09C.R580G	1.202	7.0	326000	326000	3.7	24	0	29
H-10C	RS	05/19/80	H10C.R580G	1.198	6.3	323000	309800	-0.02	53	0	65
P-14	RS	02/24/77	P14.R277G	na	7.2	350000	313300	0.9	180	0	220
P-15	RS	04/03/79	P15.R479G	na	na	na	67300	0.8	45	0	55
P-17	RS	05/11/79	P17.R579G	na	na	na	268000	1.5	650	0	790
P-18	RS	05/11/79	P18.R579G	1.266	5.4	na	327500	-2.4	400	0	490
W-25	RS	03/19/80	W25.R380G	1.173	7.2	252000	238200	4.3	80	0	98
W-26	RS	03/18/80	W26.R380G	1.078	8.5	153000	152600	-2.2	160	--	--
W-27	RS	05/21/80	W27.R580G	1.205	7.8	363000	266000	2.2	na	na	na
W-28	RS	03/20/80	W28.R380G	1.140	7.0	na	182800	-0.5	na	na	na
W-29	RS	03/18/80	W29.R380G	1.068	7.3	129000	96800	-0.3	130	0	160
W-30	RS	03/19/80	W30.R380G	1.201	7.0	302000	301600	5.3	320	0	390

Table 68. Results of Field and Laboratory Analyses by the USGS[1] -Part C - Samples from the Rustler/Salado contact zone (continued)

Sample ID	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl^- (mg/L)	$SO_4^=$ (mg/L)	F^- (mg/L)	B (mg/L)	SiO_2 (mg/L)
H01.R277G	13000	30000	56000	17000	210000	520	na	110	<0.1
H02C.R277G	9200	25000	66000	9100	200000	1300	na	150	2.0
H03B1.R277G	18000	25000	59000	14000	210000	370	na	1.9	1.0
H04C.R379G	8300	27000	66000	8600	210000	1400	1.7	360	1.3
H05C.R579G	2100	82000	14000	21000	290000	2000	<0.1	67	1.6
H06C.R479G	4200	21000	80000	8000	200000	2000	1.0	200	1.4
H07C.R380G	2600	910	22000	210	41000	2900	0.8	3.1	7.2
H08C.R980G	1200	430	46000	660	70000	5300	0.4	1.3	0.8
H09C.R580G	1300	870	130000	1200	190000	2600	0.1	19	3.8
H10C.R580G	1500	11000	100000	4000	190000	3300	0.7	120	3.2
P14.R277G	570	1200	120000	1300	180000	10000	na	1.7	2.0
P15.R479G	770	350	24000	1400	38000	2800	1.3	3.7	1.3
P17.R579G	15000	40000	23000	8800	180000	1200	3.8	0.88	15
P18.R579G	10000	37000	48000	12000	220000	480	2.3	160	0.4
W25.R380G	650	3200	90000	2400	130000	12000	na	35	2.6
W26.R380G	2700	1300	52000	1000	88000	7600	na	30	2.5
W27.R580G	1160	1040	102000	2570	154000	5190	0.2	1.3	0.1
W28.R380G	615	2070	65000	2070	102000	11000	0.2	54	6.0
W29.R380G	850	2000	32000	1000	49000	12000	0.9	21	3.5
W30.R380G	850	2300	120000	1500	170000	7000	na	77	3.5

1. Data from Mercer (1983) and Mercer and Orr (1979). Abbreviations of well names are explained in Table 1. Key: Cul = Culebra Dolomite; Mag = Magenta Dolomite; RS = Rustler/Salado Contact Zone; na = not analyzed.

Table 68. Results of Field and Laboratory Analyses by the USGS[1] - Part A-Samples from the Culebra Dolomite

Well	Zone	Date	Sample ID	Density (g/mL @ 20 C)	pH	TDS (ROI @ 105 C) (mg/L)	TDS (Calc'd) (mg/L)	CBE (%)	Alk. $CaCO_3$ (mg/L)	Alk. $CO_3^{=}$ (mg/L)	Alk. HCO_3^{-} (mg/L)
H-1	Cul	06/02/76	H01.C676G	na	7.6	30100	30200	-2.0	86	0	100
H-1	Cul	03/17/77	H01.C377G	na	7.3	na	97300	-0.7	82	0	100
H-2B1	Cul	02/22/77	H02B1.C277G	na	8.4	9700	8900	-0.5	57	5	59
H-2C	Cul	03/16/77	H02C.C377G	na	8.2	na	12500	0.8	51	0	62
H-3B1	Cul	03/17/77	H03B1.C377G	na	7.4	62000	57200	0.9	94	0	120
H-4B	Cul	12/14/78	H04B.C1278G	na	7.6	18100	18100	0.9	48	0	59
H-5B	Cul	12/19/78	H05B.C1278G	na	6.8	144000	143500	1.5	34	0	41
H-6B	Cul	12/20/78	H06B.C1278G	na	7.3	52600	52500	3.7	85	0	100
H-7B1	Cul	03/20/80	H07B1.C380G	1.001	7.0	3610	3180	-0.2	100	0	120
H-8B	Cul	02/11/80	H08B.C280G	1.000	7.3	3200	2880	3.2	61	0	74
H-9B	Cul	02/05/80	H09B.C280G	na	7.3	3590	4660	26.	90	0	110
H-10B	Cul	03/21/80	H10B.C380G	1.045	8.3	69200	65700	-2.0	37	0	45
P-14	Cul	03/14/77	P14.C377G	na	6.0	38000	33800	-3.2	290	0	360
P-15	Cul	05/10/77	P15.C577G	na	na	24000	23700	1.2	92	24	63
P-17	Cul	05/10/77	P17.C577G	na	7.4	97000	92500	-3.4	63	0	77
P-18	Cul	05/10/77	P18.C577G	na	7.2	420000	118300	-3.0	250	0	310
W-25	Cul	08/14/80	W25.C880G	1.014	7.3	22100	17000	0.8	370	0	450
W-26	Cul	08/18/80	W26.C880G	1.013	6.9	23800	15600	-6.7	130	0	160
W-27	Cul	08/22/80	W27.C880G	1.094	6.4	186000	125700	-5.2	150	0	180
W-28	Cul	08/21/80	W28.C880G	1.044	6.4	74000	55900	5.2	670	0	820
W-29	Cul	08/20/80	W29.C880G	1.178	6.1	239000	238700	-3.4	210	0	260
W-30	Cul	08/13/80	W30.C880G	1.072	6.8	110000	108900	-4.2	74	0	90

Table 69. Results of Laboratory Analysis by ITAS (WQSP Round 1)[1]

Well	Zone	Date	Sample ID	pH	Chg Bal Error (%)	TDS (ROI at 180 C) (mg/L)	TDS (Calc'd) (mg/L)
DOE-1	Cul(a)	04/24/85	D1.C485Ia	6.9	--	130000	--
DOE-1	Cul(b)	04/25/85	D1.C485Ib	na	--	na	--
DOE-2	Cul	3/11,12/85	D2.C385I	7.1	--	58000	--
H-2A	Cul	04/21/86	H02A.C486I	7.8	-2.6	13500	13200
H-3B3	Cul	02/04/85	H03B3.C285I	7.6	--	55000	--
H-3B2	Cul	12/16/85	H03B2.C1285I	7.1	-1.7	54000	54900
H-4B	Cul	07/20/85	H04B.C785I	7.6	--	20000	--
H-5B	Cul	08/26/85	H05B.C885I	7.0	-6.3	142000	144600
H-6B	Cul	09/15/85	H06B.C985I	7.2	-11	58000	55200
H-7B1	Cul	03/27/86	H07B1.C386I	7.5	-20	3400	4020
H-8B	Cul	01/21-23/86	H08B.C186I	7.9	8.0	3150	2540
H-9B	Cul	11/14/85	H09B.C1185I	7.7	10	3300	2630
H-11B3	Cul	06/03/85	H11B3.C685I	7.2	--	122000	--
H-12	Cul	08/09/85	H12.C885I	7.3	-4.4	142000	135200
P-14	Cul	02/26,27/86	P14.C286I	7.0	-0.99	26000	24200
P-17	Cul	03/17/86	P17.C386I	7.0	-2.7	88000	90400
W-25	Cul	02/12/86	W25.C286I	7.7	1.5	14000	13700
W-26	Cul	11/25/85	W26.C1185I	7.4	0.13	18000	18200
W-29	Cul	12/14/85	W29.C1285I	6.6	-3.7	330000	317200
ENGLE	Cul	03/04,05/85	XENG.C385I	6.5	--	3460	--
H-3B1	Mag	07/01/85	H03B1.M785I	7.6	--	9000	--
H-4C	Mag	11/04/86	H04C.M1186I	8.0	-5.8	22500	28200
H-5C	Mag	10/24/86	H05C.M1086I	7.4	-4.7	6800	8410
H-6C	Mag	10/01/86	H06C.M1086I	7.2	19	4600	4750
H-8A	Mag	10/21/85	H08A.M1085I	na	-5.3	na	7150
RANCH	DL	06/18/86	XRAN.D686I	7.7	-1.0	3300	2270
TWIN-P	DL	01/30,31/86	XTWP.D186I	8.0	-19	400	671
DOE-2	BC	07/23/85	D2.B785I	6.7	--	160000	--

Table 69. Results of Laboratory Analysis by ITAS (WQSP Round 1) (continued)

Sample ID	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl^- (mg/L)	$SO_4^=$ (mg/L)
D1.C485Ia	na	na	na	na	na	na
D1.C485Ib	na	na	na	na	na	na
D2.C385I	na	na	na	na	na	na
H02A.C486I	705.	170.	3600	97.5	5300	3300
H03B3.C285I	na	na	na	na	na	na
H03B2.C1285I	2100	690.	17000	480.	30000	4600
H04B.C785I	na	na	na	na	na	na
H05B.C885I	1300	1700	47000	1300	87000	6300
H06B.C985I	1900	740.	15000	485.	34000	3000
H07B1.C386I	540.	130.	210.	7.00	700.	2300
H08B.C186I	540.	170.	51.0	3.70	33.0	1650
H09B.C1185I	560.	140.	150.	7.55	200.	1450
H11B3.C685I	na	na	na	na	na	na
H12.C885I	1850	1400	44500	1500	80000	5900
P14.C286I	3900	760.	3750	44.5	14000	1600
P17.C386I	1650	1550	29000	795.	51000	6400
W25.C286I	1150	340.	3350	105.	6200	2400
W26.C1185I	1800	375.	4150	350.	9450	1950
W29.C1285I	630.	6350	90000	23000	180000	17000
XENG.C385I	na	na	na	na	na	na
H03B1.M785I	na	na	na	na	na	na
H04C.M1186I	1100	470.	7500	135.	11000	7850
H05C.M1086I	795.	190.	1500	51.5	1600	4200
H06C.M1086I	620.	170.	1050	26.0	430.	2400
H08A.M1085I	555.	10.5	1800	59.0	3000	1700
XRAN.D686I	365.	190.	180.	3.65	390.	920
XTWP.D186I	81.0	23.5	26.0	3.70	47.0	270
D2.B785I	na	na	na	na	na	na

Table 69. Results of Laboratory Analysis by ITAS (WQSP Round 1) (continued)

Sample ID	Alk. $CO_3^{=}$ (mg/L)	Alk. HCO_3^{-} (mg/L)	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- as N (mg/L)
D1.C485Ia	na	na	64.	1.0	<1	<0.1
D1.C485Ib	na	na	na	na	na	na
D2.C385I	na	na	50.	1.2	<1	<0.1
H02A.C486I	0	56	<1	14.	1.0	0.30
H03B3.C285I	na	na	1.9	1.6	1.0	<0.1
H03B2.C1285I	0	52	na	na	na	na
H04B.C785I	na	na	64.	1.7	1.1	<0.1
H05B.C885I	0	47	94.	1.3	1.1	0.40
H06B.C985I	0	100	67.	1.6	<1	0.20
H07B1.C386I	0	130	1.0	1.2	<1	0.70
H08B.C186I	0	94	<1	2.4	<1	1.4
H09B.C1185I	0	120	1.0	2.6	<1	0.20
H11B3.C685I	na	na	100	1.0	1.1	<0.1
H12.C885I	0	56	140	1.2	1.6	<0.1
P14.C286I	0	100	24.	1.2	<1	0.20
P17.C386I	0	54	98.	1.2	7.3	0.30
W25.C286I	0	120	4.2	1.6	<1	3.6
W26.C1185I	0	130	12.	1.3	<1	5.7
W29.C1285I	0	170	100	0.9	2.1	0.10
XENG.C385I	na	na	1.2	2.8	<1	0.50
H03B1.M785I	na	na	23.	1.8	1.6	<0.1
H04C.M1186I	0	100	7.0	2.2	1.0	<0.1
H05C.M1086I	0	69	4.0	2.5	<1	<0.1
H06C.M1086I	0	52	1.0	1.7	<1	<0.1
H08A.M1085I	0	30	na	na	na	na
XRAN.D686I	0	220	2.3	1.0	.96	120
XTWP.D186I	0	220	<1	0.7	<1	7.8
D2.B785I	na	na	94.	0.4	7.9	0.75

Table 69. Results of Laboratory Analysis by ITAS (WQSP Round 1) (continued)

Sample ID	B (mg/L)	Cs (mg/L)	Fe (mg/L)	Li (mg/L)	Mn (mg/L)	Si (mg/L)	Sr (mg/L)
D1.C485Ia	7.5	10.	1.3	na	0.35	11.	5.8
D1.C485Ib	6.9	7.2	1.3	na	0.43	10.	5.9
D2.C385I	24.	1.7	0.35	na	0.37	11.	28.
H02A.C486I	10.	<0.1	0.76	na	0.080	13.	6.8
H03B3.C285I	34.	1.6	0.38	na	0.18	8.8	25.
H03B2.C1285I	na	na	na	na	na	na	na
H04B.C785I	23.	<0.1	0.43	na	0.12	14.	15.
H05B.C885I	29.	<1.0	3.0	na	0.52	17.	16.
H06B.C985I	7.1	<1.0	0.55	na	0.20	20.	24.
H07B1.C386I	0.74	<0.1	0.08	na	0.050	43.	5.8
H08B.C186I	0.06	<1.	0.05	na	<0.1	26.	5.9
H09B.C1185I	<0.1	0.2	<0.1	na	0.060	18.	7.0
H11B3.C685I	13.	.29	0.66	na	0.39	15.	18.
H12.C885I	35.	<10	0.56	na	0.64	45.	18.
P14.C286I	0.065	<0.01	1.6	na	0.23	32.	48.
P17.C386I	36.	<0.1	3.8	na	0.80	<0.2	28.
W25.C286I	1.7	<0.1	0.45	na	0.11	31.	1.4
W26.C1185I	<0.01	<0.1	<0.1	na	0.090	30.	17.
W29.C1285I	5.8	<1.	2.0	na	1.8	51.	9.0
XENG.C385I	0.77	0.07	0.32	na	~0.01	25.	7.0
H03B1.M785I	4.5	<0.1	0.14	na	0.045	11.	17.
H04C.M1186I	11.	0.1	0.90	0.43	0.46	10.	13.
H05C.M1086I	10.	0.2	1.3	0.20	<0.05	12.	8.4
H06C.M1086I	2.4	0.3	0.30	0.19	<0.05	13.	7.1
H08A.M1085I	na	na	na	na	na	na	na
XRAN.D686I	0.19	0.1	0.020	na	<0.005	40.	3.2
XTWP.D186I	0.16	<0.1	0.34	na	<0.05	42.	0.6
D2.B785I	61.	3.3	9.1	na	2.5	14.	300

1. Data from Uhland and Randall (1986) and Uhland et al. (1987). Abbreviations of well names are explained in Table 1. Cul = Culebra Dolomite; Mag = Magenta Dolomite; DL = Dewey Lake Red Beds; BC = Bell Canyon Formation; na = not analyzed.

Table 70: Results of Laboratory Analyses by the NMBM&MR for the EEG

Well	Zone	Date	Sample ID	Density (mg/L)	pH	TDS-Calc'd (mg/L)	Chg Bal Error (%)	F^- (mg/L)	Li (mg/L)
DOE-1	Cul	04/24,25/85	D1.C485	1.11	7.0	111200	3.0	1.7	na
DOE-2	Cul	03/11,12/85	D2.C385	1.06	7.2	57700	-0.2	2.2	na
H-3B3	Cul	02/04/85	H03B3.C285	1.02	7.1	55300	0.2	0.23	0.30
H-4B	Cul	07/25/85	H04B.C785	1.03	7.6	18700	-0.9	2.7	0.40
H-5B	Cul	08/26/85	H05B.C885	1.12	6.8	143500	1.3	1.2	<0.5
H-6B	Cul	09/15/85	H06B.C985	1.06	7.1	56900	-0.6	1.5	<0.5
H-8B	Cul	01/22/86	H08B.C186	1.01	7.2	2670	1.5	2.1	<0.5
H-9B	Cul	11/14/85	H09B.C1185	1.01	6.9	2960	2.1	2.8	<0.5
H-11B3	Cul	06/03,04/85	H11B3.C685	1.10	7.3	109500	-0.7	1.6	0.38
H-12	Cul	08/09/85	H12.C885	1.12	7.0	122400	-4.2	2.3	0.61
P-14	Cul	02/26/86	P14.C286	1.04	7.1	24800	0.1	1.5	<0.5
P-17	Cul	03/17/86	P17.C386	1.08	6.9	81200	-1.5	1.9	<0.5
W-26	Cul	11/25/85	W26.C1185	1.03	7.5	16800	-2.6	1.5	<0.5
W-29	Cul	12/14/85	W29.C1285	1.22	6.9	265600	-3.1	4.5	<0.5
ENGLE	Cul	03/04,05/85	XENG.C385	1.01	7.8	2940	4.0	2.9	na
H-3B1	Mag	07/01/85	H03B1.M785	1.02	7.4	7820	-2.0	2.6	0.32
TWIN-P	DL	01/31/86	XTWP.D186	1.0	7.9	227	-6.3[1]	1.4	<0.5
DOE-2	BC	07/23/85	D2.B785	1.12	6.8	130800	-2.2	1.4	2.8

Sample ID	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Cl^- (mg/L)	$SO_4^=$ (mg/L)
D1.C485E	1460	1370	40500	703	61400	5800
D2.C385E	2740	962	17600	309	32600	3470
H03B3.C285E	1410	719	18300	439	29500	4900
H04B.C785E	690	409	5190	185	6670	5530
H05B.C885E	1460	1910	51300	1110	81000	6730
H06B.C985E	1970	1130	17700	430	32300	3390
H08B.C186E	520	160	55	4.6	30	1900
H09B.C1185E	560	150	150	7.4	195	1900
H11B3.C685E	1580	1360	37800	680	62000	6040
H12.C885E	1510	1650	40400	670	71700	6520
P14.C286E	3640	740	4200	60.0	13900	1650
P17.C386E	1560	1440	26200	875	45200	5960
W26.C1185E	1290	425	3820	360	8490	2370
W29.C1285E	675	4750	75400	20800	147000	17000
XENG.C385E	570	132	187	5.4	170	1880
H03B1.M785E	892	273	1370	20.0	3030	2240
XTWP.D186E	60	25	24	4.3	44	70
D2.B785E	5320	1200	41800	600	80000	1880

1. CBE for Twin Wells (Pasture) calculated using field alkalinity value. Alkalinity not included in CBE calculations for other samples.

Table 71: Comparison of Data from the Culebra at DOE-1
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
DOE-1	HGC	04/13/83 - 04/21/83	0.5 gpm	FLD	D1.C483F
DOE-1	HGC	04/19/83	0.5 gpm	KCS	D1.C483KC
DOE-1	WQSP-R1	04/12/85 - 04/25/85	8.3 gpm	FLD	D1.C485F
DOE-1	WQSP-R1	04/24,25/85	8.3 gpm	BFEC	D1.C485B
DOE-1	WQSP-R1	04/24,25/85	8.3 gpm	EEG	D1.C485E
DOE-1	WQSP-R1	04/24/85	8.3 gpm	ITAS	D1.C485Ia
DOE-1	WQSP-R1	04/25/85	8.3 gpm	ITAS	D1.C485Ib

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
D1.C483F	1.090 (sg)	7.6			
D1.C483KC					
D1.C485F		7.1			
D1.C485B			131200		0.2%
D1.C485E	1.11 (g/mL)	7.0	111200		3.0%
D1.C485Ia		6.9		130000 (180 C)	
D1.C485Ib					

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
D1.C483F		~65-70			
D1.C483KC				94000	
D1.C485F	37	45	0	73000	
D1.C485B	35	43	0	73600	7350
D1.C485E				61400	5800
D1.C485Ia					
D1.C485Ib					

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
D1.C483F					
D1.C483KC					
D1.C485F					210
D1.C485B	45800	1100	1730	1610	218
D1.C485E	40500	703	1460	1370	185
D1.C485Ia					
D1.C485Ib					

Table 71. Comparison of Data from the Culebra at DOE-1 (continued)

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
D1.C483F							
D1.C483KC							
D1.C485F						0.4	
D1.C485B	37		0.64	8.4	26	0.28	
D1.C485E							
D1.C485Ia	7.5	10		11 as Si	5.8	1.3	0.35
D1.C485Ib	6.9	7.2		10 as Si	5.9	1.3	0.43

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
D1.C483F				
D1.C483KC				
D1.C485F				
D1.C485B	56			
D1.C485E		1.7		
D1.C485Ia	64	1.0	<1	<0.1 as N
D1.C485Ib				

Table 72. Comparison of Data from the Culebra at DOE-2
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
DOE-2	WQSP-R1	02/20/85 - 03/12/85	6 gpm	FLD	D2.C385F
DOE-2	WQSP-R1	03/11,12/85	6 gpm	BFEC	D2.C385B
DOE-2	WQSP-R1	03/11,12/85	6 gpm	EEG	D2.C385E
DOE-2	WQSP-R1	03/11,12/85	6 gpm	ITAS	D2.C385I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
D2.C385F		7.0			
D2.C385B			60400		-3.2%
D2.C385E	1.06 (g/mL)	7.2	57700		-0.2%
D2.C385I		7.1		58000 (180 C)	

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
D2.C385F	55	67	0	32000	
D2.C385B	54	65	0	34600	3950
D2.C385E				32600	3470
D2.C385I					

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
D2.C385F					190
D2.C385B	18400	410	1960	1060	185
D2.C385E	17600	309	2740	962	216
D2.C385I					

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
D2.C385F						<0.02	
D2.C385B	16	<0.007	0.47	17	38	0.036	0.30
D2.C385E							
D2.C385I	24	1.7		11 as Si	28	0.35	0.37

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
D2.C385F				
D2.C385B	34	1.7	0.22	
D2.C385E		2.2		
D2.C385I	50	1.2	<1	<0.1 as N

Table 73. Comparison of Data from the Culebra at FR-10
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
FR-10	HGC	10/06/83	pump pulse test	FLD	FR10.C1083F
FR-10	HGC	10/06/83	pump pulse test	H-B	FR10.C1083HB
FR-10	HGC	10/06/83	pump pulse test	KCS	FR10.C1083KC
FR-10	HGC	10/06/83	pump pulse test	KGS	FR10.C1083K

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
FR10.C1083F	1.000 (sg)	7.4			
FR10.C1083HB					
FR10.C1083KC					
FR10.C1083K					

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
FR10.C1083F		~260			
FR10.C1083HB					
FR10.C1083KC				100	
FR10.C1083K					49.5

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
FR10.C1083F					
FR10.C1083HB	77	8.5	520	150	38.3
FR10.C1083KC					
FR10.C1083K					

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
FR10.C1083F							
FR10.C1083HB			0.51			0.06	0.04
FR10.C1083KC							
FR10.C1083K							

Sample ID	Br^- (mg/L)	I^- (mg/L)
FR10.C1083F		
FR10.C1083HB		
FR10.C1083KC		
FR10.C1083K	0.21	0.009

Table 74. Comparison of Data from the Culebra at H-1
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-1	USGS	06/02/76	bail or swab	USGS	H01.C676G
H-1	USGS	03/17/77	bail or swab	USGS	H01.C377G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H01.C676G		7.6	30200	30100 (105 C)	-2.0%
H01.C377G		7.3	97300		-0.7%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H01.C676G	86	100	0	12000	7400
H01.C377G	82	100	0	49000	11000

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H01.C676G	9400	190	780	280	62
H01.C377G	29000	5600	820	1800	188

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H01.C676G	2.4			2.7			
H01.C377G	18			.6			

Sample ID	F^- (mg/L)
H01.C676G	5.1
H01.C377G	0.8

Table 75. Comparison of Data from the Culebra at H-2
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-2B1	USGS	02/22/77	bail or swab	USGS	H02B1.C277G
H-2C	USGS	03/16/77	bail or swab	USGS	H02C.C377G
H-2C	SNL	12/10/80	recirc.	FLD	H02C.C1280F
H-2A	WQSP-R1	04/04/86 - 04/21/86	23 gph	FLD	H02A.C486F
H-2A	WQSP-R1	04/21/86	23 gph	BFEC	H02A.C486B
H-2A	WQSP-R1	04/21/86	23 gph	ITAS	H02A.C486I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H02B1.C277G		8.4	8900	9700 (105 C)	-0.5%
H02C.C377G		8.2	12500		0.8%
H02C.C1280F	1.002 (sg)	7.9			
H02A.C486F	1.009 (sg)	8.0			
H02A.C486B			12900		-1.1%
H02A.C486I		7.8	13200	13500 (180 C)	-2.6%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H02B1.C277G	57	59	5	2800	3000
H02C.C377G	51	62	0	4700	3200
H02C.C1280F					
H02A.C486F	47	57	0	(5200)	
H02A.C486B	44	54	0	5310	2980
H02A.C486I	46	56	0	5300	3300

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H02B1.C277G	2100	91	690	160	48
H02C.C377G	3600	120	680	120	43.8
H02C.C1280F					
H02A.C486F					(53)
H02A.C486B	3570	93.5	743	167	50.8
H02A.C486I	3600	97.5	705	170	49.2

Table 75. Comparison of Data from the Culebra at H-2 (continued)

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H02B1.C277G	9.5			1.7			
H02C.C377G	10			3.5			
H02C.C1280F							
H02A.C486F						1	
H02A.C486B	10	<0.01	0.22	13	9.5	1.1	0.055
H02A.C486I	10	<0.1		13 as Si	6.8	0.76	0.080

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H02B1.C277G		2.0		
H02C.C377G		1.6		
H02C.C1280F				
H02A.C486F				
H02A.C486B	5.6	2.2	0.081	
H02A.C486I	<1	14	1.0	0.30 as N

Table 76. Comparison of Data from the Culebra at H-3
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-3B1	USGS	03/17/77	bail or swab	USGS	H03B1.C377G
H-3B3	HGC	06/10/84 - 06/11/84	3 gpm	FLD	H03B3.C684F
H-3B3	HGC	06/11/84	3 gpm	BFEC	H03B3.C684B
H-3B3	HGC	06/11/84	3 gpm	UA	H03B3.C684UA
H-3B3	WQSP-R1	01/29/85 - 02/04/85	3 gpm	FLD	H03B3.C285F
H-3B3	WQSP-R1	02/04/85	3 gpm	BFEC	H03B3.C285B
H-3B3	WQSP-R1	02/04/85	3 gpm	EEG	H03B3.C285E
H-3B3	WQSP-R1	02/04/85	3 gpm	ITAS	H03B3.C285I
H-3B2	WQSP	12/16/85	4.8 gpm	ITAS	H03B2.C1285I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H03B1.C377G		7.4	57200	62000 (105 C)	0.9%
H03B3.C684F	1.03 (sg)	7.4			
H03B3.C684B			55000		-1.4%
H03B3.C684UA					
H03B3.C285F		7.4			
H03B3.C285B			55800		-1.4%
H03B3.C285E	1.02 (g/mL)	7.1	55300		0.2%
H03B3.C285I		7.6	--	55000 (180 C)	--
H03B2.C1285I		7.1	54900	54000 (180 C)	-1.7%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H03B1.C377G	94	120	0	29600	5700
H03B3.C684F					
H03B3.C684B	43	53	0	29500	5130
H03B3.C684UA					
H03B3.C285F	43	52	0	28000	
H03B3.C285B	40	49	0	30300	4820
H03B3.C285E				29500	4900
H03B3.C285I					
H03B2.C1285I	43	52	0	30000	4600

Table 76. Comparison of Data from the Culebra at H-3 (continued)

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H03B1.C377G	19000	630	1500	670	130
H03B3.C684F					
H03B3.C684B	17400	495	1550	829	145
H03B3.C684UA					
H03B3.C285F					170
H03B3.C285B	18000	425	1470	783	138
H03B3.C285E	18300	439	1410	719	129
H03B3.C285I					
H03B2.C1285I	17000	480	2100	690	162

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H03B1.C377G	20			1.2			
H03B3.C684F							
H03B3.C684B	30	<0.007	0.53	9.8	23	0.57	0.13
H03B3.C684UA							
H03B3.C285F						0.2	
H03B3.C285B	26	<0.007	0.40	11	30	0.20	0.12
H03B3.C285E	0.30						
H03B3.C285I	34	1.6		8.8 as Si	25	0.38	0.18
H03B2.C1285I							

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H03B1.C377G		0.5		
H03B3.C684F				
H03B3.C684B	29	2.1	0.13	
H03B3.C684UA				
H03B3.C285F				
H03B3.C285B	26	1.9	0.14	
H03B3.C285E		0.23		
H03B3.C285I	1.9	1.6	1.0	<0.1 as N
H03B2.C1285I				

Table 77. Comparison of Data from the Culebra at H-4
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-4B	USGS	12/14/78	bail or swab	USGS	H04B.C1278G
H-4B	SNL	05/14/81 - 05/29/81	.26 gpm	FLD	H04B.C581F
H-4B	SNL	05/29/81	.26 gpm	BFEC	H04B.C581B
H-4C	HGC	08/09/84 - 08/10/84	30 gph	FLD	H04C.C884F
H-4C	HGC	08/10/84	30 gph	BFEC	H04C.C884B
H-4B	WQSP-R1	07/08/85 - 07/25/85	20 gph	FLD	H04B.C785F
H-4B	WQSP-R1	07/20/85	20 gph	BFEC	H04B.C785B
H-4B	WQSP-R1	07/25/85	20 gph	EEG	H04B.C785E
H-4B	WQSP-R1	07/20/85	20 gph	ITAS	H04B.C785I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H04B.C1278G		7.6	18100	18100 (105 C)	0.9%
H04B.C581F	1.01 (sg)	8.0			
H04B.C581B			21700		-1.9%
H04C.C884F	1.01 (sg)	7.8			
H04C.C884B			21200		1.0%
H04B.C785F	1.015 (sg)	7.7			
H04B.C785B			20200		0.4%
H04B.C785E	1.034 (g/mL)	7.6	18700		-0.9%
H04B.C785I		7.6		20000 (180 C)	

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H04B.C1278G	48	59	0	7500	4000
H04B.C581F	58	71			~6000
H04B.C581B				7980	6230
H04C.C884F	75				
H04C.C884B				7950	5700
H04B.C785F	57	69	0	7500	
H04B.C785B	54	66	0	7480	5520
H04B.C785E				6670	5530
H04B.C785I					

Table 77. Comparison of Data from the Culebra at H-4 (continued)

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H04B.C1278G	5800	180	180	430	44
H04B.C581F					
H04B.C581B	6080	215	700	455	72.3
H04C.C884F					
H04C.C884B	6150	222	698	505	76.3
H04B.C785F					71
H04B.C785B	5850	210	691	427	69.6
H04B.C785E	5190	185	690	409	68.0
H04B.C785I					

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H04B.C1278G	19			5.2			
H04B.C581F							
H04B.C581B	18		0.39	11	14		
H04C.C884F							
H04C.C884B	20	<0.002	0.49	13	18	2.2	0.20
H04B.C785F						1	
H04B.C785B	14		0.40	14	14	0.32	0.11
H04B.C785E			0.40				
H04B.C785I	23	<0.1		14 as Si	15	0.43	0.12

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H04B.C1278G		1.9		
H04B.C581F				
H04B.C581B	42			
H04C.C884F				
H04C.C884B	48	2.1	0.23	
H04B.C785F				
H04B.C785B	43			
H04B.C785E		2.7		
H04B.C785I	64	1.7	1.1	<0.1 as N

Table 78. Comparison of Data from the Culebra at H-5
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-5B	USGS	12/19/78	bail or swab	USGS	H05B.C1278G
H-5B	SNL	05/27/81 - 06/02/81	12 gph	FLD	H05B.C681F
H-5B	SNL	06/01/81	12 gph	BFEC	H05B.C681B
H-5C	SNL	10/07/81 - 10/15/81	7.5 gph	FLD	H05C.C1081F
H-5C	SNL	10/15/81	7.5 gph	BFEC	H05C.C1081B
H-5B	WQSP-R1	08/22/85 - 08/30/85	8 gph	FLD	H05B.C885F
H-5B	WQSP-R1	08/26,27/85	8 gph	BFEC	H05B.C885B
H-5B	WQSP-R1	08/26/85	8 gph	EEG	H05B.C885E
H-5B	WQSP-R1	08/26/85	8 gph	ITAS	H05B.C885I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H05B.C1278G		6.8	143500	144000 (105 C)	1.5%
H05B.C681F	1.10 (sg)	7.9			
H05B.C681B			154400		-2.1%
H05C.C1081F	1.10 (sg)	7.9			
H05C.C1081B			154500		-2.2%
H05B.C885F	1.105 (sg)	7.4			
H05B.C885B			152600		1.5%
H05B.C885E	1.12 (g/mL)	6.8	143500		1.3%
H05B.C885I		7.0	144600	142000 (180 C)	-6.3%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H05B.C1278G	34	41	0	86000	810
H05B.C681F	66	80			~8000
H05B.C681B				89500	7360
H05C.C1081F	70	86			
H05C.C1081B				89500	7570
H05B.C885F	41	50	0	84000	
H05B.C885B	34	41	0	85400	7840
H05B.C885E				81000	6730
H05B.C885I	39	47	0	87000	6300

Table 78. Comparison of Data from the Culebra at H-5 (continued)

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H05B.C1278G	53000	1400	360	1900	174
H05B.C681F					
H05B.C681B	52400	1290	1710	2140	261
H05C.C1081F					
H05C.C1081B	52300	1300	1720	2150	262
H05B.C885F					260
H05B.C885B	54100	1350	1700	2170	263
H05B.C885E	51300	1110	1460	1910	230
H05B.C885I	47000	1300	1300	1700	204

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H05B.C1278G	36			2.1			
H05B.C681F							
H05B.C681B	33		0.77	6.2	32		
H05C.C1081F							
H05C.C1081B	35		0.77	5.8	31		
H05B.C885F						3	
H05B.C885B	34	<0.01	0.81	7.1	29	2.9	0.29
H05B.C885E			<0.5				
H05B.C885I	29	<1.0		17 as Si	16	3.0	0.52

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H05B.C1278G		1.4		
H05B.C681F				
H05B.C681B	62			
H05C.C1081F				
H05C.C1081B	64			
H05B.C885F				
H05B.C885B	49	2.0	0.19	
H05B.C885E		1.2		
H05B.C885I	94	1.3	1.1	0.40 as N

Table 79. Comparison of Data from the Culebra at H-6
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-6B	USGS	12/20/78	bail or swab	USGS	H06B.C1278G
H-6B	SNL	05/01/81 - 05/02/81	23 gpm	FLD	H06B.C581F
H-6C	SNL	05/12/81 - 05/27/81	19 gpm	FLD	H06C.C581F
H-6B	SNL	05/02/81	23 gpm	BFEC	H06B.C581B
H-6B	WQSP-R1	09/04/85 - 09/16/85	6 gpm	FLD	H06B.C985F
H-6B	WQSP-R1	09/15/85	6 gpm	BFEC	H06B.C985B
H-6B	WQSP-R1	09/15/85	6 gpm	EEG	H06B.C985E
H-6B	WQSP-R1	09/15/85	6 gpm	ITAS	H06B.C985I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H06B.C1278G		7.3	52500	52600 (105 C)	3.7%
H06B.C581F	1.04 (sg)	7.0			
H06C.C581F	1.04 (sg)	7.2			
H06B.C581B			59300		0.2%
H06B.C985F	1.042 (sg)	6.9			
H06B.C985B			57400		-0.5%
H06B.C985E	1.06 (g/mL)	7.1	56900		-0.6%
H06B.C985I		7.2	55200	58000 (180 C)	-11%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H06B.C1278G	85	100	0	28000	3800
H06B.C581F	79	96			~4000
H06C.C581F	77	94			~4000
H06B.C581B				33000	3980
H06B.C985F	77	94	0	32000	
H06B.C985B	69	84	0	32300	3570
H06B.C985E				32300	3390
H06B.C985I	82	100	0	34000	3000

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H06B.C1278G	18000	500	1200	970	140
H06B.C581F					
H06C.C581F					
H06B.C581B	18600	450	2150	1080	196
H06B.C985F					190
H06B.C985B	18000	375	2040	1040	187
H06B.C985E	17700	430	1970	1130	191
H06B.C985I	15000	485	1900	740	156

Table 79: Comparison of Data from the Culebra at H-6 (continued)

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H06B.C1278G	9.5			8.5			
H06B.C581F							
H06C.C581F							
H06B.C581B	11		0.44	20	32		
H06B.C985F						0.2	
H06B.C985B	10	<0.01	0.45	18	30	0.094	0.13
H06B.C985E			<0.5				
H06B.C985I	7.1	<1.0		20 as Si	24	0.55	0.20

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	IO_3^- (mg/L)	NO_3^- (mg/L)
H06B.C1278G		1.5			
H06B.C581F					
H06C.C581F					
H06B.C581B	34				
H06B.C985F					
H06B.C985B	34	1.9	0.096	0.10	
H06B.C985E		1.5			
H06B.C985I	67	1.6	<1		0.20 as N

Table 80. Comparison of Data from the Culebra at H-7
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-7B1	USGS	03/20/80	bail or swab	USGS	H07B1.C380G
H-7B1	WQSP-R1	03/20/86 - 03/27/86	4 gpm	FLD	H07B1.C386F
H-7B1	WQSP-R1	03/26/86	4 gpm	BFEC	H07B1.C386B
H-7B1	WQSP-R1	03/27/86	4 gpm	ITAS	H07B1.C386I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H07B1.C380G	1.001 (g/mL)	7.0	3180	3610 (105 C)	-0.2%
H07B1.C386F	1.001 (sg)	7.3			
H07B1.C386B			3220		-0.4%
H07B1.C386I		7.5	4020	3400 (180 C)	-20%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H07B1.C380G	100	120	0	350	1900
H07B1.C386F	98	120	0	310	
H07B1.C386B	98	120	0	320	1850
H07B1.C386I	110	130	0	700	2300

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H07B1.C380G	210	1.4	590	130	40
H07B1.C386F					46
H07B1.C386B	207	7.00	587	130	40.0
H07B1.C386I	210	7.00	540	130	37.7

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H07B1.C380G	0.78			39			
H07B1.C386F						0.1	
H07B1.C386B	0.76	<0.01	0.10	47	8.5	0.056	0.050
H07B1.C386I	0.74	<0.1		43 as Si	5.8	0.08	0.050

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H07B1.C380G		1.4		
H07B1.C386F				
H07B1.C386B	0.57	1.5	0.052	
H07B1.C386I	1.0	1.2	<1	0.70 as N

Table 81. Comparison of Data from the Culebra at H-8
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-8B	USGS	02/11/80	bail or swab	USGS	H08B.C280G
H-8B	WQSP-R1	01/09/86 - 01/23/86	40 gph	FLD	H08B.C186F
H-8B	WQSP-R1	01/22/86	40 gph	BFEC	H08B.C186B
H-8B	WQSP-R1	01/22/86	40 gph	EEG	H08B.C186E
H-8B	WQSP-R1	01/21-23/86	40 gph	ITAS	H08B.C186I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H08B.C280G	1.000 (g/mL)	7.3	2880	3200 (105 C)	3.2%
H08B.C186F	1.002 (sg)	7.3			
H08B.C186B			2830		-0.3%
H08B.C186E	1.01 (g/mL)	7.2	2670		1.5%
H08B.C186I		7.9	2540	3150 (180 C)	8.0%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H08B.C280G	61	74	0	57	2000
H08B.C186F	79	96	0	33	
H08B.C186B	74	90	0	30.5	1950
H08B.C186E				30	1900
H08B.C186I	77	94	0	33.0	1650

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H08B.C280G	82	4.7	570	170	42
H08B.C186F					42
H08B.C186B	55.1	3.83	548	157	40.3
H08B.C186E	55	4.6	520	160	39.1
H08B.C186I	51.0	3.70	540	170	40.9

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H08B.C280G	0.58			19			
H08B.C186F						0.09	
H08B.C186B	0.48	<0.01	0.12	29	6.9	0.036	0.021
H08B.C186E			<0.5				
H08B.C186I	0.06	<1		26 as Si	5.9	0.05	<0.1

Table 81. Comparison of Data from the Culebra at H-8 (continued)

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H08B.C280G		2.4		
H08B.C186F				
H08B.C186B	0.085	2.5	0.14	
H08B.C186E		2.1		
H08B.C186I	<1	2.4	<1	1.4 as N

Table 82. Comparison of Data from the Culebra at H-9
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-9B	USGS	02/05/80	bail or swab	USGS	H09B.C280G
H-9B	HGC	10/07/83	10 gpm	FLD	H09B.C1083F
H-9B	HGC	10/07/83	10 gpm	H-B	H09B.C1083HB
H-9B	HGC	10/07/83	10 gpm	KCS	H09B.C1083KC
H-9B	HGC	10/07/83	10 gpm	KGS	H09B.C1083K
H-9B	WQSP-R1	10/30/85 - 11/14/85	38 gph	FLD	H09B.C1185F
H-9B	WQSP-R1	11/14/85	38 gph	BFEC	H09B.C1185B
H-9B	WQSP-R1	11/14/85	38 gph	EEG	H09B.C1185E
H-9B	WQSP-R1	11/14/85	38 gph	ITAS	H09B.C1185I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H09B.C280G	na	7.3	4660	3590 (105 C)	26%
H09B.C1083F	1.000 (sg)	7.9			
H09B.C1083HB			2290		-5.4%
H09B.C1083KC					
H09B.C1083K					
H09B.C1185F	1.002 (sg)	7.4			
H09B.C1185B			3080		0.5%
H09B.C1185E	1.019 (g/mL)	6.9	2960		2.1%
H09B.C1185I		7.7	2630	3300 (180 C)	10%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H09B.C280G	90	110	0	320	2000
H09B.C1083F		~240			
H09B.C1083HB				180	1500
H09B.C1083KC				255	
H09B.C1083K				206	
H09B.C1185F	90	110	0	190	
H09B.C1185B	87	110	0	194	1900
H09B.C1185E				195	1900
H09B.C1185I	98	120	0	200	1450

Table 82. Comparison of Data from the Culebra at H-9 (continued)

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H09B.C280G	210	1400	580	150	41
H09B.C1083F					
H09B.C1083HB	110	5.0	400	94	27.7
H09B.C1083KC					
H09B.C1083K					
H09B.C1185F					41
H09B.C1185B	146	6.85	590	137	40.7
H09B.C1185E	150	7.4	560	150	40.3
H09B.C1185I	150	7.55	560	140	39.5

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H09B.C280G	0.78			26			
H09B.C1083F							
H09B.C1083HB			0.13	13 Si		0.08	<0.02
H09B.C1083KC							
H09B.C1083K							
H09B.C1185F						0.1	
H09B.C1185B	0.63	<0.01	0.18	27	7.5	0.032	0.015
H09B.C1185E			<0.5				
H09B.C1185I	<0.1	0.2		18 as Si	7.0	<0.1	0.060

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H09B.C280G		3.0		
H09B.C1083F				
H09B.C1083HB			<1	
H09B.C1083KC				
H09B.C1083K	0.43		0.109	
H09B.C1185F				
H09B.C1185B	0.24	3.3	0.11	
H09B.C1185E		2.8		
H09B.C1185I	1.0	2.6	<1	0.20 as N

Table 83. Comparison of Data from the Culebra at H-10
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-10B	USGS	03/21/80	bail or swab	USGS	H10B.C380G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H10B.C380G	1.045 (g/mL)	8.3	65700	69200 (105 C)	-2.0%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H10B.C380G	37	45	0	36000	5600

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H10B.C380G	21000	520	1600	1000	162

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H10B.C380G	13			1.5			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H10B.C380G		1.3

Table 84. Comparison of Data from the Culebra at H-11
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-11B3	WQSP-R1	05/13/85 - 06/04/85	6 gpm	FLD	H11B3.C685F
H-11B3	WQSP-R1	06/03,04/85	6 gpm	BFEC	H11B3.C685B
H-11B3	WQSP-R1	06/03,04/85	6 gpm	EEG	H11B3.C685E
H-11B3	WQSP-R1	06/03/85	6 gpm	ITAS	H11B3.C685I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H11B3.C685F	1.090 (sg)	7.2			
H11B3.C685B			117400		-0.9%
H11B3.C685E	1.10 (g/mL)	7.3	109500		-0.7%
H11B3.C685I		7.2		122000 (180 C)	

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H11B3.C685F	44	54	0	67000	
H11B3.C685B				65900	7180
H11B3.C685E				62000	6040
H11B3.C685I					

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H11B3.C685F					190
H11B3.C685B	40400	943	1700	1320	193
H11B3.C685E	37800	680	1580	1360	190
H11B3.C685I					

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H11B3.C685F						0.2	
H11B3.C685B	32		0.62		25	0.14	0.22
H11B3.C685E			0.38				
H11B3.C685I	13	0.29		15 as Si	18	0.66	0.39

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H11B3.C685F				
H11B3.C685B	47			
H11B3.C685E		1.6		
H11B3.C685I	100	1.0	1.1	<0.1 as N

Table 85. Comparison of Data from the Culebra at H-12
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-12	HGC	01/07/84 - 01/12/84	8.4 gph	FLD	H12.C184F
H-12	HGC	01/11/84	8.4 gph	H-B	H12.C184HBa
H-12	HGC	01/11/84	8.4 gph	KGS	H12.C184Ka
H-12	HGC	01/25/84	13.5 gph	H-B	H12.C184HBb
H-12	HGC	01/25/84	13.5 gph	KGS	H12.C184Kb
H-12	WQSP-R1	08/01/85 - 08/09/85	17 gph	FLD	H12.C885F
H-12	WQSP-R1	08/08/85	17 gph	BFEC	H12.C885B
H-12	WQSP-R1	08/09/85	17 gph	EEG	H12.C885E
H-12	WQSP-R1	08/09/85	17 gph	ITAS	H12.C885I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H12.C184F	1.090 (sg)	7.9			
H12.C184HBa			143700		-1.3%
H12.C184Ka					
H12.C184HBb			149100		-0.8%
H12.C184Kb					
H12.C885F	1.096 (sg)	7.2			
H12.C885B			140500		0.9%
H12.C885E	1.12 (g/mL)	7.0	122400		-4.2%
H12.C885I		7.3	135200	142000 (180 C)	-4.4%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H12.C184F					
H12.C184HBa	85000	4000			
H12.C184Ka	na	86500			
H12.C184HBb	84000	8400			
H12.C184Kb	na	80100			
H12.C885F	43	53	0	80000	
H12.C885B	40	49	0	79000	7210
H12.C885E	71700	6520			
H12.C885I	46	56	0	80000	5900

Table 85. Comparison of Data from the Culebra at H-12 (continued)

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H12.C184F					
H12.C184HBa	51000	970	1400	1300	177
H12.C184Ka					
H12.C184UAa					
H12.C184HBb	53000	1000	1300	1300	176
H12.C184Kb					
H12.C885F					240
H12.C885B	49200	1270	1760	1980	250
H12.C885E	40400	670	1510	1650	211
H12.C885I	44500	1500	1850	1400	207

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H12.C184F							
H12.C184HBa			0.25	5.0 as Si		0.55	0.10
H12.C184Ka							
H12.C184HBb			0.29	5.0 as Si		1.1	0.14
H12.C184Kb							
H12.C885F						1	
H12.C885B	39		1.2	7.2	31	0.22	0.087
H12.C885E			0.61				
H12.C885I	35	<10		45 as Si	18	0.56	0.64

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H12.C184F				
H12.C184HBa	70	0.33	<1	
H12.C184Ka	72	0.250		
H12.C184UAa				
H12.C184HBb	76	0.34	<1	
H12.C184Kb	77	0.290		
H12.C885F				
H12.C885B	76			
H12.C885E		2.3		
H12.C885I	140	1.2	1.6	<0.1 as N

Table 86. Comparison of Data from the Culebra at P-14
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
P-14	USGS	03/14/77	bail or swab	USGS	P14.C377G
P-14	WQSP-R1	02/18/86 - 02/27/86	33 gph	FLD	P14.C286F
P-14	WQSP-R1	02/26/86	33 gph	BFEC	P14.C286B
P-14	WQSP-R1	02/26/86	33 gph	EEG	P14.C286E
P-14	WQSP-R1	02/26,27/86	33 gph	ITAS	P14.C286I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balanc Error[5]
P14.C377G		6.0	33800	38000 (105 C)	-3.2%
P14.C286F	1.019 (sg)	6.8			
P14.C286B			24900		-0.9%
P14.C286E	1.04 (g/mL)	7.1	24800		0.1%
P14.C286I		7.0	24200	26000 (180 C)	-0.99%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
P14.C377G	290	360	0	20000	1400
P14.C286F	90	110	0	15000	
P14.C286B	80	98	0	14500	1590
P14.C286E				13900	1650
P14.C286I	82	100	0	14000	1600

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
P14.C377G	7600	600	3100	760	217
P14.C286F					260
P14.C286B	4360	37.9	3520	840	244.8
P14.C286E	4200	60.0	3640	740	297
P14.C286I	3750	44.5	3900	760	257

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
P14.C377G	0.70			33			
P14.C286F						2	
P14.C286B	0.72	<0.01	0.28	30	51	2.0	0.18
P14.C286E			<0.5				
P14.C286I	0.065	<0.01		32 as Si	48	1.6	0.23

Table 86. Comparison of Data from the Culebra at P-14 (continued)

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
P14.C377G		0.9		
P14.C286F				
P14.C286B	72	1.7	0.42	
P14.C286E		1.5		
P14.C286I	24	1.2	<1	0.20 as N

Table 87. Comparison of Data from the Culebra at P-15
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
P-15	USGS	05/10/77	bail or swab	USGS	P15.C577G
P-15	USGS	04/11/79	bail or swab	SNL	P15.C479S

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
P15.C577G			23700	24000 (105 C)	1.2%
P15.C479S	1.060 (g/mL)		89600		-0.8%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
P15.C577G	92	63	24	11000	3200
P15.C479S	160	150	23	47100	7430

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
P15.C577G	6900	1700	770	63	44
P15.C479S	26000	6610	780	1510	163

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
P15.C577G	4.7			1.6			
P15.C479S							

Sample ID	Br^- (mg/L)	F^- (mg/L)
P15.C577G		1.2
P15.C479S		

Table 88. Comparison of Data from the Culebra at P-17
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
P-17	USGS	05/10/77	bail or swab	USGS	P17.C577G
P-17	WQSP-R1	03/04/86 - 03/17/86	.5 gpm	FLD	P17.C386F
P-17	WQSP-R1	03/17/86	.5 gpm	BFEC	P17.C386B
P-17	WQSP-R1	03/17/86	.5 gpm	EEG	P17.C386E
P-17	WQSP-R1	03/17/86	.5 gpm	ITAS	P17.C386I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
P17.C577G		7.4	92500	97000 (105 C)	-3.4%
P17.C386F	1.065 (sg)	7.5			
P17.C386B			86500		-1.2%
P17.C386E	1.08 (g/mL)	6.9	81200		-1.5%
P17.C386I		7.0	90400	88000 (180 C)	-2.7%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
P17.C577G	63	77	0	54000	5000
P17.C386F	52	64	0	48000	
P17.C386B	43	52	0	48200	6020
P17.C386E				45200	5960
P17.C386I	44	54	0	51000	6400

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
P17.C577G	30000	120	1700	1600	216
P17.C386F					220
P17.C386B	28300	782	1620	1460	201
P17.C386E	26200	875	1560	1440	196
P17.C386I	29000	795	1650	1550	210

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
P17.C577G	1.7			1.0			
P17.C386F						5	
P17.C386B	38	<0.01	0.87	8.5	29	4.0	0.87
P17.C386E			<0.5				
P17.C386I	36	<0.1		<0.2 as Si	28	3.8	0.80

Table 88. Comparison of Data from the Culebra at P-17 (continued)

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
P17.C577G		1.5		
P17.C386F				
P17.C386B	72	1.9	0.18	
P17.C386E		1.9		
P17.C386I	98	1.2	7.3	0.30 as N

Table 89. Comparison of Data from the Culebra at P-18
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
P-18	USGS	05/10/77	bail or swab	USGS	P18.C577G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
P18.C577G		7.2	118300	420000 (105 C)	-3.0%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
P18.C577G	250	310	0	80000	980

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
P18.C577G	9200	6200	5600	16000	1590

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
P18.C577G	100			1.0			

Sample ID	Br^- (mg/L)	F^- (mg/L)
P18.C577G		1.2

Table 90. Comparison of Data from the Culebra at WIPP-25
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-25	USGS	08/14/80	bail or swab	USGS	W25.C880G
W-25	SNL	08/19/80 - 08/20/80	33 gpm	FLD	W25.C880F
W-25	SNL	08/20/80	33 gpm	BFEC	W25.C880B
W-25	WQSP-R1	01/31/86 - 02/13/86	7 gpm	FLD	W25.C286F
W-25	WQSP-R1	02/12/86	7 gpm	BFEC	W25.C286B
W-25	WQSP-R1	02/12/86	7 gpm	ITAS	W25.C286I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W25.C880G	1.014 (g/mL)	7.3	17000	22100 (105 C)	0.8%
W25.C880F	1.01 (sg)	6.9			
W25.C880B			12100		1.4%
W25.C286F	1.010 (sg)	7.2			
W25.C286B			13600		-1.4%
W25.C286I		7.7	13700	14000 (180 C)	1.5%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
W25.C880G	370	450	0	8300	2400
W25.C880F	170	210	0	5200	~3000
W25.C880B				5250	2500
W25.C286F	110	130	0	6200	
W25.C286B	100	120	0	6320	2380
W25.C286I	98	120	0	6200	2400

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W25.C880G	5100	0.9	920	250	66
W25.C880F			910		66
W25.C880B	3160	73.5	905	260	66.6
W25.C286F					85
W25.C286B	3180	102	1140	315	82.8
W25.C286I	3350	105	1150	340	85.4

Table 90. Comparison of Data from the Culebra at WIPP-25 (continued)

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W25.C880G	1.9			29			
W25.C880F						~0.6	
W25.C880B	1.5		0.20	34	12		
W25.C286F						0.5	
W25.C286B	1.7	<0.01	0.22	33	17	0.50	0.11
W25.C286I	1.7	<0.1		31 as Si	1.4	0.45	0.11

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
W25.C880G		1.4		
W25.C880F				
W25.C880B	2.6			
W25.C286F				
W25.C286B	3.4	1.7	0.042	
W25.C286I	4.2	1.6	<1	3.6 as N

Table 91. Comparison of Data from the Culebra at WIPP-26
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-26	USGS	08/18/80	bail or swab	USGS	W26.C880G
W-26	SNL	08/23/80 - 08/24/80	34 gpm	FLD	W26.C880F
W-26	SNL	08/24/80	34 gpm	BFEC	W26.C880B
W-26	SNL	08/24/80	34 gpm	KCS	W26.C880KC
W-26	WQSP-R1	11/19/85 - 11/26/85	52 gph	FLD	W26.C1185F
W-26	WQSP-R1	11/25/85	52 gph	BFEC	W26.C1185B
W-26	WQSP-R1	11/25/85	52 gph	EEG	W26.C1185E
W-26	WQSP-R1	11/25/85	52 gph	ITAS	W26.C1185I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W26.C880G	1.013 (g/mL)	6.9	15600	23800 (105 C)	-6.7%
W26.C880F	1.005 (sg)	6.9			
W26.C880B			15100		-0.4%
W26.C880KC					
W26.C1185F	1.012 (sg)	7.1			
W26.C1185B			17600		-1.6%
W26.C1185E	1.033 (g/mL)	7.5	16800		-2.6%
W26.C1185I		7.4	18200	18000 (180 C)	0.13%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
W26.C880G	130	160	0	8200	2300
W26.C880F	120	140	0	6900	~3000
W26.C880B				7200	2480
W26.C880KC				8240	
W26.C1185F	98	120	0	8500	
W26.C1185B	96	120	0	8770	2420
W26.C1185E				8490	2370
W26.C1185I	110	130	0	9450	1950

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W26.C880G	3600	2.0	1200	340	88
W26.C880F			1300		91
W26.C880B	3620	170	1240	355	91.1
W26.C880KC					
W26.C1185F					100
W26.C1185B	4220	343	1340	380	98.2
W26.C1185E	3820	360	1290	425	99.3
W26.C1185I	4150	350	1800	375	121

Table 91. Comparison of Data from the Culebra at WIPP-26 (continued)

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W26.C880G	1.8			20			
W26.C880F						~0.3	
W26.C880B	1.4		0.24	33	17		
W26.C880KC							
W26.C1185F						0.1	
W26.C1185B	1.6	<0.01	0.23	35	20	0.026	<0.01
W26.C1185E			<0.5				
W26.C1185I	<0.01	<0.1		30 as Si	17	<0.1	0.090

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
W26.C880G		1.5		
W26.C880F				
W26.C880B	3.2			
W26.C880KC				
W26.C1185F				
W26.C1185B	3.9	1.7	0.070	
W26.C1185E		1.5		
W26.C1185I	12	1.3	<1	5.7 as N

Table 92. Comparison of Data from the Culebra at WIPP-27
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-27	USGS	08/22/80	bail or swab	USGS	W27.C880G
W-27	SNL	09/02/80 - 09/05/80	25 gpm	FLD	W27.C980F
W-27	SNL	09/03/80	25 gpm	BFEC	W27.C980B

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W27.C880G	1.094 (g/mL)	6.4	125700	186000 (105 C)	-5.2%
W27.C980F	1.09 (sg)	6.4			
W27.C980B			134700		-1.5%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
W27.C880G	150	180	0	77000	3900
W27.C980F	98	120	0	77000	~4000
W27.C980B				78500	3830

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W27.C880G	39000	714	3100	2000	320
W27.C980F			3300		320
W27.C980B	39200	8060	3210	1900	316

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W27.C880G	1.9			13			
W27.C980F						~0.4	
W27.C980B	2.3		0.33	23	51		

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
W27.C880G		0.5		
W27.C980F				
W27.C980B	28			

Table 93. Comparison of Data from the Culebra at WIPP-28
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-28	USGS	08/21/80	bail or swab	USGS	W28.C880G
W-28	SNL	09/09/80 - 09/12/80	17 gpm	FLD	W28.C980F
W-28	SNL	09/11/80	17 gpm	BFEC	W28.C980B
W-28	SNL	09/11/80	17 gpm	KCS	W28.C980KC

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W28.C880G	1.044 (g/mL)	6.4	55900	74000 (105 C)	5.2%
W28.C980F	1.03 (sg)	6.5			
W28.C980B			46600		-0.9%
W28.C980KC					

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
W28.C880G	670	820	0	30000	3200
W28.C980F	(<290)	(<350)	0	24000	~4000
W28.C980B				24800	4380
W28.C980KC				21600	

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W28.C880G	21000	4.0	1200	470	99
W28.C980F			1200		100
W28.C980B	15200	485	1180	555	104
W28.C980KC					

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W28.C880G	5.4			28			
W28.C980F						~0.8	
W28.C980B	5.8		0.30	36	16		
W28.C980KC							

Sample ID	Br^- (mg/L)	F^- (mg/L)
W28.C880G		1.1
W28.C980F		
W28.C980B	7.2	
W28.C980KC		

Table 94. Comparison of Data from the Culebra at WIPP-29
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-29	USGS	08/20/80	bail or swab	USGS	W29.C880G
W-29	SNL	08/26/80 - 08/28/80	37 gpm	FLD	W29.C880F
W-29	SNL	08/28/80	37 gpm	BFEC	W29.C880B
W-29	SNL	08/28/80	37 gpm	KCS	W29.C880KC
W-29	WQSP-R1	12/05/85 - 12/15/85	60 gph	FLD	W29.C1285F
W-29	WQSP-R1	12/14/85	60 gph	BFEC	W29.C1285B
W-29	WQSP-R1	12/14/85	60 gph	EEG	W29.C1285E
W-29	WQSP-R1	12/14/85	60 gph	ITAS	W29.C1285I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W29.C880G	1.178 (g/mL)	6.1	238700	239000 (105 C)	-3.4%
W29.C880F	1.16 (sg)	6.1			
W29.C880B			245400		-2.3%
W29.C880KC					
W29.C1285F	1.216 (sg)	5.9			
W29.C1285B			324100		-1.8%
W29.C1285E	1.220 (g/mL)	6.9	265600		-3.1%
W29.C1285I		6.6	317200	330000 (180 C)	-3.7%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
W29.C880G	210	260	0	140000	13000
W29.C880F	170	210	0	130000	~10000
W29.C880B				138000	14000
W29.C880KC				201000	
W29.C1285F	130	160	0	180000	
W29.C1285B	120	150	0	179000	20000
W29.C1285E				147000	17000
W29.C1285I	140	170	0	180000	17000

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W29.C880G	79000	150	810	5700	510
W29.C880F			1100		480
W29.C880B	71400	15600	950	5480	497
W29.C880KC					
W29.C1285F					610
W29.C1285B	94900	23300	413	6500	553
W29.C1285E	75400	20800	675	4750	423
W29.C1285I	90000	23000	630	6350	552

Table 94. Comparison of Data from the Culebra at WIPP-29 (continued)

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W29.C880G	45			11			
W29.C880F						~0.8	
W29.C880B	4.4		0.78	22	29		
W29.C880KC							
W29.C1285F						1	
W29.C1285B	5.2	<0.01	0.70	15	13	1.1	1.7
W29.C1285E			<0.5				
W29.C1285I	5.8	<1		51 as Si	9.0	2.0	1.8

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
W29.C880G		0.7		
W29.C880F				
W29.C880B	45			
W29.C880KC				
W29.C1285F				
W29.C1285B	61	4.6	0.38	
W29.C1285E		4.5		
W29.C1285I	100	0.9	2.1	0.10 as N

Table 95. Comparison of Data from the Culebra at WIPP-30
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-30	USGS	08/13/80	bail or swab	USGS	W30.C880G
W-30	SNL	09/02/80 - 09/06/80	.3->.1, av.2gpm	FLD	W30.C980F
W-30	SNL	09/06/80	.3->.1, av.2gpm	BFEC	W30.C980B
W-30	SNL	09/06/80	.3->.1, av.2gpm	KCS	W30.C980KC

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W30.C880G	1.072 (g/mL)	6.8	108900	110000 (105 C)	-4.2%
W30.C980F	1.02 (sg)	8.8			
W30.C980B			29100		-2.5%
W30.C980KC					

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
W30.C880G	74	90	0	64000	5050
W30.C980F	61	40	17	15000	~4000
W30.C980B				14600	4120
W30.C980KC				18700	

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W30.C880G	37000	888	1100	870	130
W30.C980F			1200		97
W30.C980B	8570	255	1140	460	94.7
W30.C980KC					

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W30.C880G	64			2.9			
W30.C980F						~0.05	
W30.C980B	6.1		0.27	6.5	18		
W30.C980KC							

Sample ID	Br^- (mg/L)	F^- (mg/L)
W30.C880G		0.5
W30.C980F		
W30.C980B	10	
W30.C980KC		

Table 96. Comparison of Data from the Culebra at Engle Well
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
ENGLE	HGC	11/04/83 - 11/10/83	9.8 gpm	FLD	XENG.C11
ENGLE	HGC	11/10/83	9.8 gpm	H-B	XENG.C11
ENGLE	HGC	11/10/83	9.8 gpm	KGS	XENG.C11
ENGLE	HGC	11/10/83	9.8 gpm	UA	XENG.C11
ENGLE	WQSP-R1	02/26/85 - 03/05/85	.8 gpm	FLD	XENG.C38
ENGLE	WQSP-R1	03/05/85	.8 gpm	BFEC	XENG.C38
ENGLE	WQSP-R1	03/04,05/85	.8 gpm	EEG	XENG.C38
ENGLE	WQSP-R1	03/04,05/85	.8 gpm	ITAS	XENG.C38

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
XENG.C1183F		7.3			
XENG.C1183HB					
XENG.C1183K					
XENG.C385F		7.4			
XENG.C385B			3270		1.0%
XENG.C385E	1.015 (g/mL)	7.8	2940		4.0%
XENG.C385I		6.5		3460 (180 C)	

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
XENG.C1183F		~230			
XENG.C1183HB				230	1100
XENG.C1183K		98		163	
XENG.C385F	90	110	0	220	
XENG.C385B	87	110	0	231	1990
XENG.C385E				170	1880
XENG.C385I					

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
XENG.C1183F					
XENG.C1183HB					
XENG.C1183K					
XENG.C385F					42
XENG.C385B	200	5.60	588	152	41.9
XENG.C385E	187	5.4	570	132	39.3
XENG.C385I					

Table 96. Comparison of Data from the Culebra at Engle Well (continued)

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
XENG.C1183F							
XENG.C1183HB				9 as Si			
XENG.C1183K							
XENG.C385F						0.5	
XENG.C385B	0.97	<0.001	0.17	29	8.4	0.59	0.060
XENG.C385E							
XENG.C385I	0.77	0.07		25 as Si	7.0	0.32	<0.01

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
XENG.C1183F				
XENG.C1183HB				2
XENG.C1183K	0.47		0.008	
XENG.C385F				
XENG.C385B	0.27	2.8	0.12	
XENG.C385E		2.9		
XENG.C385I	1.2	2.8	<1	0.50 as N

Table 97. Comparison of Data from the Magenta at H-1
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-1	USGS	06/04/76	bail or swab	USGS	H01.M676G
H-1	USGS	05/10/77	bail or swab	USGS	H01.M577G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H01.M676G		7.4	18900	18900 (105 C)	1.3%
H01.M577G		7.2	22200		2.8%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H01.M676G	75	92	0	8000	3900
H01.M577G	76	93	0	10000	3600

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H01.M676G	5700	70	890	270	67
H01.M577G	6200	840	1000	460	87.7

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H01.M676G	2.2			1.3			
H01.M577G	3.3			1.7			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H01.M676G		2.8
H01.M577G		2.0

Table 98. Comparison of Data from the Magenta at H-2
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-2A	USGS	02/22/77	bail or swab	USGS	H02A.M277G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H02A.M277G		8.6	10300	12000 (105 C)	2.3%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H02A.M277G	61	74	0	4100	2400

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H02A.M277G	2700	81	820	170	55

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H02A.M277G	0.22			6.0			

Table 99. Comparison of Data from the Magenta at H-3
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-3B1	USGS	05/10/77	bail or swab	USGS	H03B1.M577G
H-3B1	USGS	05/10/79	bail or swab	SNL	H03B1.M579S
H-3B1	WQSP-R1	06/17/85 - 07/02/85	14 gph	FLD	H03B1.M785F
H-3B1	WQSP-R1	07/01/85	14 gph	BFEC	H03B1.M785B
H-3B1	WQSP-R1	07/01/85	14 gph	EEG	H03B1.M785E
H-3B1	WQSP-R1	07/01/85	14 gph	ITAS	H03B1.M785I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H03B1.M577G		8.0	29700	32000 (105 C)	1.6%
H03B1.M579S	1.019 (g/mL)		29000		1.1%
H03B1.M785F	1.006 (sg)	8.0			
H03B1.M785B			8560		-1.0%
H03B1.M785E	1.02 (g/mL)	7.4	7820		-2.0%
H03B1.M785I		7.6		9000 (180 C)	

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H03B1.M577G	42	51	0	15000	3400
H03B1.M579S	43	52	0	14300	3580
H03B1.M785F	39	47	0	3400	
H03B1.M785B	35	43	0	3360	2310
H03B1.M785E				3030	2240
H03B1.M785I					

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H03B1.M577G	9300	250	1200	480	99
H03B1.M579S	7810	1360	1120	730	116
H03B1.M785F					74
H03B1.M785B	1520	34.5	1000	292	73.9
H03B1.M785E	1370	20.0	892	273	67.0
H03B1.M785I					

Table 99. Comparison of Data from the Magenta at H-3 (continued)

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H03B1.M577G	13			6.4			
H03B1.M579S							
H03B1.M785F						0.7	
H03B1.M785B	2.0	<0.01	0.32	10	17	0.11	0.028
H03B1.M785E			0.32				
H03B1.M785I	4.5	<0.1		11 as Si	17	0.14	0.045

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
H03B1.M577G		1.8		
H03B1.M579S				
H03B1.M785F				
H03B1.M785B	5.8	2.4	1.2	
H03B1.M785E		2.6		
H03B1.M785I	23	1.8	1.6	<0.1 as N

Table 100. Comparison of Data from the Magenta at H-4
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-4A	USGS	12/14/78	bail or swab	USGS	H04A.M1278G
H-4C	WQSP-R1	10/30/86 - 11/04/86	4 gph	FLD	H04C.M1186F
H-4C	WQSP-R1	11/04/86	4 gph	BFEC	H04C.M1186B
H-4C	WQSP-R1	11/04/86	4 gph	ITAS	H04C.M1186I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H04A.M1278G		8.0	22300	22300 (105 C)	-1.0%
H04C.M1186F	1.019 (sg)	8.4			
H04C.M1186B			23900		-1.4%
H04C.M1186I		8.0	28200	22500 (180 C)	-5.8%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H04A.M1278G	52	63	0	7500	7000
H04C.M1186F	69	70	7	8400	
H04C.M1186B	61	74	0	8460	7100
H04C.M1186I	82	100	0	11000	7850

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H04A.M1278G	7000	130	210	410	44
H04C.M1186F					70
H04C.M1186B	7110	85.1	651	411	66.2
H04C.M1186I	7500	135	1100	470	93.5

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H04A.M1278G	13			6.4			
H04C.M1186F						0.7	
H04C.M1186B	12	<0.01	0.46	9.1	12	0.71	0.29
H04C.M1186I	11	0.1	0.43	10 as Si	13	0.90	0.46

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	IO_3^- (mg/L)	NO_3^- (mg/L)
H04A.M1278G		2.5			
H04C.M1186F					
H04C.M1186B	5.9	2.4	0.31	<0.01	
H04C.M1186I	7.0	2.2	1.0		<0.1 as N

Table 101. Comparison of Data from the Magenta at H-5
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-5A	USGS	12/14/78	bail or swab	USGS	H05A.M1278G
H-5C	WQSP-R1	10/07/86 - 10/24/86	12 gph	FLD	H05C.M1086F
H-5C	WQSP-R1	10/24/86	12 gph	BFEC	H05C.M1086B
H-5C	WQSP-R1	10/24/86	12 gph	ITAS	H05C.M1086I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H05A.M1278G		7.8	6090		0.2%
H05C.M1086F	1.006 (sg)	8.0			
H05C.M1086B			6980		0.2%
H05C.M1086I		7.4	8410	6800 (180 C)	-4.7%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H05A.M1278G	41	50	0	880	3200
H05C.M1086F	46	56	0	1100	
H05C.M1086B	41	50	0	1070	3620
H05C.M1086I	57	69	0	1600	4200

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H05A.M1278G	1500	53	240	170	26
H05C.M1086F					43
H05C.M1086B	1480	33.6	550	173	41.7
H05C.M1086I	1500	51.5	795	190	55.3

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H05A.M1278G	11			9.0			
H05C.M1086F						1	
H05C.M1086B	11	<0.01	0.20	11	10	1.5	0.020
H05C.M1086I	10	0.2	0.20	12 as Si	8.4	1.3	<0.05

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	IO_3^- (mg/L)	NO_3^- (mg/L)
H05A.M1278G		2.8			
H05C.M1086F					
H05C.M1086B	2.7	2.5	0.31	<0.01	
H05C.M1086I	4.0	2.5	<1		<0.1 as N

Table 102. Comparison of Data from the Magenta at H-6
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-6A	USGS	12/20/78	bail or swab	USGS	H06A.M1278G
H-6C	WQSP-R1	09/22/86 - 10/01/86	23 gph	FLD	H06C.M1086F
H-6C	WQSP-R1	10/01/86	23 gph	BFEC	H06C.M1086B
H-6C	WQSP-R1	10/01/86	23 gph	ITAS	H06C.M1086I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H06A.M1278G		7.3	5780		-1.6%
H06C.M1086F	1.003 (sg)	7.7			
H06C.M1086B			4540		-0.3%
H06C.M1086I		7.2	4750	4600 (180 C)	19%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H06A.M1278G	42	51	0	1200	2700
H06C.M1086F	42	51	0	420	
H06C.M1086B	39	47	0	428	2700
H06C.M1086I	43	52	0	430	2400

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H06A.M1278G	1100	46	520	160	39
H06C.M1086F					41
H06C.M1086B	642	16.6	546	160	40.4
H06C.M1086I	1050	26.0	620	170	44.9

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H06A.M1278G	2.5			7.7			
H06C.M1086F						0.4	
H06C.M1086B	2.2	<0.01	0.21	11	9.8	0.26	0.010
H06C.M1086I	2.4	0.3	0.19	13 as Si	7.1	0.30	<0.05

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	IO_3^- (mg/L)	NO_3^- (mg/L)
H06A.M1278G		1.4			
H06C.M1086F					
H06C.M1086B	1.1	1.5	0.086	<0.01	
H06C.M1086I	1.0	1.7	<1		<0.1 as N

Table 103. Comparison of Data from the Magenta at H-8
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-8A	USGS	02/12/80	bail or swab	USGS	H08A.M280G
H-8A	WQSP-R1	10/21/85	40 gph	ITAS	H08A.M1085I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H08A.M280G	1.006 (g/mL)	9.3	8970	9410 (105 C)	3.1%
H08A.M1085I		~7.5	7150		-5.3%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H08A.M280G	26			3500	2100
H08A.M1085I	25	30	0	3000	1700

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H08A.M280G	2400	84	870	17	45
H08A.M1085I	1800	59.0	555	10.5	28.6

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H08A.M280G	3.1			0.9			
H08A.M1085I							

Sample ID	Br^- (mg/L)	F^- (mg/L)
H08A.M280G		0.7
H08A.M1085I		

Table 104. Comparison of Data from the Magenta at H-9
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-9A	USGS	02/05/80	bail or swab	USGS	H09A.M280G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H09A.M280G	1.003 (g/mL)	8.5	5000	5460 (105 C)	-0.4%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H09A.M280G	35			750	2700

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H09A.M280G	800	28	550	170	41

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H09A.M280G	2.6			3.3			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H09A.M280G		1.8

Table 105. Comparison of Data from the Magenta at H-10
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-10A	USGS	03/21/80	bail or swab	USGS	H10A.M380G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H10A.M380G	1.175 (g/mL)	7.1	261300	270000 (105 C)	-2.0%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H10A.M380G				160000	2700

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H10A.M380G	93000	510	2500	2600	340

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H10A.M380G	3.9			1.9			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H10A.M380G		1.3

Table 106. Comparison of Data from the Magenta at WIPP-25
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-25	USGS	09/04/80	bail or swab	USGS	W25.M980G
W-25	SNL	09/16/80 - 09/18/80	34 gpm	FLD	W25.M980F
W-25	SNL	09/17/80	34 gpm	BFEC	W25.M980B

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W25.M980G	1.010 (g/mL)	7.5	11800	18700 (105 C)	0.7%
W25.M980F	1.004 (sg)	6.9			
W25.M980B			11900		-1.3%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
W25.M980G	150	180	0	5600	1900
W25.M980F	150	180	0	4900	~3000
W25.M980B				5250	2490

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W25.M980G	3100	0.8	910	240	65
W25.M980F			920		66
W25.M980B	2910	71.5	905	260	66.6

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W25.M980G	1.9			25			
W25.M980F						~0.6	
W25.M980B	1.5		0.20	33	12		

Sample ID	Br^- (mg/L)	F^- (mg/L)
W25.M980G		1.5
W25.M980F		
W25.M980B	2.5	

Table 107. Comparison of Data from the Magenta at WIPP-27
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-27	USGS	09/04/80	bail or swab	USGS	W27.M980G
W-27	SNL	09/24/80 - 09/25/80	9.4 gpm	FLD	W27.M980F
W-27	SNL	09/25/80	9.4 gpm	BFEC	W27.M980B

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W27.M980G		6.5	146500	173000 (105 C)	0.3%
W27.M980F	1.09 (sg)	6.4			
W27.M980B			145700		-0.7%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
W27.M980G	180	220	0	85000	2900
W27.M980F	170	210	0	84000	~3000
W27.M980B				85200	3410

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W27.M980G	43000	10000	3600	2000	340
W27.M980F			3600		330
W27.M980B	43200	8090	3660	2100	355

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W27.M980G	0.23			13			
W27.M980F						~2	
W27.M980B	2.3		0.34	30	59		

Sample ID	Br^- (mg/L)	F^- (mg/L)
W27.M980G		0.4
W27.M980F		
W27.M980B	28	

Table 108. Comparison of Data from the Magenta at WIPP-30
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-30	USGS	09/20/80	bail or swab	USGS	W30.M980G
W-30	SNL	12/02/80 - 12/10/80	100->50 mL/min	FLD	W30.M1280F

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W30.M980G	na	8.8	18400	19000 (105 C)	-3.3%
W30.M1280F	(<1.01) (sg)	(~8.6)			

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
W30.M980G	62			8700	3200
W30.M1280F	~60	~50	~10	<4000	<4000

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W30.M980G	5500	190	690	170	48
W30.M1280F			<620		<44

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W30.M980G	12			0.7			
W30.M1280F						~0.1	

Sample ID	Br^- (mg/L)	F^- (mg/L)
W30.M980G		1.9
W30.M1280F		

Table 109. Serial-Sampling Field Data from the Magenta at WIPP-30 (12/80) Compared with USGS Laboratory Data

Serial Sample No.	Date	Time	Temp (C)	pH	Alk. total meq/L	Alk. HCO_3^- mg/L	Alk. $CO_3^=$ mg/L	$SO_4^=$ mg/L	Cl^- mg/L	X^{++} meq/L	Ca^{++} mg/L
G*	09/20/80	--		8.8				3200	8700	48	690
1	12/03/80	13:35	17.0	8.25	1.28	78	0	1500	4900	29	370
2	12/04/80	08:55	15.0	8.6	1.25	68	9				
3	12/04/80	12:55	20.0	8.45	1.28	75	4	1600	5000	30	370
**											
4	12/05/80	12:45	19.0	8.55	1.21	55	18	4400	8800	56	800
5	12/06/80	08:50	14.0	8.55	1.21	63	11				
6	12/06/80	12:45	20.0	8.6	1.19	58	14				
7	12/07/80	08:30	15.0	8.55	1.20	64	9	3700	5400	47	680
8	12/08/80	08:15	4.0	8.55	1.05	48	15	--			
9	12/08/80	14:40	5.0	8.55	1.06	50	14	--			
10	12/09/80	08:30	7.0	8.6	1.06	49	15	--			
11	12/10/80	08:10	7.5	8.55	1.09	59	8	--	4000	44	620

* USGS laboratory data (from Mercer, 1983).

** Depth to water measured with steel tape during the afternoon of 12/04 after serial sample 3 was collected (exact time unknown).

Table 110. Comparison of Data from the Rustler/Salado Contact Zone at H-1
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-1	USGS	02/23/77	bail or swab	USGS	H01.R277G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H01.R277G		7.9	327200	480000 (105 C)	0.3%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H01.R277G	550	680	0	210000	520

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H01.R277G	56000	17000	13000	30000	3100

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H01.R277G	110			<0.1			

Table 111. Comparison of Data from the Rustler/Salado Contact Zone at H-2
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-2C	USGS	02/23/77	bail or swab	USGS	H02C.R277G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H02C.R277G		5.9	310800	450000 (105 C)	-0.6%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H02C.R277G	160	200	0	200000	1300

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H02C.R277G	66000	9100	9200	25000	2500

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H02C.R277G	150			2.0			

Table 112. Comparison of Data from the Rustler/Salado Contact Zone at H-3
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-3B1	USGS	02/23/77	bail or swab	USGS	H03B1.R277G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H03B1.R277G		7.6	326800	327000 (105 C)	-0.6%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H03B1.R277G	380	470	0	210000	370

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H03B1.R277G	59000	14000	18000	25000	2900

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H03B1.R277G	1.9			1.0			

Table 113. Comparison of Data from the Rustler/Salado Contact Zone at H-4
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-4C	USGS	03/16/79	bail or swab	SNL	H04C.R379S
H-4C	USGS	03/16/79	bail or swab	USGS	H04C.R379G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H04C.R379S	1.208 (g/mL)		315200		-0.2%
H04C.R379G			321300	322000 (105 C)	-2.1%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H04C.R379S	<10	<10	0	202000	730
H04C.R379G	1	1	0	210000	1400

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H04C.R379S	64400	14500	8560	25400	2510
H04C.R379G	66000	8600	8300	27000	2600

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H04C.R379S							
H04C.R379G	360			1.3			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H04C.R379S		
H04C.R379G		1.7

Table 114. Comparison of Data from the Rustler/Salado Contact Zone at H-5
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-5C	USGS	05/16/79	bail or swab	SNL	H05C.R579S
H-5C	USGS	05/16/79	bail or swab	USGS	H05C.R579G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H05C.R579S	1.258 (g/mL)		372300		-0.4%
H05C.R579G			411400	412000 (105 C)	-1.6%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H05C.R579S	160	200	0	262000	1430
H05C.R579G	180	300	0	290000	2000

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H05C.R579S	14200	16100	1780	76400	6350
H05C.R579G	14000	21000	2100	82000	6800

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H05C.R579S							
H05C.R579G	67			1.6			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H05C.R579S		
H05C.R579G		<0.1

Table 115. Comparison of Data from the Rustler/Salado Contact Zone at H-6
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-6C	USGS	04/09/79	bail or swab	SNL	H06C.R479S
H-6C	USGS	04/09/79	bail or swab	USGS	H06C.R479G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H06C.R479S	1.207 (g/mL)		312600		-1.9%
H06C.R479G			315200	316000 (105 C)	-0.7%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H06C.R479S	<10	<10	0	201000	1450
H06C.R479G	1	1	0	200000	2000

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H06C.R479S	79400	6670	4170	20200	1860
H06C.R479G	80000	8000	4200	21000	1900

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H06C.R479S							
H06C.R479G	200			1.4			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H06C.R479S		
H06C.R479G		1.0

Table 116. Comparison of Data from the Rustler/Salado Contact Zone at H-7
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-7C	USGS	03/20/80	bail or swab	USGS	H07C.R380G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H07C.R380G	1.048 (g/mL)	6.8	69600	79800 (105 C)	-2.2%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H07C.R380G	35	43	0	41000	2900

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H07C.R380G	22000	210	2600	910	200

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H07C.R380G	3.1			7.2			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H07C.R380G		0.8

Table 117. Comparison of Data from the Rustler/Salado Contact Zone at H-8
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-8C	USGS	09/06/80	bail or swab	USGS	H08C.R980G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H08C.R980G		7.6	123600	130000 (105 C)	0.7%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H08C.R980G	21	26	0	70000	5300

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H08C.R980G	46000	660	1200	430	95

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H08C.R980G	1.3			0.8			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H08C.R980G		0.4

Table 118. Comparison of Data from the Rustler/Salado Contact Zone at H-9
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-9C	USGS	05/20/80	bail or swab	USGS	H09C.R580G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H09C.R580G	1.202 (g/mL)	7.0	326000	326000 (105 C)	3.7%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
H09C.R580G	24	29	0	190000	2600

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H09C.R580G	130000	1200	1300	870	140

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H09C.R580G	19			3.8			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H09C.R580G		0.1

Table 119. Comparison of Data from the Rustler/Salado Contact Zone at H-10
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
H-10C	USGS	05/19/80	bail or swab	USGS	H10C.R580G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
H10C.R580G	1.198 (g/mL)	6.3	309800	323000 (105 C)	-0.02%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
H10C.R580G	53	65	0	190000	3300

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
H10C.R580G	100000	4000	1500	11000	980

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
H10C.R580G	120			3.2			

Sample ID	Br^- (mg/L)	F^- (mg/L)
H10C.R580G		0.7

Table 120. Comparison of Data from the Rustler/Salado Contact Zone at P-14
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
P-14	USGS	02/24/77	bail or swab	USGS	P14.R277G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
P14.R277G		7.2	313300	350000 (105 C)	0.9%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
P14.R277G	180	220	0	180000	10000

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
P14.R277G	120000	1300	570	1200	130

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
P14.R277G	1.7			2.0			

Table 121. Comparison of Data from the Rustler/Salado Contact Zone at P-15
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
P-15	USGS	04/03/79	bail or swab	SNL	P15.R479S
P-15	USGS	04/03/79	bail or swab	USGS	P15.R479G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
P15.R479S	1.045 (g/mL)		67600		-0.6%
P15.R479G			67300		0.8%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
P15.R479S	78	95	0	38000	3350
P15.R479G	45	55	0	38000	2800

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
P15.R479S	23700	1350	800	320	66.2
P15.R479G	24000	1400	770	350	67

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
P15.R479S							
P15.R479G	3.7			1.3			

Sample ID	Br^- (mg/L)	F^- (mg/L)
P15.R479S		
P15.R479G		1.3

Table 122. Comparison of Data from the Rustler/Salado Contact Zone at P-17
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
P-17	USGS	05/11/79	bail or swab	SNL	P17.R579S
P-17	USGS	05/11/79	bail or swab	USGS	P17.R579G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
P17.R579S	1.194 (g/mL)				
P17.R579G			268000		1.5%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
P17.R579S	610	740	0	186000	540
P17.R579G	650	790	0	180000	1200

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
P17.R579S	lost	lost	lost	lost	
P17.R579G	23000	8800	15000	40000	4000

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
P17.R579S							
P17.R579G	0.88			15			

Sample ID	Br^- (mg/L)	F^- (mg/L)
P17.R579S		
P17.R579G		3.8

Table 123. Comparison of Data from the Rustler/Salado Contact Zone at P-18
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
P-18	USGS	05/11/79	bail or swab	SNL	P18.R579S
P-18	USGS	05/11/79	bail or swab	USGS	P18.R579G

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
P18.R579S	1.221 (g/mL)		325200		-0.7%
P18.R579G	1.266 (g/mL)	5.4	327500		-2.4%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
P18.R579S	330	400	0	217000	610
P18.R579G	400	490	0	220000	480

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
P18.R579S	45600	11700	10200	39800	3770
P18.R579G	48000	12000	10000	37000	3500

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
P18.R579S							
P18.R579G	160			0.4			

Sample ID	Br^- (mg/L)	F^- (mg/L)
P18.R579S		
P18.R579G		2.3

Table 124. Comparison of Data from the Rustler/Salado Contact Zone at WIPP-25
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-25	USGS	03/19/80	bail or swab	USGS	W25.R380G
W-25	SNL	07/16/80 - 07/17/80	1.1 gpm	FLD	W25.R780F
W-25	SNL	07/17/80	1.1 gpm	BFEC	W25.R780B

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W25.R380G	1.173 (g/mL)	7.2	238200	252000 (105 C)	4.3%
W25.R780F		7.4			
W25.R780B			334400		0.4%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
W25.R380G	80	98	0	130000	12000
W25.R780F	110	130	0	190000	
W25.R780B				192000	12400

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W25.R380G	90000	2400	650	3200	290
W25.R780F					290
W25.R780B	122800	3330	560	3260	295

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W25.R380G	35			2.6			
W25.R780F							
W25.R780B	41		1.6	4.0	11		

Sample ID	Br^- (mg/L)
W25.R380G	
W25.R780F	
W25.R780B	51

Table 125. Comparison of Data from the Rustler/Salado Contact Zone at WIPP-26
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-26	USGS	03/18/80	bail or swab	USGS	W26.R380G
W-26	SNL	07/22/80 - 07/23/80	.42 gpm	FLD	W26.R780F
W-26	SNL	07/23/80	.42 gpm	BFEC	W26.R780B

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W26.R380G	1.078 (g/mL)	8.5	152600	153000 (105 C)	-2.2%
W26.R780F		7.7			
W26.R780B			188400		0.3%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
W26.R380G	160			88000	7600
W26.R780F	220	270	0	110000	na
W26.R780B				108000	7480

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W26.R380G	52000	1000	2700	1300	240
W26.R780F					190
W26.R780B	68600	1200	1420	1660	207

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W26.R380G	30			2.5			
W26.R780F							
W26.R780B	32		1.2	6.2	27		

Sample ID	Br^- (mg/L)
W26.R380G	
W26.R780F	
W26.R780B	19

Table 126. Comparison of Data from the Rustler/Salado Contact Zone at WIPP-27
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-27	USGS	05/21/80	bail or swab	USGS	W27.R580G
W-27	SNL	08/05/80 - 08/07/80	.13->.02 gpm	FLD	W27.R780F

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W27.R580G	1.205 (g/mL)	7.8	266000	363000 (105 C)	2.2%
W27.R780F	(~1.07) (sg)	(~7.1)			

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
W27.R580G				154000	5190
W27.R780F	(~60)	(~70)	0	(~58000)	(~10000)

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W27.R580G	102000	2570	1160	1040	140
W27.R780F					(~220)

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W27.R580G	1.3			0.1			
W27.R780F							

Sample ID	Br^- (mg/L)	F^- (mg/L)
W27.R580G		0.2
W27.R780F		

Table 127. Comparison of Data from the Rustler/Salado Contact Zone at WIPP-28
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-28	USGS	03/20/80	bail or swab	USGS	W28.R380G
W-28	SNL	07/30/80 - 07/31/80	3.1 gpm	FLD	W28.R780F
W-28	SNL	07/31/80	3.1 gpm	BFEC	W28.R780B

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W28.R380G	1.140 (g/mL)	7.0	182800		-0.5%
W28.R780F	1.18 (sg)	7.0			
W28.R780B			277100		-0.9%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
W28.R380G				102000	11000
W28.R780F	140	170	0	150000	~20000
W28.R780B				155000	16700

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W28.R380G	65000	2070	615	2070	200
W28.R780F					300
W28.R780B	97100	4300	605	3400	309

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W28.R380G	54			6.0			
W28.R780F						~0.1	
W28.R780B	46		1.8	7.8	12		

Sample ID	Br^- (mg/L)	F^- (mg/L)
W28.R380G		0.2
W28.R780F		
W28.R780B	29	

Table 128. Comparison of Data from the Rustler/Salado Contact Zone at WIPP-29
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-29	USGS	03/18/80	bail or swab	USGS	W29.R380G
W-29	SNL	07/22/80 - 07/24/80	1.5 gpm	FLD	W29.R780F
W-29	SNL	07/24/80	1.5 gpm	BFEC	W29.R780B

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W29.R380G	1.068 (g/mL)	7.3	96800	129000 (105 C)	-0.3%
W29.R780F		7.2			
W29.R780B			111000		-1.0%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
W29.R380G	130	160	0	49000	12000
W29.R780F	160	200	0	57000	~10000
W29.R780B				58000	12000

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W29.R380G	32000	1000	850	2000	210
W29.R780F					230
W29.R780B	36100	1480	1080	2320	244

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W29.R380G	21			3.5			
W29.R780F							
W29.R780B	20		1.3	15	21		

Sample ID	Br^- (mg/L)	F^- (mg/L)
W29.R380G		0.9
W29.R780F		
W29.R780B	12	

Table 129. Comparison of Data from the Rustler/Salado Contact Zone at WIPP-30
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-30	USGS	03/19/80	bail or swab	USGS	W30.R380G
W-30	SNL	07/16/80 - 07/17/80	.22 gpm	FLD	W30.R780F
W-30	SNL	07/17/80	.22 gpm	BFEC	W30.R780B

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance .Error[5]
W30.R380G	1.201 (g/mL)	7.0	301600	302000 (105 C)	5.3%
W30.R780F		7.5			
W30.R780B			325900		0.1%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
W30.R380G	320	390	0	170000	7000
W30.R780F	510	620	0	180000	
W30.R780B				192000	7390

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W30.R380G	120000	1500	850	2300	230
W30.R780F			(~900)		260
W30.R780B	120600	2180	955	2770	275

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
W30.R380G	77			3.5			
W30.R780F							
W30.R780B	82		0.72	5.5	18		

Sample ID	Br^- (mg/L)
W30.R380G	
W30.R780F	
W30.R780B	78

Table 130. Comparison of Data from the Dewey Lake Red Beds at Pocket Well
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
POCKET	HGC	10/27/83 - 11/02/83	8.6 gpm	FLD	XPOC.D1183F
POCKET	HGC	11/02/83	8.6 gpm	H-B	XPOC.D1183HB
POCKET	HGC	11/02/83	8.6 gpm	KGS	XPOC.D1183Ka
POCKET	HGC	11/02/83	8.6 gpm	KGS	XPOC.D1183Kb

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
XPOC.D1183F	1.000 (sg)	7.7			
XPOC.D1183HB			1880		0.8%
XPOC.D1183Ka					
XPOC.D1183Kb					

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
XPOC.D1183F		~140			
XPOC.D1183HB				210	1100
XPOC.D1183Ka		120		340	
XPOC.D1183Kb		95		214	

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
XPOC.D1183F					
XPOC.D1183HB	95	2.4	380	96	26.9
XPOC.D1183Ka					
XPOC.D1183Kb					

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
XPOC.D1183F							
XPOC.D1183HB			0.06	12 Si		0.14	0.02
XPOC.D1183Ka							
XPOC.D1183Kb							

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
XPOC.D1183F				
XPOC.D1183HB				8
XPOC.D1183Ka	.71		0.019	
XPOC.D1183Kb	.46		0.012	
XPOC.D1183UA				

Table 131. Comparison of Data from the Dewey Lake Red Beds at Ranch Well
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
RANCH	WQSP-R1	06/13/86 - 06/18/86	5.5 gpm	FLD	XRAN.D
RANCH	WQSP-R1	06/18/86	5.5 gpm	BFEC	XRAN.D
RANCH	WQSP-R1	06/18/86	5.5 gpm	ITAS	XRAN.D

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
XRAN.D686F	1.002 (sg)	7.0			
XRAN.D686B			2520		0.3%
XRAN.D686I		7.7	2270	3300 (180 C)	-1.0%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
XRAN.D686F	180	220	0	400	
XRAN.D686B	140	170	0	418	1100
XRAN.D686I	180	220	0	390	920

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
XRAN.D686F					38
XRAN.D686B	200	4.00	420	202	37.6
XRAN.D686I	180	3.65	365	190	33.8

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
XRAN.D686F						0.1	
XRAN.D686B	0.10	<0.01	0.12	52	5.9	0.024	<0.01
XRAN.D686I	0.19	0.1		40 as Si	3.2	0.020	<0.005

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	IO_3^- (mg/L)	NO_3^- (mg/L)
XRAN.D686F					
XRAN.D686B	2.3	0.82	0.13	0.15	520
XRAN.D686I	2.3	1.0	.96		120 as N (= 530 as NO_3^-)

Table 132. Comparison of Data from the Dewey Lake Red Beds at Twin Wells
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
TWIN-P	WQSP-R1	01/24/86 - 02/02/86	33 gph	FLD	XTWP.D186F
TWIN-P	WQSP-R1	01/30/86	33 gph	BFEC	XTWP.D186B
TWIN-P	WQSP-R1	01/31/86	33 gph	EEG	XTWP.D186E
TWIN-P	WQSP-R1	01/30,31/86	33 gph	ITAS	XTWP.D186I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
XTWP.D186F	0.998 (sg)	7.8			
XTWP.D186B			401		9.2%*
XTWP.D186E	1.0 (g/mL)	7.9	227		-6.3%
XTWP.D186I		8.0	671	400 (180 C)	-19%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
XTWP.D186F	190	230	0	45	
XTWP.D186B	120	150	0	44.1	75.1
XTWP.D186E				44	70
XTWP.D186I	180	220	0	47.0	270

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
XTWP.D186F					5.9
XTWP.D186B	25.4	3.85	80.4	22.5	5.86
XTWP.D186E	24	4.3	60	25	5.05
XTWP.D186I	26.0	3.70	81.0	23.5	5.98

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
XTWP.D186F						0.05	
XTWP.D186B	0.13	<0.01	<.05	47	1.1	<0.01	<0.01
XTWP.D186E			<0.5				
XTWP.D186I	0.16	<0.1		42 as Si	0.6	0.34	<0.05

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
XTWP.D186F				
XTWP.D186B	0.17	0.58	<0.01	
XTWP.D186E		1.4		
XTWP.D186I	<1	0.7	<1	7.8 as N

* CBE is -1.0% if field alkalinity value used instead of lab value.

Table 133. Comparison of Data from the Dewey Lake Red Beds at Unger Well
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
UNGER	HGC	01/26/84	9.6 gpm	H-B	XUNG.D1
UNGER	HGC	01/26/84	9.6 gpm	KGS	XUNG.D1

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
XUNG.D184HB			2840		-2.9%
XUNG.D184K					

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
XUNG.D184HB				260	1800
XUNG.D184K		130		268	

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
XUNG.D184HB	120	3.2	530	130	36.9
XUNG.D184K					

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
XUNG.D184HB			0.05	1 as Si		<0.05	<0.03
XUNG.D184K							

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
XUNG.D184HB	15		0.06	11
XUNG.D184K	.56		0.010	

Table 134. Comparison of Data from the Bell Canyon Formation at DOE-2
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
DOE-2	WQSP-R1	07/20/85 - 07/23/85	swab	FLD	D2.B785F
DOE-2	WQSP-R1	07/23/85	swab	BFEC	D2.B785B
DOE-2	WQSP-R1	07/23/85	swab	EEG	D2.B785E
DOE-2	WQSP-R1	07/23/85	swab	ITAS	D2.B785I

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
D2.B785F		6.8			
D2.B785B			149500		0.2%
D2.B785E	1.122 (g/mL)	6.8	130800		-2.2%
D2.B785I		6.7		160000 (180 C)	

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^{=}$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^{=}$ (mg/L)
D2.B785F				90000	
D2.B785B	39	48	0	89700	2020
D2.B785E				80000	1880
D2.B785I					

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
D2.B785F					400
D2.B785B	49600	885	5910	1330	405
D2.B785E	41800	600	5320	1200	364
D2.B785I					

Sample ID	B (mg/L)	Cs (mg/L)	Li (mg/L)	SiO_2 (mg/L)	Sr (mg/L)	Fe (mg/L)	Mn (mg/L)
D2.B785F							
D2.B785B	54	<0.01	5.8	2.5	150	11	2.8
D2.B785E			2.8				
D2.B785I	61	3.3		14 as Si	300	9.1	2.5

Sample ID	Br^- (mg/L)	F^- (mg/L)	I^- (mg/L)	NO_3^- (mg/L)
D2.B785F				
D2.B785B	250	1.1	6.4	
D2.B785E		1.4		
D2.B785I	94	0.4	7.9	0.75 as N

Table 135. Comparison of Data from the Alluvium at WIPP-15
(Footnotes follow Table 135)

Well[1]	Agency[2]	Collection Date	Pumping Rate	Lab[3]	Sample ID
W-15	USGS	03/12/79	bail or swab	SNL	W15.Q379S

Sample ID	Density/ Specific Gravity[4]	pH	TDS (calc) (mg/L)[5]	TDS (ROI) (mg/L)	Charge-Balance Error[5]
W15.Q379S	0.999 (g/mL)		1920		1.0%

Sample ID	Alkalinity (mg/L $CaCO_3$)[6]	HCO_3^- (mg/L)[6]	$CO_3^=$ (mg/L)[6]	Cl^- (mg/L)	$SO_4^=$ (mg/L)
W15.Q379S	1100	1130	92	109	32

Sample ID	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	X^{++} (meq/L)[7]
W15.Q379S	480	20	20	42	4.44

Footnotes for Tables to 71 to 135:

1. Abbreviations of well names are explained in Table 1.

2. Key to agencies that collected samples:
   HGC: Hydro Geo Chem, Inc. Tucson, AZ
   SNL: Sandia National Laboratories, Albuquerque, NM
   USGS: United States Geological Survey
   WQSP-R1: Water Quality Sampling Program, Round One

3. Key to labs that did analyses:

BFEC:	Bendix Field Engineering Corp., Grand Junction, CO (now UNC Technical Services; called UNC/Bendix in the text)
EEG:	New Mexico Bureau of Mines & Mineral Resources, Socorro, NM
FLD:	Field measurements, either steady-state values or best available values
H-B:	Bendix Field Engineering Corp., Grand Junction, CO
ITAS:	IT Analytical Services, Murraysville, PA
KCS:	KC Services
KGS:	Kansas Geological Survey
UA:	University of Arizona, Laboratory of Isotope Geochemistry
USGS:	United States Geological Survey, Central Laboratories

4. Density/specific gravity: designation "sg" after a value means that value is a specific gravity. The units "mg/L" indicate that the value is a density.

5. Total-dissolved-solids (TDS-calc) concentrations and charge-balance errors (CBEs) were calculated as described in the text. Except for the Twin Well/Pasture Well sample, alkalinity values were not included in the CBE calculations for the EEG samples. Lab alkalinity values were used to calculate CBEs for the UNC/Bendix, ITAS, and USGS samples.

6. Alkalinities originally reported as mg/L $CaCO_3$ were converted to HCO_3/CO_3 when the sample pH was less than 8.0, as described in the text. Alkalinities originally reported as mg/L HCO_3/CO_3 were converted to $CaCO_3$ as described in the text.

7. Laboratory values of divalent cations, X^{++}, were calculated as described in the text.

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