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Sandia National Laboratories
Annual Compliance Monitoring
Parameter Assessment for 2003

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Executive Summary

This document reports the fifth annual (2003) derivation and assessment of the Waste Isolation Pilot Plant (WIPP) Compliance Monitoring Parameters (COMPs). The COMPs program is a requirement of the Environmental Protection Agency (EPA) disposal regulations (EPA 1993 and 1996). The concept of deriving and assessing COMPs is explained in Sandia National Laboratories (SNL) Nuclear Waste Management Program Analysis Plan, AP-069 titled: *An Analysis Plan for Annually Deriving Compliance Monitoring Parameters and their Assessment Against Performance Expectations to Meet the Requirements of 40 CFR 194.42* (SNL 2000a).

As required by the WIPP Land Withdrawal Act (U. S. Congress 1992), DOE is required to submit documentation to EPA for the recertification of the WIPP every five years following the first receipt of waste. This will require that a Compliance Recertification Application (CRA) be prepared and submitted to the EPA no later that March 26, 2004. This is the last reporting cycle prior to EPA's recertification of WIPP. A new baseline performance assessment (PA) will likely provide new expected values for COMPs or change the way they are assessed. As such, an analysis of the monitoring program similar to that performed to meet 40 CFR 194.42 requirements during the first WIPP certification (documented in the Compliance Certification Application (CCA; DOE 1996)) shall be performed after the recertification baseline is established. This may result in changes to the compliance monitoring program. The monitoring analysis uses information from baseline sensitivity studies.

The WIPP has many monitoring programs, each designed to meet various regulatory and operational safety requirements. The comprehensive monitoring effort is not under the auspice of one program, but is comprised of many discrete elements, one of which was designed to fulfill the EPA requirements found at 40 CFR Part 191 Subparts B and C and 40 CFR 194. The expected performance of the repository was determined through a PA implemented by DOE for the CCA. Monitoring parameters that are related to the long-term performance of the repository were identified in a Sensitivity Study[1] (since these parameters fulfill a regulatory function, they were termed Compliance Monitoring Parameters so that they would not be confused with similar PA parameters).

The PA is used to predict the containment performance of the WIPP. COMPs can indicate conditions that are not within PA expectations and may alert the project of conditions not accounted for or expected. COMPs values and ranges were developed such that exceedance of these values indicate a condition that is potentially outside PA expectations. These values were appropriately termed "trigger values." Deriving COMPs trigger values (TV) was the first step in assessing the monitoring data. TVs were derived and documented in the *Trigger Value Derivation Report* (SNL 2002a). In some instances a COMP will not have a TV because it has been shown to be insensitive to PA results though EPA's sensitivity analysis (EPA 1998).

As the quantity of information in the monitoring database grows over time, the data will become more useful for assessing the monitoring program's performance and usefulness. With each annual assessment and knowledge gained through ongoing activities, the basis for assessing COMPs and assigning TVs will undergo improvements. The Trigger Value Derivation Report was

[1] Attachment MONPAR to Appendix MON in the CCA (DOE 1996) documents the analysis of monitoring parameters. The analysis was performed to fulfill 40 CFR 194.42 requirements.

revised in 2002 to include values for groundwater composition and flow COMPs (SNL 2002a). Additionally, the first recertification PA will likely change the way COMPs are assessed since PA assumptions, parameters and conceptual models will be updated, thus potentially changing PA expectations used to assess monitoring parameters. Specifically, new Culebra water level ranges will be used in the recertification PA to account for data from the water level monitoring program. A new inventory estimate will be used to include actual waste emplacement and new waste information. This inventory information affects the waste activity COMP. Therefore, a monitoring program analysis will be conducted after a new compliance baseline is established during the recertification to evaluate the impacts on the compliance monitoring program. If necessary, the program will be revised and new TVs will be derived.

EPA approved ten COMPs: two relating to human activities, five relating to geotechnical performance, two relating to regional hydrogeology and one relating to the radioactive components of the waste. The EPA also requires the DOE to report any negative condition that would indicate the repository would not function as predicted or a condition that is substantially different from the information contained in the most recent compliance application. Annual assessments of COMPs will allow the DOE to monitor the predicted performance of the repository and report any condition adverse to the containment performance. This compliance monitoring program is described in greater detail in DOE's *40 CFR Parts 191 and 194 Compliance Monitoring Implementation Plan* (MIP; DOE 1999).

As outlined in the MIP, the Management and Operating Contractor (M&OC), currently Westinghouse TRU Solutions (WTS) and Washington Regulatory and Environmental Services (WRES), are responsible for implementing the monitoring programs that collect and report the monitoring data. The Scientific Advisor (SA) is responsible for assessing these data and compiling the results as they pertain to performance expectations. The SA is also responsible for making recommendations to improve or change the monitoring programs based on the results. This document reports these results and the recommendations based on the 2003 Annual COMPs Assessment. This assessment concludes that the COMP values assessed in this annual report do not indicate a condition for which the repository will perform in a manner other than that represented in WIPP PAs.

As stated in the 2002 COMPs report, the Culebra water levels are outside ranges used in the CCA PA at some wells (SNL 2002b). This condition brought about work, (initiated in 2001) to account for these water levels in the groundwater model. As a result, additional data from Culebra ground water monitoring activities were incorporated in the ground water model used in the first CRA. New transmissivity fields were generated for the CRA to account for a new range of Culebra water levels. This conclusion demonstrates the effectiveness of the monitoring program to identify potential conditions that are different than those expected or represented in PA, and reconcile them.

1 Introduction

The WIPP is governed by the EPA's long-term radioactive waste disposal regulations at 40 CFR Part 191 Subparts B and C (EPA 1993) and the WIPP-specific certification criteria at 40 CFR Part 194 (EPA 1996). Monitoring WIPP performance is an "assurance requirement" of these regulations and is intended to provide additional assurance that the WIPP will protect the public and environment (see 40 CFR 191.14). In the WIPP Compliance Certification Application (CCA; DOE 1996), the DOE made commitments to conduct a number of monitoring activities to comply with the criteria at 40 CFR § 194.42 and to ensure that deviations from the expected long-term performance of the repository are identified at the earliest possible time. These DOE commitments are represented by ten COMPs, which are listed in Section 2.

The COMPs are an integral part of the overall WIPP monitoring strategy. The DOE's MIP (DOE 1999) describes the overall monitoring program and responsibilities for COMPs derivation and assessment. Collecting and reporting data from the WIPP monitoring programs are the responsibilities of the M&OC. SNL, as the SA, uses these monitoring data and observations to derive data values which indicate potential issues (termed "trigger values") for the ten COMPs and evaluate the COMPs against performance expectations for the disposal system. The performance expectations are based on scenarios, conceptual models and computational results using the WIPP PA methodology and its associated codes and parameter values that form part of the DOE's Compliance Baseline. The results of the SA's evaluation of COMPs are reported to the DOE Carlsbad Field Office (CBFO) via the Office of Environmental Compliance (OEC). This report documents the results of the reporting year 2003 COMPs assessment (September 16th 2002 to June 30th 2003). The reporting period has changed to match the reporting period of the 194.4(b)(4) report (EPA 2003).

1.2 Monitoring and Evaluation Strategy

The MIP illustrates the process for evaluation of COMP-related monitoring data and observations (Fig 4.2; DOE 1999). Figure 1.1 (of this document) graphically describes the three basic Compliance Monitoring Program elements which include the TV generation and reporting function, the annual COMP reporting cycle and the five-year recertification element. The Compliance Monitoring Program is an integrated effort between the M&OC, the SA and the CBFO. The M&OC operates the monitoring systems at the WIPP site and collects the basic data, while the SA is responsible for generating the COMPs from the basic data and assessing the results. The CBFO oversees and directs the monitoring program to ensure compliance with the EPA monitoring and reporting requirements. The SA is also responsible for the development and maintenance of the TVs. Exceedance of these values represents a condition that requires further actions, but does not necessarily indicate an out-of-compliance condition. Rather, this approach assures that conditions that are not consistent with expected repository performance are recognized as early as possible. These conditions may include data inconsistent with the conceptual models implemented in PA, or invalidation of assumptions and arguments used in the screening of Features, Events and Processes (FEPs) screened into PA.

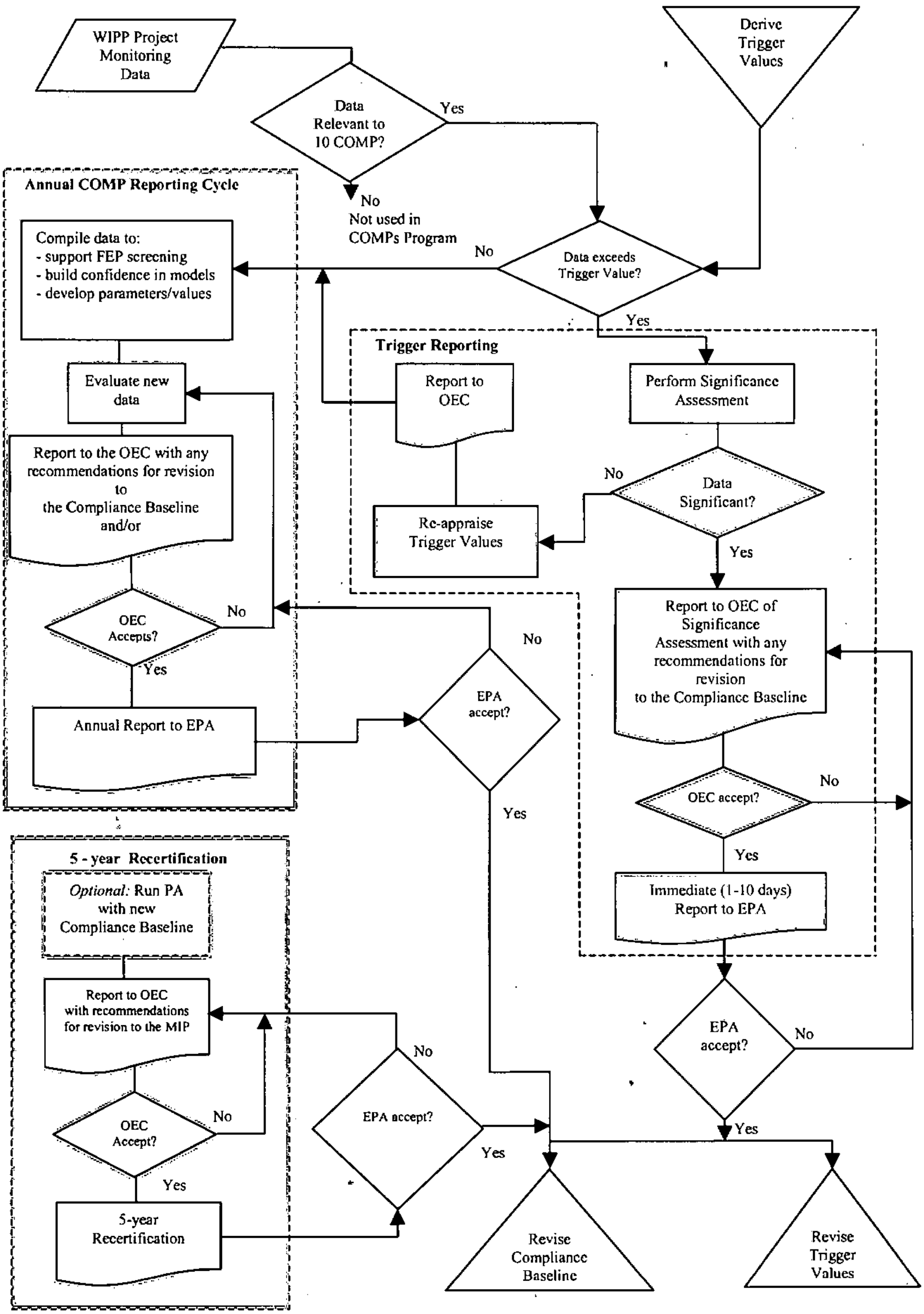

Figure 1.1: Activities evaluating and reporting compliance monitoring parameters

1.3 Annual Reporting Cycle

Reporting results of the annual COMPs assessment is necessary to meet the EPA monitoring requirements. Under 40 CFR §194.4, the DOE is required to report significant, and non-significant, changes to the EPA. Monitoring data, associated parameter values and monitoring information that change must be reported even if the assessment concludes there is no impact on the repository. Whether or not the monitoring data agree with expectations, as defined by the evaluation, all the data will ultimately be compiled and reported to the DOE to assist in DOE's annual reporting cycle to the EPA. The SA's role in this reporting cycle is to use the monitoring data to derive the COMPs, and to use the new and updated information to make any recommendations for modification to the Compliance Baseline, both to monitoring programs and TVs.

2 Assessment of COMPs

The compliance monitoring program tracks the following ten COMPs:

1. Drilling Rate
2. Probability of Encountering a Castile Brine Reservoir
3. Waste Activity
4. Subsidence
5. Changes in Culebra Groundwater Flow
6. Change in Culebra Groundwater Composition
7. Creep Closure
8. Extent of Deformation
9. Initiation of Brittle Deformation
10. Displacement of Deformation Features

An annual review of these COMPs is necessary to meet the intent of 40 CFR §191.14 assurance requirements, which states:

> "(b) Disposal systems shall be monitored after disposal to detect substantial and detrimental deviations from expected performance. This monitoring shall be done with techniques that do not jeopardize the isolation of the wastes and shall be conducted until there are no significant concerns to be addressed by further monitoring."

In the following section, each COMP is evaluated and compared to the applicable TV. This assessment is performed under Analysis Plan AP-069 (SNL 2000a). This section summarizes the results of the 2003 calendar year assessment. Specifically, AP-069 contains five steps to derive TVs and assess COMPs. Steps 1 and 2 generate a table that maps COMP-related data to PA parameters, FEPs screening arguments, conceptual models, model assumptions and the M&OC organization that generates the data used to derive each COMP. Table 2.1 contains this information which was derived using information in the CCA (DOE 1996).

Table 2.1 Monitoring parameters

40 CFR 194 Monitoring Parameter	Responsible Program M&OC/*SA* (SA in italics)	Trigger Value(s)	Related Performance Assessment Parameter	Major FEPs Screening Decisions Related to Monitoring
Creep Closure and Stresses	Geotechnical Monitoring Program *Rock Mechanics Program*	Greater than 1 order of magnitude increase in the rate.	Not directly related to a PA Parameter. *Provides a short-term (operational) observation of the deformational properties of halite and anhydrite. Can provide confidence in the CCA creep closure model.*	*Salt creep, room closure, excavation-induced stress changes, changes in stress field, pressurization, consolidation of waste.*
Extent of Deformation	Geotechnical Monitoring Program *Rock Mechanics Program*	Greater than 1 meter/year increase.	Not directly related to a PA Parameter. *Provides a short-term observation of the extent of deformation. Can provide confidence in the long-term behavior of Disturbed Rock Zone (DRZ) as modeled in CCA and DRZ parameters (e.g., permeability and porosity).* *Intrinsic shaft DRZ permeability.*	*DRZ, roof falls, consolidation of seal elements, compaction of waste.*
Initiation of Brittle Deformation	Geotechnical Monitoring Program *Seals and Rock Mechanics Programs*	None	Not directly related to a PA parameter. *Provides related repository observation data on initiation or displacement of major brittle deformation features in the roof or surrounding rock.*	*Disruption due to gas effects.*

40 CFR 194 Monitoring Parameter	Responsible Program M&OC/*SA* (SA in italics)	Trigger Value(s)	Related Performance Assessment Parameter	Major FEPs Screening Decisions Related to Monitoring
Displacement of Deformation Features	Geotechnical Monitoring Program *Rock Mechanics Program*	Obscured borehole (qualitative)	Not directly related to a PA Parameter. *Provides related repository operational data on initiation or displacement of major brittle deformation features in the roof or surrounding rock.*	*Seismic activity, creep closure, consolidation of waste.*
Culebra Ground Water Compositions	Ground Water Monitoring Program *Far Field Monitoring Program*	Both duplicate analyses for any major ion falling outside the 95% Confidence Intervals given in Table 4.2 for three consecutive sampling periods.	Average Culebra brine composition and matrix distribution coefficient for U (IV,VI), Pu(III,IV), Th(IV), Am(III). *Matrix distribution coefficient is not a sensitive parameter for the CCA PA. Can provide information on well integrity around the site.*	*Groundwater geochemistry, actinide sorption.*
Change in Culebra Ground Water Flow (Water Level)	Ground Water Monitoring Program *Far Field Monitoring Program*	Comparison to ranges of freshwater heads used in CCA T-Fields (Table 4.1 of Trigger Report)	Culebra transmissivity, fracture & matrix porosity, fracture spacing, dispersivity, & climate Index. *The CCA modeling allowed the water level to rise to the land surface. Can provide information on well integrity around the site.*	*Groundwater flow and recharge/discharge; Infiltration and Precipitation.*

40 CFR 194 Monitoring Parameter	Responsible Program M&OC/*SA* (SA in italics)	Trigger Value(s)	Related Performance Assessment Parameter	Major FEPs Screening Decisions Related to Monitoring
Drilling Rate	Delaware Basin Monitoring Program *Direct Release Program*	53.5 boreholes per square kilometer per 10,000 yrs.	Drilling rate per unit area. *In the CCA the drilling rate was determined to be 46.8 boreholes per square kilometer per 10,000 yrs.*	*Drilling.*
Probability of Encountering a Castile Brine Reservoir	Delaware Basin Monitoring Program *Direct Release Program*	None	Probability of encountering a Castile brine reservoir, reservoir pressure, and volume. *In the CCA, 8% was used; in the Performance Assessment Validation Test, a range of 1 - 60% was used.*	*Drilling fluid flow, drilling fluid loss, blowout and brine reservoirs.*
Subsidence Measurements	Subsidence Monitoring Program *Rock Mechanics Program*	10 millimeters/ year	Not directly related to a PA Parameter. *Can provide spatial information on surface subsidence (if any) over the influence area of the underground openings during operations.*	*Changes to ground water flow due to mining effects, subsidence baseline.*

40 CFR 194 Monitoring Parameter	Responsible Program M&OC/*SA* (SA in italics)	Trigger Value(s)	Related Performance Assessment Parameter	Major FEPs Screening Decisions Related to Monitoring
Waste Activity	WIPP Waste Information System (WWIS) *PA Methodology*	5.1 million curies (RH Only)	Radionuclide inventory. *In the CCA, the SA used the Baseline Inventory Report information scaled to the Land Withdrawal Act (LWA) limits of 6.2 million cubic feet for CH TRU waste and 5.1 million curies for RH TRU waste (limits are listed in table WCA-1 in the CCA)*	*Waste characteristics, radiological characteristics, consolidation of waste, actinide source term.*

2.1 Human Activities COMPs

The CCA identifies ten COMPs that the DOE is required to monitor and assess during the WIPP operational period. Two of these parameters monitor "Human Activities" in the WIPP vicinity which include:

- Probability of Encountering a Castile Brine Reservoir
- Drilling Rate

2.1.1 Probability of Encountering a Castile Brine Reservoir

Data used for the CCA were compiled from drilling record searches for the region surrounding the WIPP. The results of this initial search recorded 27 drilling encounters with pressurized brine (water) in the Castile Formation. Of these encounters, 25 were hydrocarbon wells scattered over a wide area in the vicinity of the WIPP site; two wells, ERDA 6 and WIPP 12, were drilled in support of the WIPP site characterization effort (see DOE 2003a, Table 11 for a complete listing of brine encounters). The Delaware Basin Drilling Surveillance Program reviews the well files of all new wells drilled in the New Mexico portion of the Delaware Basin each year looking for instances of Castile brine encounters. The program also sends out an annual survey to operators of new wells to determine if pressurized brine was encountered. Since the CCA, data have been compiled through August 2003. No pressurized Castile brine encounters have been reported in the drilling records for wells drilled in the New Mexico portion of the Delaware Basin (DOE 2003a).

As reported in WID 2001, there were two Castile Brine encounters reported by area drillers to WIPP Site personnel that do not appear in records on file at New Mexico Oil Conservation District (NMOCD) offices. The following year, WID 2002 reported three additional brine encounters reported to site personnel that do not appear in the records for these wells at the NMOCD offices. Two encounters were located near ERDA 6 northeast of the WIPP Site that reported encountering brine at an initial rate of several hundred barrels per hour. All brine was contained within the drilling pits and therefore did not require reporting to the NMOCD. The third encounter was to the southwest of the WIPP Site reporting an initial rate of 400 to 500 barrels per hour that dissipated in a matter of minutes. No additional encounters were reported during this reporting cycle. Of the five Castile Brine encounters reported to site personnel since 1996, four were identified when WIPP Site personnel were performing field-work and talked to area drillers while the remaining brine encounter was reported through the Area Drillers Annual Survey. All new encounters since 1996 have been in areas where Castile Brine is expected during the drilling process.

The impacts of brine encounters are modeled in the PA. The original assessment included 27 encounters in the WIPP vicinity and determined a 0.08 probability of encountering brine reservoirs. In the Performance Assessment Verification Test (PAVT), the EPA mandated a range of 0.01 to 0.6. These higher values did not influence the predicted performance of the repository. Thus, the EPA determined that this parameter (PBRINE, # 3493) does not have a significant impact on PA results (EPA 1998). Additionally, the PAVT parameter values have been incorporated into the compliance baseline and will be used in recertification calculations.

Probability of Encountering a Brine Reservoir - 2003:

Trigger Value Derivation				
COMP Title:	Probability of Encountering a Castile Brine Reservoir			
COMP Units:	Unitless			
Related Monitoring Data				
Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value	
DBMP[(1)]	NA	Driller's survey – observations	0.08 constant – CCA 0.01 to .60 - PAVT	
COMP Derivation Procedure				
Analysis of encounters of pressurized brine recorded and reported by industry in the 9-township area centered on WIPP.				
Year 2003 COMP Assessment Value				
No new data reported in State record during the reporting period; 32 Total Brine Encounters 27 CCA total occurrences before 1996 0 State Record occurrences since 1996 5 Site Personnel/ Drillers Survey occurrences since 1996				
Related Performance and Compliance Elements				
Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
Probability of Encountering Brine	Parameter PRBRINE ID # 3493	CCA MASS Attachment 18-6 geostatistical study based on area occurrences. EPA TSD justified the upper value in their range by rounding up the upper value interpreted from the TDEM survey, which suggested a 10 to 55% areal extent.	0.08 0.01 to 0.60	Not a sensitive parameter.
Monitoring Data Trigger Values				
Monitoring Parameter ID	Trigger Value	Basis		
Probability of Encountering a Castile Brine Reservoir	None	After the DOE proposed the brine reservoir probability as potentially significant in the CCA Appendix MONPAR, the EPA conducted analyses that indicate a lack of significant effects on performance from changes in this parameter. Since no value of this parameter can significantly affect the performance of the disposal system predicted by the CCA PA and since the parameter is evaluated at least once annually, no TV is needed.		

(1) Delaware Basin Monitoring Program

2.1.2 Drilling Rate

The drilling rate COMP tracks intrusion activities relating to resource extraction. Drilled boreholes relating to resources include potash and sulfur core holes, hydrocarbon exploration wells, saltwater disposal wells and water wells drilled in the Delaware Basin. The drilling rate that was reported in the CCA was determined using an equation provided in 40 CFR Part 194. The formula is as follows: number of deep holes times 10,000 years divided by 23,102.1 square kilometers (area of the Delaware Basin) divided by 100 years equals the number of boreholes per square kilometer per 10,000 years. The number of deep boreholes over the last 100 years is used in the equation (1896 – 1996 for the CCA value). Deep holes are defined as any resource hole that terminated at a depth equal to or greater than the repository depth. The rate reported in the CCA using this equation was 46.8 boreholes per square kilometer over 10,000 years. Including the time period after the CCA (June 1995 to August 2003) increases the rate to 53.3 boreholes per square kilometer per 10,000 years (DOE 2003a).

Table 2.2 Drilling Rates for Each Year Since the CCA

Year	Number of Boreholes Deeper than 2,150 feet	DRILLING RATE (BORE HOLES PER SQUARE KILOMETER PER 10,000 YEARS)
1996 (CCA Value)	10,804	46.8
1997	11,444	49.5
1998	11,616	50.3
1999	11,684	50.6
2000	11,828	51.2
2001	12,056	52.2
2002	12,219	52.9
2002 (revised)	12,139	52.5
2003	12,316	53.3

As shown in Table 2.2, the drilling rate has risen from 46.8 holes per square kilometer to 53.3 holes per square kilometer since 1996. The rate will continue to climb because of the method used to calculate the rate. Since the first well drilled in the area occurred in 1911, it will be 2011 before one well is dropped from the count and 2014 before the next well is dropped from the count. In the meantime, numerous wells will have been added, increasing the drilling rate. For this reason, other methods and approaches are being investigated to derive a more meaningful TV. Some of the approaches that may be considered include using a rate change as the trigger indicator or using a different rate calculation that uses more than a 100-year window for the COMPs data.

The TV for this COMP is 53.5 and is not based on calculated performance because an order of magnitude change in the drilling rate does not result in an out-of-compliance condition (EEG 1998). However, the FEPs-related assumptions used in the PA could be affected by drilling related changes. For this reason, a TV of 53.5 was chosen so that when this rate was reached, drilling related FEPs arguments would be revisited to assure that there is no impact to the original arguments. It should be stated that an exceedance of this TV is not an indication of an out-of-compliance condition, but is a point at which further analysis is needed to refine the baseline of the compliance monitoring program.

Drilling Rate - 2003:

<table>
<tr><td colspan="5">Trigger Value Derivation</td></tr>
<tr><td>COMP Title:</td><td colspan="4">Drilling Rate</td></tr>
<tr><td>COMP Units:</td><td colspan="4">Deep boreholes (i.e., > 2,150 feet deep)/square kilometer/10,000 years</td></tr>
<tr><td colspan="5">Related Monitoring Data</td></tr>
<tr><td>Monitoring Program</td><td>Monitoring Parameter ID</td><td>Characteristics (e.g., number, observation)</td><td colspan="2">Compliance Baseline Value</td></tr>
<tr><td>DBMP</td><td>Deep hydrocarbon boreholes drilled</td><td>Integer per year</td><td colspan="2">10,640 per 100 years</td></tr>
<tr><td>DBMP</td><td>Deep sulfur coreholes drilled</td><td>Integer per year</td><td colspan="2">89 per 100 years</td></tr>
<tr><td>DBMP</td><td>Deep potash coreholes drilled</td><td>Integer per year</td><td colspan="2">19 per 100 years</td></tr>
<tr><td>DBMP</td><td>Deep stratigraphic coreholes drilled</td><td>Integer per year</td><td colspan="2">56 per 100 years (excluding WIPP test holes)</td></tr>
<tr><td>DBMP</td><td>Other deep boreholes drilled</td><td>Integer per year</td><td colspan="2">0</td></tr>
<tr><td colspan="5">COMP Derivation Procedure</td></tr>
<tr><td colspan="5">(Total number of deep boreholes drilled/number of years of observations (100)) x (10,000/23,102.1) [i.e., over 10,000 years divided by the area of the Delaware Basin in square kilometers]</td></tr>
<tr><td colspan="5">Year 2003 COMP Assessment Value</td></tr>
<tr><td colspan="5">(12,316 boreholes on record for the Delaware Basin) Drilling Rate = 53.3 boreholes per square kilometer per 10,000 yrs.</td></tr>
<tr><td colspan="5">Related Performance and Compliance Elements</td></tr>
<tr><td>Element Title</td><td>Parameter Type & ID or Model Description</td><td>Derivation Procedure</td><td>Compliance Baseline</td><td>Impact of Change</td></tr>
<tr><td>Drilling rate</td><td>Parameter LAMBDAD #3494</td><td>COMP/10,000 years</td><td>4.68E-03 per square kilometer per year</td><td>23-fold increase over 10,000 years exceeds release limits at 0.1 probability (EEG, 1998). Proportional increase in cuttings/cavings releases.</td></tr>
<tr><td colspan="5">Monitoring Data Trigger Values</td></tr>
<tr><td>Monitoring Parameter ID</td><td>Trigger Value</td><td colspan="3">Basis</td></tr>
<tr><td>Deep boreholes drilled (derived from the sum of the five monitoring parameters given above)</td><td>53.5 boreholes per square kilometer per 10,000 yrs.</td><td colspan="3">CCA direct releases are influenced by drilling rate changes, however only a dramatic and improbable change in drilling rate could affect compliance with the containment requirements. There is little information upon which to justify the choice of a TV based on FEP screening decisions. A change of drilling rate greater than approximately 15% (i.e., greater than 53.5 boreholes per square kilometer per 10,000 years) is considered prudent as a TV to revisit the low-consequence assumptions associated with the effects of abandoned boreholes on fluid flow and climatic changes used to construct the PA calculations.</td></tr>
</table>

2.2 Geotechnical COMPs

The CCA lists ten monitoring parameters that the DOE is required to monitor and assess during the WIPP operational period. Five of these parameters are considered "geotechnical" in nature and include:

- Creep Closure
- Extent of Deformation
- Initiation of Brittle Deformation
- Displacement of Deformation Features
- Subsidence

Data needed to derive and evaluate the geotechnical COMPs are available from the most recent annual Geotechnical Analysis Report (GAR; DOE 2003b), annual Subsidence Monument Leveling Survey (DOE 2003c) and results extracted from the geotechnical experimental programs (Chapin and Hansen 2003) undertaken by the SA to characterize the disturbed rock zone (DRZ). Three of the geotechnical parameters lend themselves to quantification: creep closure, displacement of deformation features and subsidence. In contrast, the extent of deformation and initiation of brittle deformation are qualitative or observational parameters.

The WIPP GARs have been available since 1983 and are currently prepared by the M&OC on an annual basis. The purpose of the GAR is to present and interpret geotechnical data from the underground excavations. These data are obtained as part of a regular monitoring program and are used to characterize current conditions, to compare actual performance to the design assumptions, and to evaluate and forecast the performance of the underground excavations during operations. Additionally, the GAR fulfills various regulatory requirements and through the monitoring program, provides early detection of conditions that could affect operational safety, data to evaluate disposal room closure, and guidance for design changes. Data are presented for specific areas of the facilities including: (1) Shafts and Keys, (2) Shaft Stations, (3) Northern Experimental Area, (4) Access Drifts, and (5) Waste Disposal Areas. Data are acquired using a variety of instruments including convergence points and meters, multipoint borehole extensometers, rockbolt load cells, pressure cells, strain gauges, piezometers and joint meters. All of the geotechnical COMPs involve analyses of deformations/displacements, so the most pertinent data derived from the GAR are convergence and extensometer data. The most recent GAR (DOE 2003b) summarizes data collected from July 2001 through June 2002.

Subsidence monitoring leveling survey reports are also prepared by the M&OC on an annual basis and present the results of leveling surveys performed for nine vertical control loops comprising approximately 18 linear miles traversed over the ground surface of the WIPP site. Elevations are determined for 51 monuments and 14 National Geodetic Survey vertical control points using digital leveling techniques to achieve Second-Order Class II loop closures or better. The data are used to estimate total subsidence and subsidence rates in fulfillment of regulatory requirements. The most recent survey (DOE 2003c) summarizes data collected during September 2003.

Geotechnical experimental programs conducted by the SA are currently underway to characterize the DRZ that develops around underground openings in salt. Data from the program are used primarily for PA and for assessing improvements to seal design, but also provide useful information for characterizing extent of deformation, initiation of brittle deformation and possibly displacement of deformation features. Results from the program were reported as they became available (e.g. Chapin and Hansen 2003). In addition, Hansen (2003) summarizes the WIPP DRZ with respect to changes since the original certification, including treatment of the DRZ for the Option D Panel Closure and the technical baseline migration for PA.

Comparisons between available data and the TVs allow evaluation of the most recent geotechnical observations for the COMPs program. The cited reports and programs provide a good evaluation of all observations where deviations from historical normal occurrences are recorded. This process, as engaged for COMPs assessments, not only focuses attention on monitored parameters, it allows for reassessment of the proposed TVs. Notable deviations are addressed in the GAR and other references, and are reexamined here in the context of COMPs and TVs.

Geotechnical COMPs can be derived from or related to the repository's operational safety monitoring program, which has been implemented to ensure worker and mine safety. By nature, changes in geotechnical conditions evolve slowly; however, they are monitored continuously and reported annually. Since pertinent data from the underground reflect slowly evolving conditions, relationships that correlate to geotechnical COMPs also evolve slowly. Therefore, geotechnical conditions warranting action for operational safety will become evident before such conditions would impact long-term waste isolation. Monitoring underground response allows continuing assessment of conceptual geotechnical models supporting certification. In effect, these annual comparisons of actual geotechnical response with expected response serve to validate or improve models.

Annual reviews allow discovery of conditions or trends that lay outside expectations. In principal, the annual geotechnical analysis seeks trends or conditions that are "off normal." At this early stage of the repository history, the WIPP monitoring program is establishing parametric values, rates, conditions or observations that would identify a need for further evaluation. Conditions beyond normal or outside expectations do not automatically impact compliance determinations, but instead alert geotechnical program personnel to scrutinize incoming data more closely and to make assessments of possible performance impacts.

Displacement, deformation, closure, and fracturing evolve slowly. Therefore, annual assessment of the geotechnical COMPs will adequately address conditions that would be of concern for predicting repository performance or that are related to long-term regulatory compliance. This assessment contains the fifth geotechnical monitoring report since disposal operations began. Implementation and evaluation of possible trigger events, features, phenomena, trends, and conditions that would warrant further actions will be refined as experience is gained.

The previous annual assessments of geotechnical COMPs provided the opportunity to review parameters and phenomena in the context of EPA's monitoring requirements. The geomechanical monitoring program reported in the GAR is implemented primarily for continuous assessment of the underground facilities. Data for interpreting the behavior of underground openings are compared with established design criteria. The SA evaluates these data with respect to PA as required by the EPA rule.

2.2.1 Creep Closure

The GAR compiles all geotechnical operational safety data gathered from the underground. The most readily quantifiable geomechanical response in the WIPP underground is creep closure. The GAR routinely measures and reports creep deformation, either from rib-to-rib, roof-to-floor, or extensometer borehole measurements. Rates of closure are relatively constant within each zone of interest and usually range from about 1-5 cm/yr. A closure rate in terms of cm/yr can be expressed as a global or nominal creep rate by dividing the displacement by the room dimension and converting time into seconds. Nominally these rates are of the order of 1×10^{-10}/s and are quite steady over significant periods. From experience, increases and decreases of rates such as these might vary by 20 percent without undue concern. Therefore, the "trigger value" for creep deformation was set as one order of magnitude increase in creep rate. Such a rate increase would alert the M&OC geotechnical staff to scrutinize the area exhibiting accelerating creep rates. Tertiary creep is an expected (eventually) phenomenon and its manifestation would help validate predictive capabilities of the computational models.

Extensive GAR data suggest that possible TV could be derived from creep rate changes. The WIPP underground is very stable, relative to most operating production mines, and deformation is steady for long periods. However, under certain conditions creep rates accelerate, indicating a change in the deformational processes. Arching of microfractures to an overlying clay seam might create the onset of the roof beam de-coupling and increase the measured closure rate. Phenomena of fracture coalescence and DRZ growth comprise important elements of PA assumption confirmation. Therefore, a measured creep rate change over a yearly period constitutes the COMP TV for creep closure. Rate changes are necessarily evaluated on a case-by-case basis since closure is related to many factors such as age of the opening, location in the room or drift, convergence history, recent excavations, and geometry of the excavations.

The creep deformation COMP is addressed by examining the deformations measured in specific regions of the underground including: (1) Shafts and Shaft Stations, (2) the Northern Experimental Area, and (3) Access Drifts and Waste Disposal Areas. Figure 2.1 shows the current configuration of the WIPP underground with specific elements and regions annotated for reference. Details of the examination for each of these three regions are discussed below under separate headings.

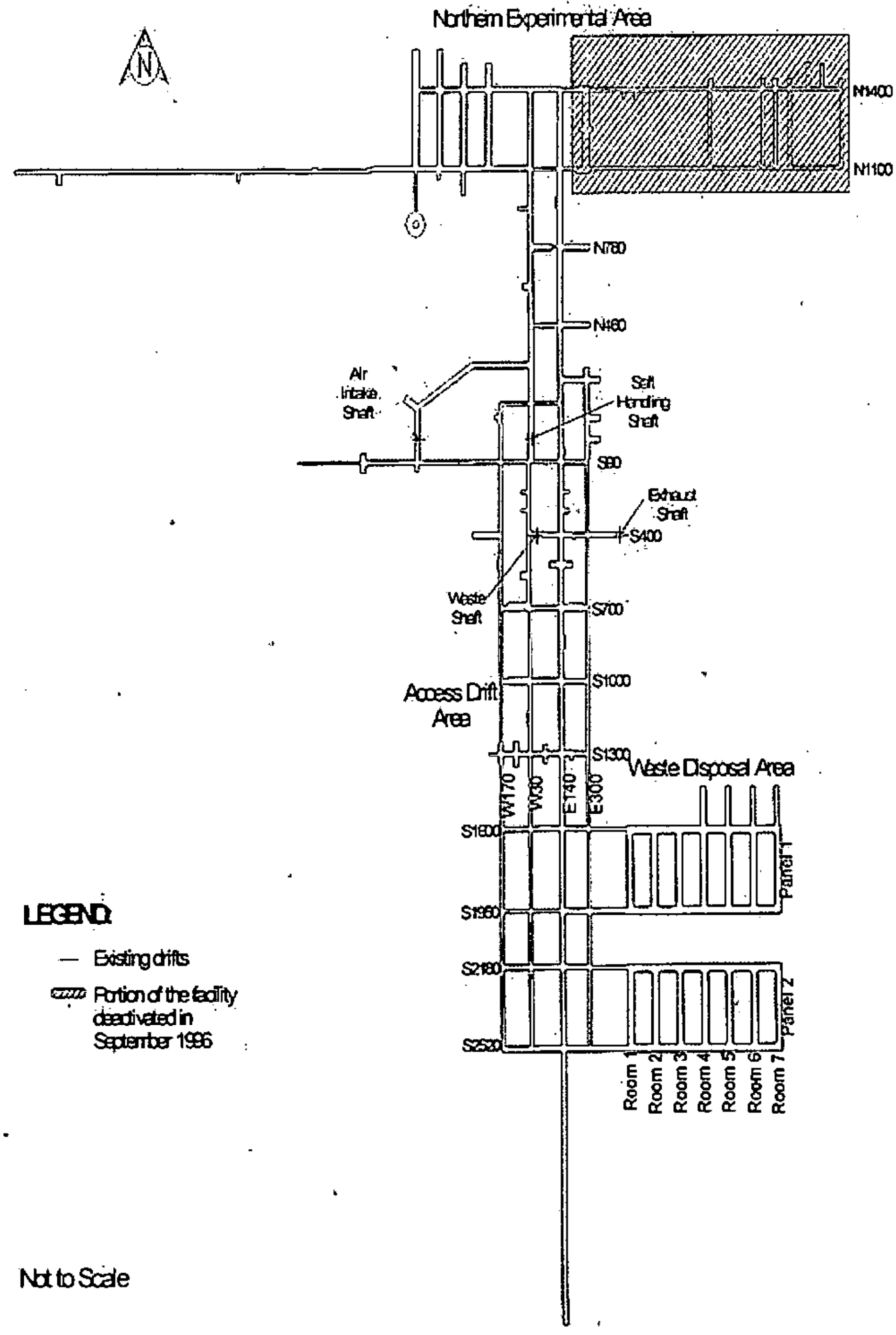

Figure 2.1 Configuration of the WIPP Underground for Geotechncial COMPs (after DOE, 2003b – Reporting Period July 2001 through June 2002).

Shafts and Shaft Stations
The WIPP underground is serviced by four vertical shafts including the following: (1) Salt Handling Shaft, (2) Waste Shaft, (3) Exhaust Shaft, and (4) Air Intake Shaft. At the repository level (approximately 650 m below ground surface), enlarged rooms have been excavated around the Salt Handling and Waste shafts to allow for movement of equipment, personnel, mined salt and waste into or out of the facility. The enlarged rooms are called shaft stations and assigned designations consistent with the shaft they service, e.g., Salt Handling Shaft Station.

Shafts. With the exception of the Salt Handling Shaft, the shafts are configured nearly identically. From the ground surface to the top of the Salado Formation, the shafts are lined with unreinforced concrete. Reinforced concrete keys are cast at the Salado/Rustler interface with the shafts extending through the keys to the Salado. Below the keys, the shafts are essentially "open holes" through the Salado Formation and terminate either at the repository horizon or at sumps that extend approximately 40m below the repository horizon. In the Salt Handling Shaft, a steel liner is grouted in place from the ground surface to the top of the Salado. Similar to the three other shafts, the Salt Handling Shaft is configured with a reinforced concrete key and is "open-hole" to its terminus. For safety purposes, the portions of the open shafts that extend through the Salado are typically supported using wire mesh anchored with rock bolts to contain rock fragments that may become detached from the shaft walls. Within the Salado Formation, the shaft diameters range from 3.65 m to 7.0 m.

Data available for assessing creep deformations in the salt surrounding the shafts are derived exclusively from routine inspections and extensometers extending radially from the shaft walls. These data are reported in the GAR. The Salt Handling Shaft, Waste Shaft, and Air Intake Shaft are inspected weekly by underground operations personnel. Although the primary purpose of these inspections is to assess the conditions of the hoisting and mechanical equipment, observations are also made to determine the condition of the shaft walls, particularly with respect to water seepage, loose rock, and sloughing. In contrast to the other three shafts, the Exhaust Shaft is inspected quarterly using remote-controlled video equipment. *Based on these visual observations, all four shafts are in satisfactory condition and have required no significant ground-control support during the reporting period.*

Shortly after its construction, each shaft was instrumented with extensometers to measure the inward movement of the salt at three levels within the Salado Formation. In addition to COMPs assessment, measurements of shaft closure are used periodically as a calibration of calculational models and have been used in shaft seal system design. The approximate depths corresponding to the three instrumented levels are 330 m, 480 m and 630 m. Three extensometers are emplaced at each level to form an array. The extensometers comprising each array extend radially outward from the shaft walls and are equally spaced around the perimeter of the shaft wall. Over the years, some of these extensometers have malfunctioned. As a result, reliable data are not available at some locations. The DOE currently has no plans to replace failed instrumentation installed in any of the shafts because monitoring data acquired to date have shown no unusual shaft movements or displacements.

Table 2.3 provides a summary of the current (July 2001 – June 2002) displacement rates of the shaft walls based on extensometer data reported in the GAR. The rates make use of collar displacement measured relative to the deepest anchor for individual extensometers. Rates range from 0.010 in/yr to 0.097 in/yr (0.025 cm/yr to 0.246 cm/yr) and increase with depth, as expected, because of the higher stress levels associated with the overburden at greater depth. Dividing the displacement rates by the typical shaft radius (say 3 m) and expressing the results in units of 1/sec yields creep rates that range from 2.6×10^{-12}/s to 2.6×10^{-11}/s. These creep rates are very low and are typical of rates for stable openings mined from salt. Table 2.3 also gives displacement rates for the previous reporting period (2000 to 2001) and the percentage change in these rates compared to the current rates. In general, the rate changes are small. Somewhat larger increases in displacement rates are shown for the Exhaust Shaft compared to the Waste Handling Shaft, but the rates are still considered acceptable. *Based on visual observations and quantitative displacement measurements, creep deformations associated with the WIPP shafts are acceptable and meet the TV requiring creep deformation rates to change by less than one-order of magnitude in a one-year period.*

Shaft Station. Shaft station openings are typically rectangular in cross-section with heights ranging from approximately 4 to 6 m and widths ranging from 6 to 10 m. Over the life-time of the individual shaft stations, modifications have been made that have altered the dimensions of the openings. For example, portions of the Salt Handling Shaft Station have been enlarged by removing the roof beam that extended up to anhydrite "b". In the Waste Handling Shaft Station, the walls have been trimmed to enlarge the openings for operational purposes.

The effects of creep on the shaft stations are assessed through visual observations and displacement measurements made using extensometers and convergence points. Because of the modifications made over the years, some of the original instrumentation has been removed or relocated. In addition, some instruments have malfunctioned or been damaged and no longer provide reliable data. Displacement rates available from the GAR for the current reporting period (2001-2002) and the previous reporting period (2000-2001) are summarized in Table 2.3. Creep data are available only for the Salt Handling and Waste Shaft Stations (data for the Air Intake Shaft Station are reported below under the Access Drift section of this report). Most of the measurements are for vertical closure; however, at least one measurement of horizontal closure is available for both stations. Based on convergence data, current vertical displacement rates range from about 0.350 to 1.816 in/yr (0.89 to 4.61 cm/yr), while current horizontal displacement rates range from about 0.934 to 1.109 in/yr (2.4 to 2.8 cm/yr). Dividing convergence rates by the average room dimension (say 6 m) and expressing the results in units of 1/sec yields vertical and horizontal creep rates between approximately 5×10^{-11}/s to 2×10^{-10}/s. These rates are somewhat higher than those measured in the shafts but are still low and represent typical creep rates for stable openings in salt. An examination of the percentage changes in displacement rates shown in Table 2.3 suggests the current shaft station displacement rates are essentially identical to those measured during the previous reporting period. Based on the extensometer and convergence data, as well as the limited maintenance required in the shaft stations during the last year, *creep deformations associated with the WIPP shaft stations are considered acceptable and meet the TV requiring creep deformation rates to change by less than one-order of magnitude in a one-year period.*

Table 2.3 Summary of Closure Rates for WIPP Shafts and Shaft Stations

Location	Inst. Type[a]	Displacement Rate (in/yr) 2000–2001	Displacement Rate (in/yr) 2001–2002	Change In Rate (%)
Salt Handling Shaft	No extensometers remain functional			
Waste Handling Shaft				
1071 ft (326 m) level, S15W	Ext	0.010	0.010	0.0
1566 ft (477 m) level, N45W	Ext	0.035	0.037	5.7
1566 ft (477 m) level, N75E	Ext	0.033	0.033	0.0
1566 ft (477 m) level, S15W	Ext	0.036	0.037	2.8
2059 ft (628 m) level, N45W	Ext	0.089	0.092	3.4
2059 ft (628 m) level, N75E	Ext	0.074	0.080	8.1
2059 ft (628 m) level, S15W	Ext	0.087	0.097	11.5
Exhaust Shaft				
1573 ft (479 m) level, N75E	Ext	0.020	0.024	20.0
1573 ft (479 m) level, N45W	Ext	0.023	0.026	13.0
1573 ft (479 m) level, S15W	Ext	0.023	0.027	17.4
2066 ft (630 m) level, N75E	Ext	0.087	0.087	0.0
2066 ft (630 m) level, S15W	Ext	0.062	0.068	9.7
Salt Handling Shaft Station				
E0 Drift – N39 (Vert. CL[b])	CP	1.887	1.816	-3.8
E0 Drift – N39 (Horiz. CL)	CP	1.135	1.109	-2.3
E0 Drift – S18 (Vert. CL)	CP	1.681	1.653	-1.7
E0 Drift – S30 (Vert. CL)	CP	1.772	1.725	-2.7
E0 Drift – S65 (Vert. CL)	CP	1.354	1.335	-1.4
Waste Shaft Station				
S400 Drift – W30 (Vert. CL)	Ext	0.348	0.350	0.6
S400 Drift – E140 (Vert. CL)	Ext	0.715	0.826	15.5
S400 Drift – E30 (Horiz. CL)	CP	0.916	0.934	2.0
S400 Drift – E90 (Horiz. CL)	CP	1.005	1.002	-0.3
Air Intake Shaft Station	Information provided below under access drift discussion			

(a) Instrument Type: Ext = extensometer; CP = convergence point.
(b) CL = Centerline

Northern Experimental Area

The Northern Experimental Area, defined as all excavations north of the N1100 drift (see Figure 2.1), was constructed in the early 1980's to characterize the site and obtain in situ geotechnical data from underground excavations. During the experiments, the area was heavily instrumented to examine the structural response of the openings. Following completion of the experiments, access to the area was blocked in 1996. As a result, only a few of the instruments (primarily extensometers and convergence meters) remained active and were monitored remotely because of restricted access to the area. During the period from July 1999 to June 2000, portions of the Northern Experimental Area were reopened to assess ground conditions. Following spot bolting, systematic pattern bolting in SPDV Test Room 4 and activation of ventilation, operational use of the area for salt storage was established. Numerous manual convergence measurements were re-established following re-entry and new convergence meters were also installed in some areas; however, some measurements were lost when a data logger and some of the existing instrumentation were removed to allow for roof beam removal and vehicular traffic.

A summary of the displacement rates measured along the vertical and horizontal midpoints of the openings in the Northern Experimental Area is provided in Table 2.4 for both the current and previous reporting periods. As shown, displacement rates in 2001-2002 have remained approximately the same as those reported for 2000-2001. The largest increases in horizontal and vertical displacement rates, i.e. 30 to 35%, have occurred in the N1100 Drift at W783 and W951, respectively.

Based on the evaluations of displacement rates, *creep deformations associated with openings in the Northern Experimental Area are considered acceptable and meet the TV requiring creep deformation rates to change by less than one-order of magnitude in a one-year period.*

Access Drifts and Waste Disposal Area

Access Drifts. The access drifts comprise the four major North-South drifts extending southward from near the Salt Handling Shaft to the entries into the waste disposal panels and several short cross-drifts intersecting these major drifts (see Figure 2.1). The access drifts are typically rectangular in cross-section with heights ranging from 2.4 m to 6.4 m and widths ranging from 4.3 m to 9.2 m. Two of the North-South drifts also extend northward to provide access to the Northern Experimental Area. The portions of the four drifts extending to the south provide haulage ways for salt excavated from and waste transported to the waste disposal areas. In addition, the access drifts are used for ventilation.

Drift E140 was excavated to the southern boundary (S3650) of the repository in the early 1980s. Drifts W170, W30, and E300 were developed at approximately the same time as Drift E140, but were terminated at S2180. During July 1999 to June 2000, the three drifts were extended southward to S2520 and other portions of the drifts were trimmed, scaled and milled all in an effort to allow access for mining of Waste Disposal Panel 2. During the current reporting period (July 2001 to June 2002), these three drifts were rough-cut to approximately S3141 and final cut to S2758 to provide access for mining of Waste Disposal Panel 3. Panel 3 will be excavated at a slightly higher elevation than either Panels 1 or 2. Upon completion, the Panel 3 roof will be coincident with Clay G.

Table 2.4 Summary of Closure Rates for Openings in the Northern Experimental Area

Location	Inst. Type[(a)]	Displacement Rate (in/yr)		
		2000–2001	2001–2002	% Change
E140 Drift – N1266, Horiz. CL[(b)], E. Rib	Ext	0.622	0.624	0.3
E140 Drift – N1266, Horiz. CL, W. Rib	Ext	0.474	0.462	-2.5
Room L4, Vert. CL, Roof	Ext	NA[(c)]	0.324	NA
SPDV[(d)] Room 4 – N1325, Vert. CL, Roof	Ext	NA	1.033	NA
SPDV Room 4 – N1250, Vert. CL, Roof	Ext	NA	0.544	NA
SPDV Room 4 – Center, Horiz. CL, E. Rib	Ext	1.411	0.635	-55.0
SPDV Room 4 – Center, Horiz. CL, W. Rib	Ext	0.480	0.518	7.9
SPDV Room 4 – N1175, Vert. CL, Roof	Ext	NA	0.505	NA
N1420 – E140 Intersection, Vert. CL,	CP	1.447	1.508	4.2
E140 Drift – N1266, Vert. CL	CP	2.144	2.253	5.1
E140 Drift – N1266, Horiz. CL	CP	1.296	1.298	0.2
N1100 – E140 Intersection, Vert. CL	CP	1.702	1.734	1.9
N1100 Drift – E80, Vert. CL	CP	0.957	0.738	-19.8
N1100 Drift – E80, Horiz. CL	CP	0.807	0.788	-2.4
N1420 – E0 Intersection, Vert. CL	CP	1.357	1.380	1.7
E0 Drift – N1266, Vert. CL	CP	0.072[(e)]	2.148	NA
E0 Drift – N1266, Horiz. CL	CP	1.092	1.177	7.8
E0 – N1100 Intersection, Vert. CL	CP	1.597	1.597	0.0
N1420 – TR1 Intersection, Vert. CL	CP	2.012	1.345	-33.2
N1100 – TR1 Intersection, Vert. CL	CP	1.592	1.529	-4.0
N1420 Drift – W258, Vert. CL	CP	0.940	0.991	5.4
N1420 Drift – W258, Horiz. CL	CP	0.735	0.830	12.9
N1420 – TR2 Intersection, Vert. CL	CP	1.858	1.853	-0.3
N1100 – TR2 Intersection, Vert. CL	CP	1.429	1.408	-1.5
N1420 Drift – W391, Vert. CL	CP	0.925	0.911	-1.5
N1420 Drift – W391, Horiz. CL	CP	0.776	0.888	14.4
N1420 – TR3 Intersection, Vert. CL	CP	1.467	1.413	-3.7
N1100 – TR3 Intersection, Vert. CL	CP	1.207	1.211	0.3
N1420 – TR4 Intersection, Vert. CL	CP	2.010	2.045	1.7
SPDV Room 4 N1325, Vert. CL	CP	1.846	1.900	2.9
SPDV Room 4 N1325, Horiz. CL	CP	1.413	1.421	0.6
SPDV Room 4 Center, Vert. CL	CP	1.897	1.964	3.5
SPDV Room 4 Center, Horiz. CL	CP	1.258	1.224	-2.7
SPDV Room 4 N1175, Vert. CL	CP	1.816	1.920	5.7
SPDV Room 4 N1175, Horiz. CL	CP	1.114	1.089	-2.2
N1100 TR4 Intersection, Vert. CL	CP	1.168	1.152	-1.4
N1100 Drift – W783, Vert. CL	CP	0.618	0.722	16.8
N1100 Drift – W783, Horiz. CL	CP	0.462	0.612	32.5
N1100 Drift – W951, Vert. CL	CP	0.558	0.754	35.1
N1100 Drift – W1159, Vert. CL	CP	0.583	0.671	15.1
N1100 Drift – W1347, Vert. CL	CP	0.562	NA	NA
N1420 Drift – E1551, Vert. CL	CM	NA	0.815	NA
N1420 Drift – E1451, Vert. CL	CM	NA	0.855	NA

(a) Instrument Type: Ext = extensometer; CP = convergence point; CM = convergence meter.
(b) CL = Centerline
(c) NA = Not available
(d) SPDV = Site Preliminary Design Validation
(e) Rate determined to be anomalous.

Table 2.4 – Continued - Summary of Closure Rates for Openings in the Northern Experimental Area

Location	Inst. Type[(a)]	Displacement Rate (in/yr)		
		2000–2001	2001–2002	% Change
Room D – N1432, Vert. CL	CM	NA	1.171	NA
Room D – N1266, Vert. CL	CM	NA	0.880	NA
Room D – N1187, Vert. CL	CM	NA	0.965	NA
N1100 Drift – E1620, Vert. CL	CM	NA	0.448	NA
N1100 Drift – 1530, Vert. CL	CM	NA	0.574	NA
E300 Drift – N1275, Vert. CL	CM	NA	3.039	NA

(a) Instrument Type: Ext = extensometer; CP = convergence point; CM = convergence meter.
CL = Centerline
NA = Not available
SPDV = Site Preliminary Design Validation

Assessment of creep deformations in the access drifts is made through the examination of extensometer and convergence point data reported annually in the GAR. Tables 2.5 and 2.6 summarize, respectively, the vertical and horizontal displacement data reported in the most recent GAR. Each table examines percentage changes between displacement rates measured during the current and previous annual reporting periods and breaks these percentage changes into ranges (e.g, 0 to 25%). Only data from instruments located along the drift centerlines are reported here. In addition, extensometer data are based only on the displacements of the collar relative to the deepest anchor. The numbers shown in the tables represent the number of instrumented locations that fall within the range of the indicated percentage change. For example, data from fifty four vertically-oriented extensometers installed in the access drifts were assessed with twenty three of these instruments showing percentage changes < 0% (i.e., the rate decreased or slowed), seventeen showing changes between 0 and 25%, eleven showing changes between 25 and 50%, none showing changes between 50 and 75%, one showing a change between 75 and 100%, and two showing changes between 100 and 150%. The maximum displacement rates corresponding to these data are given below:

Maximum Vertical Displacement Rates Along Access Drift Centerlines:

10.25 cm/yr – based on extensometer data
15.74 cm/yr – based on convergence point data

Maximum Horizontal Displacement Rate Along Access Drift Centerlines:

4.93 cm/yr – based on convergence point data

Table 2.5 Summary of Changes in Vertical Displacement Rates Measured Along the Centerlines of the WIPP Access Drifts and Waste Disposal Area Openings

Location	Number of Instrument Locations Where the Indicated Percentage Change has Occurred					
	Percentage Increase in Displacement Rate for Measurements Made During the 2000-2001 and 2001-2002 Reporting Periods					
	< 0%	0 – 25%	25 – 50%	50 – 75%	75 – 100%	100 – 150%
Access Drifts						
Extensometers[(a)]	23	17	11	0	1	2
Convergence Points	53	85	3	0	1	0
Waste Disposal Area						
Panel 1:						
Extensometers[(a)]	21	26	4	0	0	0
Convergence Points	12	19	3	0	0	0
Panel 2:						
Extensometers[(a)]	11	0	0	0	0	0
Convergence Points	42	0	0	0	0	0

(a) Based on displacement of collar relative to deepest anchor.

Table 2.6 Summary of Changes in Horizontal Displacement Rates Measured Along the Centerlines of WIPP Access Drifts and Waste Disposal Area Openings

Location	Number of Instrument Locations Where the Indicated Percentage Change has Occurred				
	Percentage Increase in Displacement Rate for Measurements Made During the 2000-2001 and 2001-2002 Reporting Periods				
	< 0%	0 – 25%	25 – 50%	50 – 75%	75 – 100%
Access Drifts					
Extensometers[(a)]	0	0	0	0	0
Convergence Points	33	35	2	0	0
Waste Disposal Area					
Panel 1:					
Extensometers[(a)]	4	8	1	0	1
Convergence Points	3	21	1	0	0
Panel 2:					
Extensometers[(a)]	0	0	0	0	0
Convergence Points	28	0	0	0	0

(a) Based on displacement of collar relative to deepest anchor.

Using a typical average drift dimension of 5 m and the maximum displacement rates shown above yields an inferred maximum creep rate of approximately 10×10^{-10}/s. This rate is relatively high so further analyses were performed as described below.

Most (approximately 98% of all data) of the changes in vertical and horizontal displacement rates fall within three categories or subdivisions shown in Tables 2.5 and 2.6, i.e., < 0%, 0 to 25%, and 25 to 50% indicating that current creep deformations in the access drifts are approximately the same as they were for the previous reporting period. The few remaining data show relatively large changes in rate and indicate accelerations of displacement in some locations. As a general rule, accelerations in displacement would be cause for concern; however, a careful examination of these relatively large accelerations in displacement reveals that the extensometers/convergence points associated with these accelerations are either experiencing anchor problems or are located in an area of localized roof fracturing (e.g., E140 Drift - S1375 and E140 Drift - S1775; see Figure 2.1). Portions of E140 have been excavated to Clay G to improve ground control.

The largest displacements notwithstanding, creep deformations associated with the Access Drifts are acceptable and meet the TV requiring creep deformation rates to change by less than one-order of magnitude in a one-year period. High displacement rates observed at a few locations have little affect on safety as geotechnical engineering provides continuous ground control monitoring and remediation on an as-needed basis.

Waste Disposal Area: The Waste Disposal Area is located at the extreme southern end of the WIPP facility and is serviced by the access drifts described above. Eventually, the Waste Disposal Area will include eight disposal panels, each comprising seven rooms (the major north-south access drifts adjacent to the eight panels will also be used for waste disposal and will make up ninth and tenth panels). Currently however, only two panels have been completely excavated including Panel 1 constructed in the late 1980s and Panel 2 constructed during the 1999-2000 reporting period. Excavation of Panel 3 is progressing at the time of this report. Waste emplacement operations are complete in Panel 1 and have recently moved into Panel 2. The waste emplacement rooms are rectangular in cross-section with a height of 4 m and a width of 10 m. Entry drifts that provide access into the disposal rooms are also rectangular with heights of 3.65 m and widths of 4.3 m.

Assessment of creep deformation in the waste disposal area is made through the examination of extensometer and convergence point data reported annually in the GAR. Tables 2.5 and 2.6 (presented previously) summarize, respectively, the vertical and horizontal displacement data reported in the most recent GAR for both Panels 1 and 2. Each table examines percentage changes between displacement rates measured during the current and previous annual reporting periods and breaks these percentage changes into ranges. Only data from instruments located along the drift centerlines are reported here. In addition, extensometer data are based only on displacements of the collar relative to the deepest anchor. The maximum displacement rates corresponding to these data are given below.

Maximum Vertical Displacement Rates Along Waste Disposal Area Centerlines:

5.43 cm/yr – based on extensometer data
11.09 cm/yr – based on convergence point data

Maximum Horizontal Displacement Rates Along Waste Disposal Area Centerlines:

5.91 cm/yr – based on extensometer data
6.04 cm/yr – based on convergence point data

Using a nominal disposal-area-opening dimension of 8 m and the maximum displacement rates shown above yields an inferred maximum creep rate of approximately 4.4×10^{-10}/sec. Maximum creep rates for the waste disposal area are less than the maximum creep rates observed for the access drifts and are considered acceptable. Furthermore, most of the changes in creep rate are negative, particularly for Panel 2, indicating the higher creep rates induced by excavating Panel 2 have now equilibrated.

Creep deformations associated with the Waste Disposal Area are acceptable and meet the TV requiring creep deformation rates to change by less than one-order of magnitude in a one-year period.

Creep Closure - 2003:

Trigger Value Derivation				
COMP Title:	Creep Closure			
COMP Units:	Closure Rate (sec^{-1})			
Related Monitoring Data				
Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value	
Geotechnical	Closure	Instrumentation throughout the underground.	Munson-Dawson (MD) Constitutive Model	
COMP Derivation Procedure				
Annually evaluate GAR for centerline closure rates, compare to previous year's rate. If closure rate increases by greater than one order of magnitude, initiate technical review.				
Related Performance and Compliance Elements				
Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
Repository Fluid Flow	Creep Closure	Porosity Surface, waste compaction, characteristics, waste properties, evolution of underground setting	SANTOS, surface porosity calculations	Provides validation of the CCA creep closure model.
Monitoring Data Trigger Values				
Monitoring Parameter ID	Trigger Value	Basis		
Creep Closure	Greater than one order of magnitude increase in closure rate.	The closure rate increase signals potential de-coupling of rock.		

2.2.2 Extent of Deformation

The extent of brittle deformation can have important implications to PA. As modeled in PA, the DRZ releases brine to the disposal room while properties of the DRZ control hydrologic communication between disposal panels. Therefore, extent of deformation relates directly to a conceptual model used in performance determination. If characteristics could be tracked from inception, the spatial and temporal evolution of the DRZ would provide a validation benchmark for damage calculations. To this end, a hydrologic profile including permeability and pore pressure is being compiled within the WIPP Rock Mechanics Program.

Measurements in the GAR include borehole inspections, fracture mapping and borehole logging. These observations are linked closely to other monitoring requirements concerned with initiation of brittle deformation and displacement of deformation features. These monitoring requirements define the characteristics of the DRZ, which help validate the baseline conceptual model, and its flow characteristics. The extent of deformation quantifies the DRZ, a significant element of PA analyses.

The Geotechnical Engineering Department at WIPP has compiled back-fracturing data into a database. The supporting data for the GAR (Volume 2, DOE 2003b) consists of plan and isometric plots of fractures. Fracture development is most continuous parallel to the rooms and near the upper corners. These fractures are designated "low angle fractures" relative to the horizontal axis. The original excavation horizon results in a 2.4-m thick beam of halite between the roof and Clay Seam G. Low angle fractures arch over rooms and asymptotically connect with Clay Seam G. Although the preponderance of monitoring information derives from the roof (back), buckling extends into the floor to the base of Marker Bed 139, which is located about 2 m below the disposal room floors. Fracture mapping thus far is consistent with expectations and tracks stress trajectories derived from computational work. At this time, a comprehensive model and supporting data for model parameters for damage evolution has not been developed for PA.

Excavation of Panel 3 raises the waste disposal panels by 2.4 m such that the roof of the disposal rooms will be coincident with Clay Seam G and the floor will be an additional 2.4 m above Marker Bed 139. This planned change will likely alter the typical fracture patterns observed to date. Effects of excavation to Clay G have been evaluated by finite element analyses to assess possible impact to PA (Park and Holland 2003). Their modeling shows that the DRZ does not extend below MB139 at the new horizon, as it does at the original horizon. The rise in repository elevation otherwise causes no discernable change to the porosity surface used in PA.

In addition to results presented in the GAR by the M&OC, the SA together with international partners has been analyzing the development of disturbed rock zones in salt through ongoing studies of cores recovered from near existing underground openings. Recent studies have examined cores recovered from angled boreholes drilled from the corner of the WIPP Room Q alcove and from boreholes drilled from lined (cemented steel) and unlined drifts of the 80-year-old Asse mine, Germany (Chapin and Hansen 2003). Results of these studies indicate that:

- fractures form parallel to opening faces and follow the maximum stress trajectories
- fracture aperture ranges from less than 50 μm to more than 700 μm with the largest apertures near opening faces
- fracture density is high within 1 to 2 m of opening faces but reduces rapidly with distance

from the face
- fracturing is less pervasive near opening face corners
- fracturing patterns near lined drifts are similar to the patterns near unlined drifts even after 80 years

Data provided in the GAR suggest that brittle deformation extends at least 2.4 m (to Clay Seam G) and perhaps as much as 4.5 m (to Clay Seam H) above the roof of the WIPP openings. In addition, brittle deformation extends below the floor of the openings to at least the base of Marker Bed 139 (approximately 2 to 3 m). Recent studies performed by the SA to characterize the DRZ have shown that the extent of brittle deformation is likely to be 1 to 2 m; however, these results are for older openings in which the DRZ and deformational features have matured (essentially a snapshot in time), but provide little information on how brittle deformation evolves with time. Therefore, it is evident that the preliminary TV of 1 m of growth per year is neither tractable nor quantitatively meaningful with the current data set. The TV for extent of deformation may need to be re-evaluated or other means of monitoring may need to be developed if the current TV is to be retained. To this end, the SA has prepared a test plan to conduct a mine-by experiment in which the extent of the DRZ and degree of fracturing within the DRZ will be measured as a function of time from long boreholes drilled parallel to a planned but yet unexcavated access drift (SNL 2003a). Owing to the fact that ground-control is currently not an issue, the need for immediate re-evaluation of the TV is not essential to underground operations.

Extent of Deformation - 2003:

Trigger Value Derivation

COMP Title:	Extent of Deformation
COMP Units:	Areal extent (length, direction)

Related Monitoring Data

Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value
Geotechnical	Displacement	Meters	Room geometry

COMP Derivation Procedure

Extent of deformation deduced from borehole extensometers, feeler gauges, and visual inspections are examined yearly for active cross sections. Anomalous growth is determined by comparison.

Related Performance and Compliance Elements

Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
DRZ Conceptual Model	Micro- and macro-fracturing in the Salado Formation	Constitutive model from laboratory and field databases.	Permeability around panel closures was assigned a constant value of $10^{-15} m^2$ for the CCA and a uniform distribution from 3.16 x $^{-13}$ to 3.98 x 10^{-20} m^2 for the PAVT (current baseline)	DRZ spatial and temporal properties have important PA implications for permeability to gas, brine, and two-phase flow.

Monitoring Data Trigger Values

Monitoring Parameter ID	Trigger Value	Basis
Fractures at depth	Growth of 1 m/y[(a)]	Coalescence of fractures at depth in rock surrounding drifts will control panel closure functionality and design, as well as discretization of PA models.

(a) TV may need to be re-evaluated.

2.2.3 Initiation of Brittle Deformation

Initiation of brittle deformation around WIPP openings is not being directly measured and is therefore a qualitative observational parameter. By definition, qualitative COMPs can be subjective and are not prone to the development of well-defined TVs. This COMP is not directly related to a PA parameter. Brittle deformation eventually leads to features that are measured as part of geotechnical monitoring requirements, such as the extent and displacement of deformation features. Initiation of brittle deformation is expected to begin immediately upon creation of an opening. Initiation and growth of the DRZ are fundamental observational goals of the DRZ investigations currently being conducted under the geotechnical experimental programs, as discussed above. The ongoing geophysical program will help quantify damage evolution around WIPP openings. Initiation and growth of damaged rock zones are important considerations to operational period panel closures as well as compliance PA calculations. As stated previously, this COMP is qualitative and is not directly related to PA parameters. No changes to the technical positions are suggested for this COMP.

Initiation of Brittle Deformation - 2003:

Trigger Value Derivation				
COMP Title:	Initiation of Brittle Deformation			
COMP Units	Qualitative			
Related Monitoring Data				
Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value	
Geotechnical	Closure	Observational	Operational and Remedial	
COMP Derivation Procedure				
Qualitative and pertinent to operational considerations. Captured qualitatively in association with other COMPs				
Performance and Compliance Elements				
Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
Not directly related to PA as currently measured	NA	NA	NA	NA
Monitoring Data Trigger Values				
Monitoring Parameter ID	Trigger Value	Basis		
Initiation of Brittle Deformation	None[(a)]	Qualitative COMPs can be subjective and are not prone to the development of meaningful TVs.		

(a) Recommendation could be considered to add acoustic emissions for brittle monitoring or to replace this parameter with another more directly tied to PA.

2.2.4 Displacement of Deformation Features

The displacement of deformation features primarily focuses on those features located in the immediate vicinity of the underground openings, e.g., mining-induced fractures and lithological units within several meters of the roof and floor. As discussed previously, fracture development is most continuous parallel to the openings and near the upper corners. These fractures tend to propagate or migrate by arching over and under the openings and, thus are designated "low angle fractures" relative to the horizontal axis. Typically, the fractures intersect or asymptotically approach lithologic units such as clay seams and anhydrite stringers. As a result, salt beams are formed. In the roof, the beams are de-coupled from the surrounding formation requiring use of ground support. In the floor, the beams sometimes buckle into the openings requiring floor milling and trimming. Lithologic units of primary interest are Clay G and H. These features are located approximately 2.4 m and 4.5 m respectively, above the roof of Panels 1, 2, 7 and 8 while Marker Bed 139 (anhydrite) is located approximately 2 m below the floor of these panels. For Panels 3 through 7, the panels are mined up to Clay G. Clay H is therefore located 2.1 m above the roof of these panels and Marker Bed 139 is located approximately 4.4 m below the panel floors.

Monitoring of these deformation features is accomplished by measuring the offset of observation boreholes drilled from the openings through the feature of interest. In general, these boreholes are aligned vertically (normal to the roof and floor surfaces) because of the location and orientation of the fractures and lithological units of interest. All of the observation holes are 7.6-cm (3-in) in diameter, and many intersect more than one deformation feature. The ages of the observation holes vary from more than 20 years to less than one year (5 boreholes were drilled in Panel 2 during the current reporting period of the GAR).

The offset(s) in each observation borehole is determined by visually estimating the degree of borehole occlusion. The direction of offset along displacement features is defined as the movement of the stratum nearer the observer relative to the stratum farther from the observer. Typically, the nearer stratum moves toward the center of the excavation. Based on previous observations in the underground, the magnitude of offset is usually greater in boreholes located near the ribs as compared to boreholes located along the centerline of openings.

Nearly 400 observation boreholes have been drilled since 1983; however, many of these boreholes are no longer accessible for monitoring purposes. For example, boreholes drilled in the floor have become filled with crushed-salt over time and thus, visual observations cannot be made without continual maintenance of the boreholes. In addition, observation boreholes drilled in the roof of Panel 1 cannot be inspected because monitoring personnel cannot enter disposal rooms once waste has been emplaced. Therefore, displacement data are currently reported for only 95 features intersected by 69 boreholes (not counting the 5 new boreholes drilled in Panel 2).

Based on the limited data available from the current GAR, displacements along 10 of the 95 deformation features (or 10.5%) have resulted in the full occlusion of the observation boreholes. All of these occluded boreholes are located near the Waste Shaft Station or in the East 140 drift and were drilled from 1991-1996. In addition, displacements along 17 of the 95 features (or 18%) have closed the boreholes by as much as 75 to <100% and were measured in boreholes drilled at approximately the same time as the fully-occluded boreholes. None of the observation boreholes drilled in Panel 2 during 2000 are fully occluded but several are now more than 50% occluded and are expected to be fully occluded within the next few years.

The TV for displacement of deformation features is the observation of a fully occluded borehole. *Based on the limited data available from the current GAR, approximately 10% of all the offsets being monitored meet or exceed the TV and another 18% are expected to reach the TV within a relatively short period of time.* Exceedence of the TV, in and of itself, is not necessarily a cause for concern, particularly given that no significant impact on safety or performance has occurred in those locations where the TV has been exceeded. However, to limit the formation of low angle fractures and de-coupled beams over the roof, the elevation of future disposal panels (i.e., Panels 3, 4, 5, 6, and 7) will be raised approximately 2.4 m so the roof will then coincide with Clay G. This horizon change was implemented to improve ground control. As such, the horizon change will change the expected deformation and displacement behavior necessitating a reanalysis of the TV.

Displacement of deformation features has been useful for implementation of ground control alternatives (i.e., horizon change to Clay G). Displacement features complement observation of brittle deformation initiation and corroborate estimates of the extent of deformation.

Displacement of Deformation Features - 2003:

<table>
<tr><td colspan="5">Trigger Value Derivation</td></tr>
<tr><td>COMP Title:</td><td colspan="4">Displacement of Deformation Features</td></tr>
<tr><td>COMP Units:</td><td colspan="4">Length</td></tr>
<tr><td colspan="5">Related Monitoring Data</td></tr>
<tr><td>Monitoring Program</td><td>Monitoring Parameter ID</td><td>Characteristics (e.g., number, observation)</td><td colspan="2">Compliance Baseline Value</td></tr>
<tr><td>Geotechnical</td><td>Delta D/D_0</td><td>Observational</td><td colspan="2">Not established</td></tr>
<tr><td colspan="5">COMP Derivation Procedure</td></tr>
<tr><td colspan="5">Observational – Lateral deformation across boreholes.</td></tr>
<tr><td colspan="5">Related Performance and Compliance Elements</td></tr>
<tr><td>Element Title</td><td>Parameter Type & ID or Model Description</td><td>Derivation Procedure</td><td>Compliance Baseline</td><td>Impact of Change</td></tr>
<tr><td>Not directly related to PA</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td colspan="5">Monitoring Data Trigger Values</td></tr>
<tr><td>Monitoring Parameter ID</td><td>Trigger Value</td><td colspan="3">Basis</td></tr>
<tr><td>Borehole diameter closure</td><td>Obscured observational borehole.</td><td colspan="3">If lateral displacement is sufficient to close diameter of observational borehole, technical evaluation of consequences will be initiated.</td></tr>
</table>

2.2.5 Subsidence

Subsidence is currently monitored via elevation determination of 51 existing monuments and 14 of the National Geodetic Survey's vertical control points. To address EPA monitoring requirements, the most recent survey results (DOE 2003c) are reviewed and compared to derived TVs. Because of the low extraction ratio and the relatively deep emplacement horizon (650 m), subsidence over the WIPP is expected to be much lower and slower than over potash mines. Maximum observed subsidence over potash mines near the WIPP is 1.5 m, occurring over a time period of months to a few years. In contrast, calculations show that the maximum subsidence predicted directly above the WIPP waste emplacement panels is 0.62 m assuming emplacement of CH-TRU waste and no backfill (Backfill Engineering Analysis Report [BEAR; WID 1994]). Further considerations, such as calculations of room closure, suggest that essentially all surface subsidence would occur during the first few centuries following construction of the WIPP, so the maximal vertical displacement rates would be approximately 0.002 m/yr (0.006 ft/yr). Obviously, these predicted rates could be higher or lower depending on mining activities as well as other factors such as time. Because the annual vertical elevation changes are very small, survey accuracy, expressed as the vertical closure of an individual loop times the square root of the loop length, is of primary importance. For the current annual subsidence surveys, a Second-Order Class II loop closure accuracy of 8 mm $\times \sqrt{\text{km}}$ (or 0.033 ft $\times \sqrt{\text{mile}}$) or better was achieved in all cases.

Over the years, different data sets have been included in the annual surveys. In general, the data sets have included:

- 29 monuments surveyed from 1987 to 2003
- 2 monuments surveyed from 1989 to 2003
- 19 monuments surveyed from 1992 to 2003
- 1 monument surveyed from 1993 to 2001
- 14 National Geodetic Survey vertical control points surveyed from 1996 to 2003.

Four other monuments have also been included in various annual surveys, but were not included in the current surveys because the monuments no longer exist or have been physically disturbed. Historically, the surveys were conducted by private companies under subcontract to DOE; however, since 1993, the WIPP M&OC has conducted the surveys using a set of standardized methods. Starting with the 2002 survey, the M&OC was following WIPP procedure, WP 09-ES4001 (WTS 2002).

The current annual surveys comprise nine leveling loops containing as few as five to as many as eleven monuments/control points per loop as shown in Figure 2.2 (Surveys of Loop 1 benchmarks have been discontinued because only two benchmarks comprise this loop and these benchmarks are redundant to other survey loops). Elevations are referenced to Monument S-37 located approximately 7,700 feet north of the most northerly boundary of the WIPP underground excavation. This location is considered to be far enough from the WIPP facility to be unaffected by excavation-induced subsidence expected directly above and near the WIPP underground. The elevation of S-37 has been fixed for all of the subsidence leveling surveys conducted since 1993. Survey accuracy for all loops was 0.024 ft or better, which exceeds the Second-Order Class II closure accuracy by about a factor of two. Adjusted elevations are determined for every monument/control point by proportioning the vertical closure error for each survey loop to the monuments/control points comprising the loop. The proportions are based on the number of instrument setups and distance between adjacent points within a survey loop.

The adjusted elevations for each monument/control point are plotted as functions of time to assess subsidence trends. Figures 2.3 through 2.7 provide, respectively, elevations for selected monuments including those located (1) directly above the first waste emplacement panel, (2) directly above the second waste emplacement panel, (3) directly above the north experimental area, (4) near the salt handling shaft, and (5) well outside the repository footprint of the WIPP underground excavation. As expected, subsidence is occurring directly above the underground openings (Figures 2.3 through 2.6); however the magnitude of the subsidence above the openings is small ranging from about -0.10 feet to -0.20 feet. Most of the observed subsidence has occurred in the time period from 1987 to 1993, but as discussed above, consistent surveying practices were not implemented until 1993 so some of the observed elevation changes may be related to differences in methodology rather than subsidence.

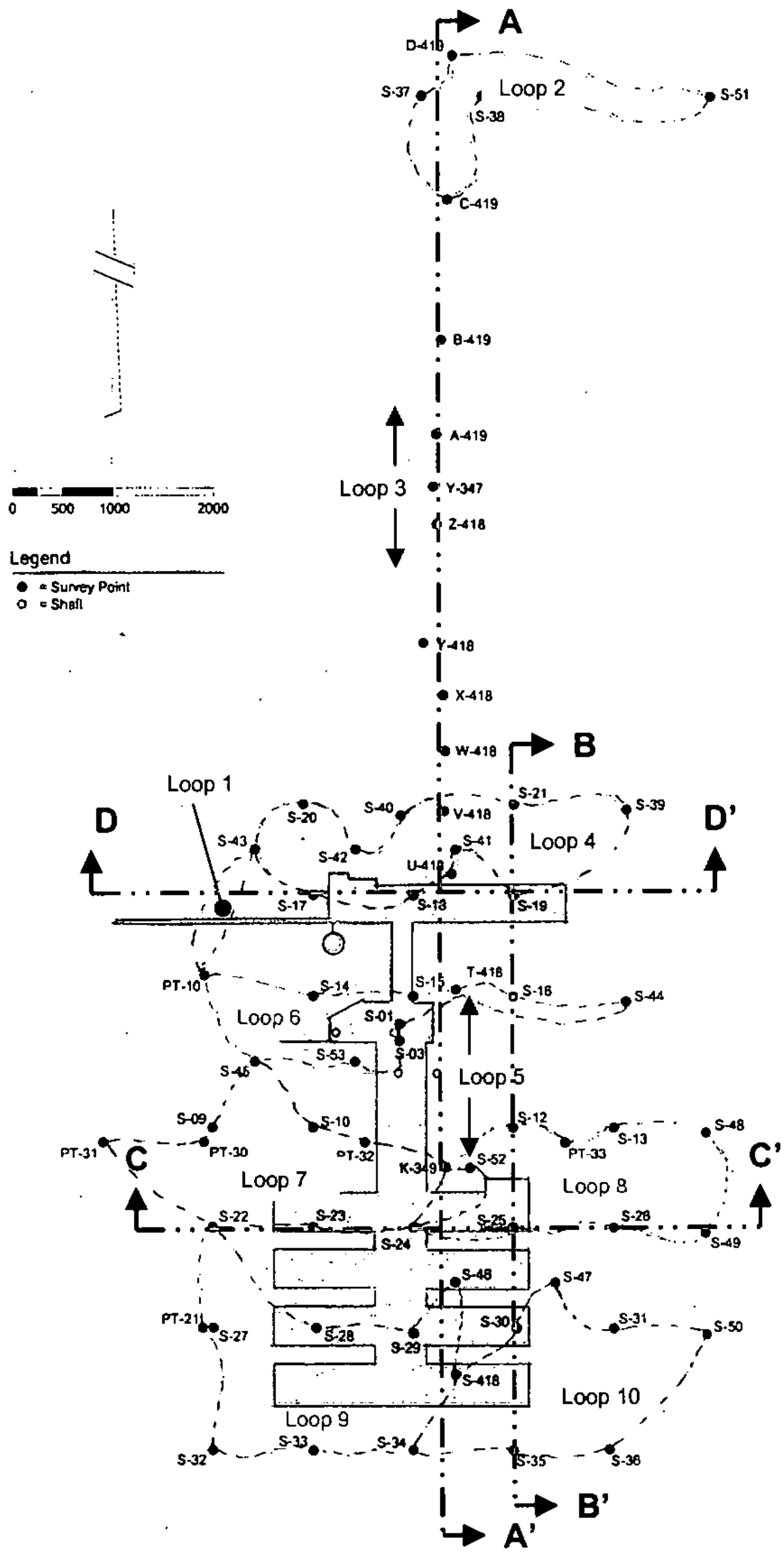

Figure 2.2. Monuments and vertical control points comprising WIPP subsidence survey loops.

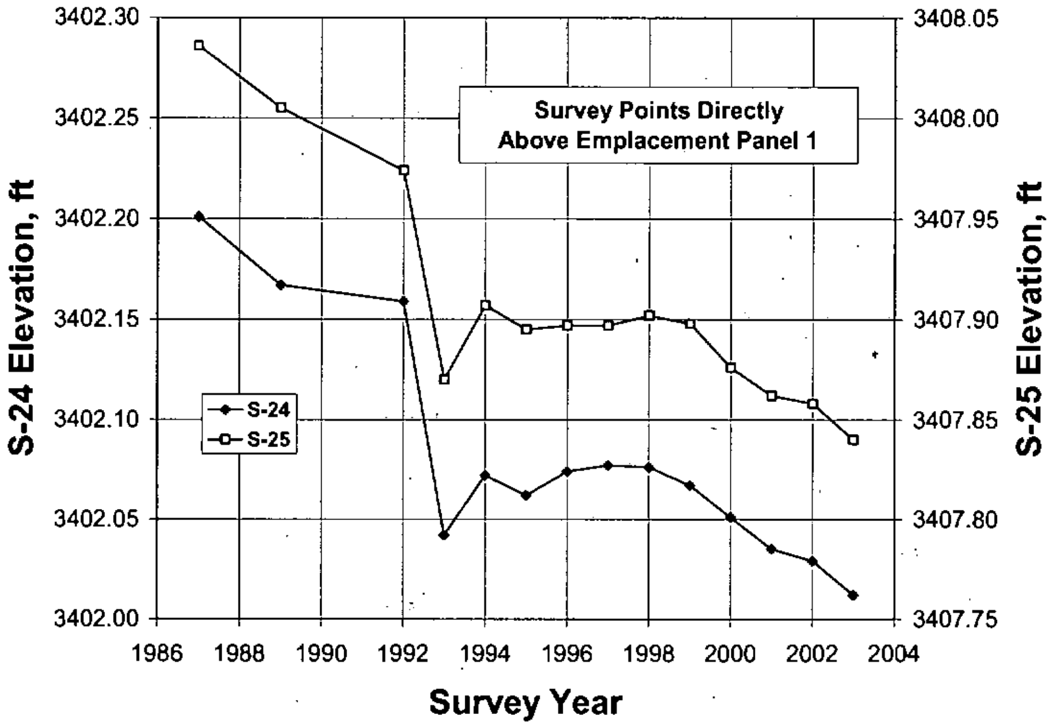

Figure 2.3. Elevations of WIPP monuments S-24 and S-25 located directly above emplacement Panel 1.

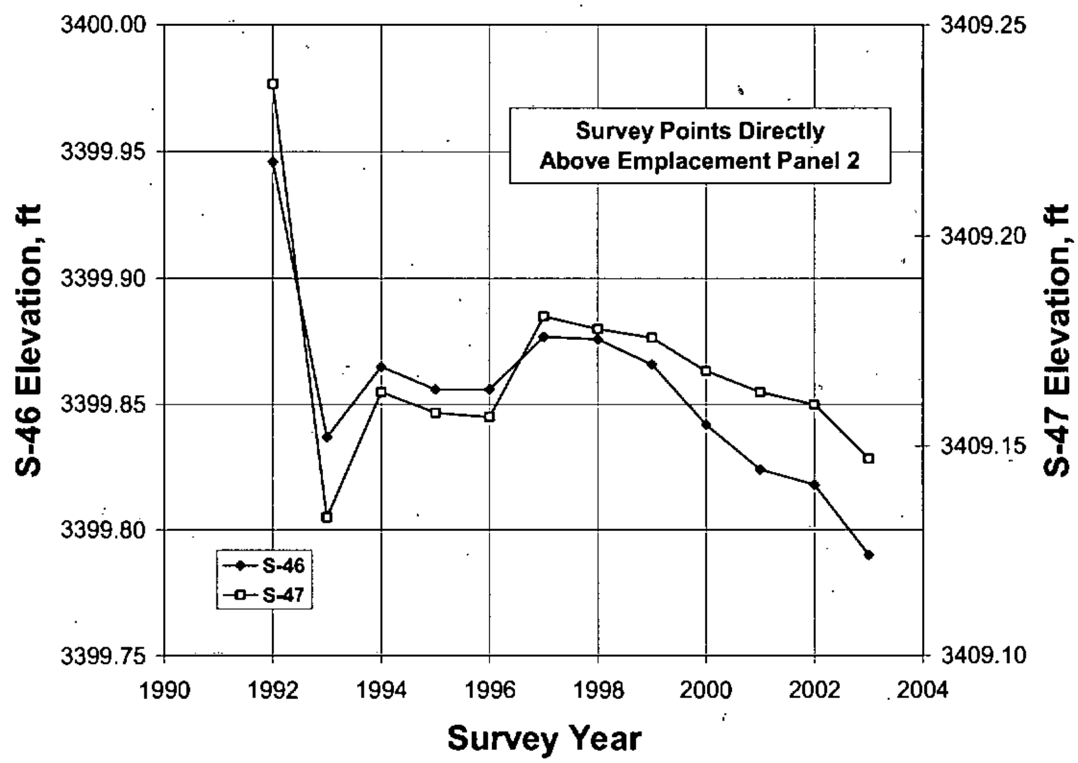

Figure 2.4. Elevations of WIPP monuments S-46 and S-47 located directly above emplacement Panel 2.

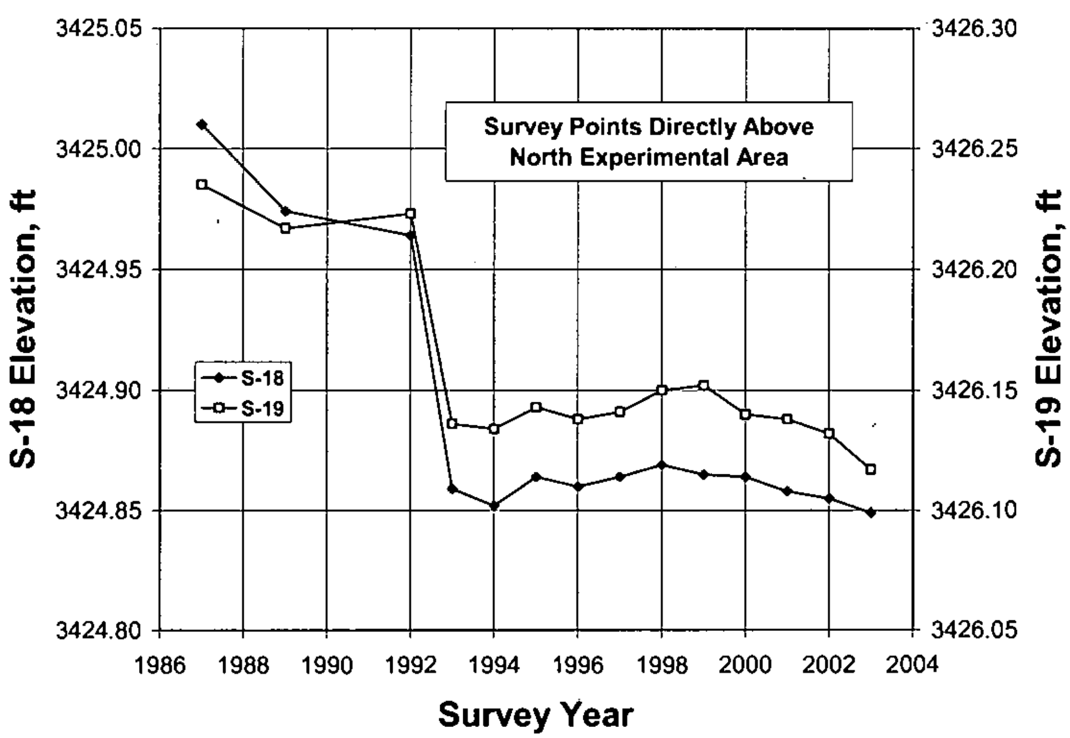

Figure 2.5. Elevations of WIPP monuments S-18 and S-19 located directly above the north experimental area.

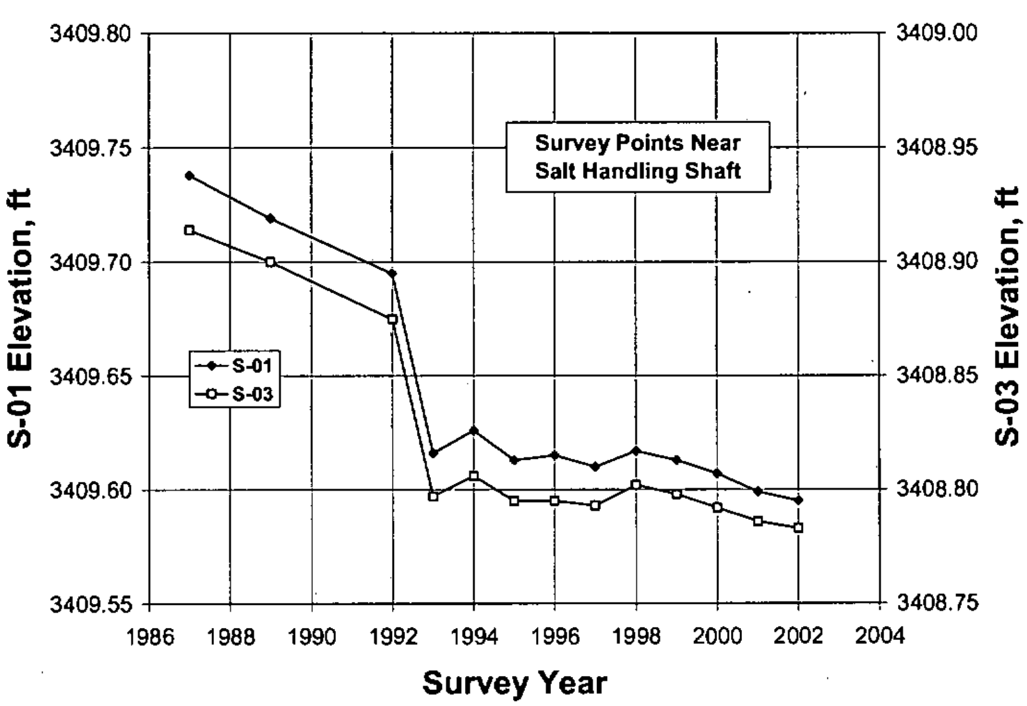

Figure 2.6. Elevations of WIPP monuments S-01 and S-03 located near the Salt Handling Shaft.

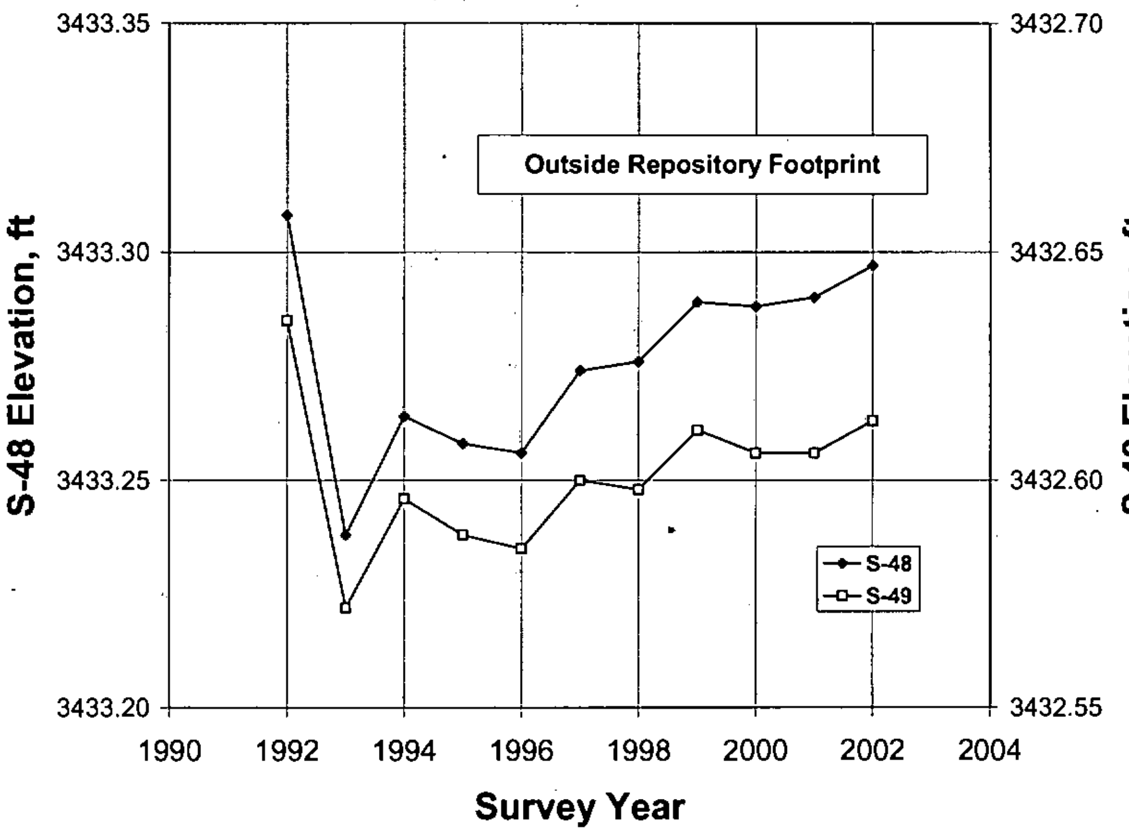

Figure 2.7. Elevations of WIPP monuments S-48 and S-49 located outside the repository footprint.

Elevations of survey points located directly above Waste Emplacement Panel 1 were stable during the 1994 to 1998 surveys, as shown in Figure 2.3. However, when the excavation of Panel 2 was initiated in 1999, the elevations of the survey points above Panel 1 began to decrease with time in a nearly linear manner. These higher rates of subsidence were anticipated because the excavation of Panel 2 caused a redistribution of stress in the salt around Panel 1, leading to higher creep rates in the salt and higher convergence rates of panel rooms. Based on three-dimensional modeling conducted by Patchet et al. (2001), the convergence rates within Panel 1 were predicted to increase by as much as 60 to 96 percent as a result of the mining of Panel 2. A manifestation of these higher convergence rates is higher subsidence rates at the surface, particularly above Panel 1. Higher subsidence rates were also expected directly above Panel 2 because of the excavation. Figure 2.4 shows that the elevations of the survey points located above Panel 2 also began to decrease immediately following the initiation of Panel 2 excavation in 1999. With the completion of the Panel 2 excavation in October 2000, subsidence rates of survey points located above both Panel 1 and Panel 2 slowed as indicated by the 2002 survey results shown in Figures 2.3 and 2.4, but then accelerated again in 2003 (particularly above Panel 2) most likely as a result of the initiation of excavation of Panel 3 and its access drifts.

As time passes, subsidence is expected to be most pronounced directly above the WIPP underground excavations and will be minimal away from the repository footprint. Early results suggest this pattern is already occurring, as shown in Figures 2.8 through 2.11 for the following subsidence profiles (shown in plan view in Figure 2.2):

- Section A-A′, North-South section extending through the WIPP site
- Section B-B′, North-South section extending from the north experimental area through the south emplacement panels
- Section C-C′, East-West section extending through Panel 1
- Section D-D′, East-West section extending through the north experimental area.

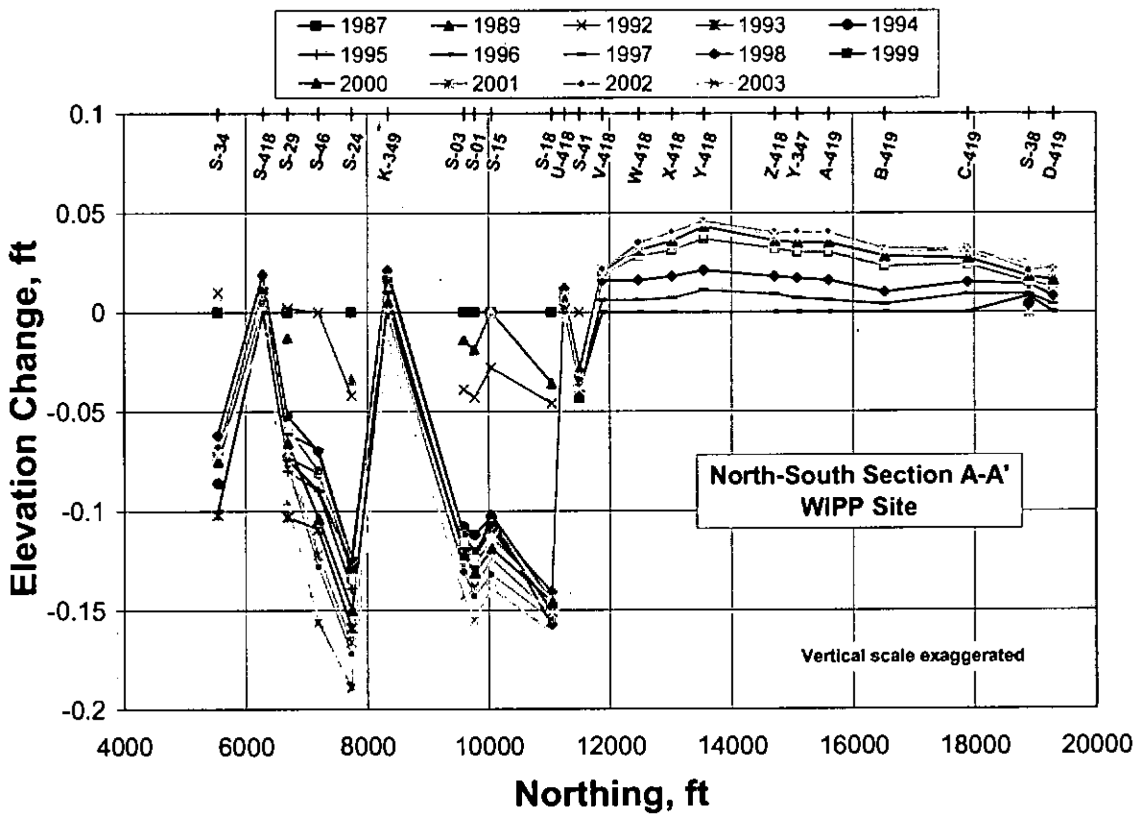

Figure 2.8. North-South subsidence profile A-A′.

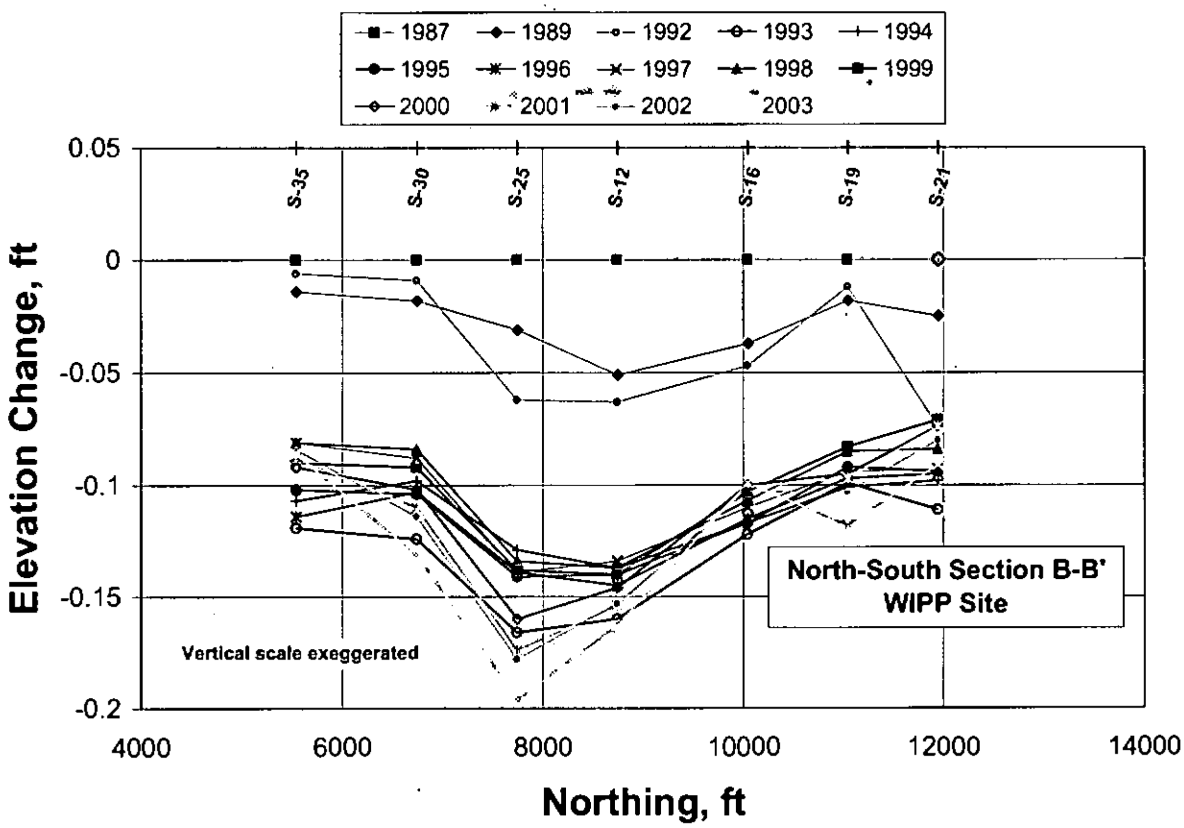

Figure 2.9. North-South subsidence profile B-B′.

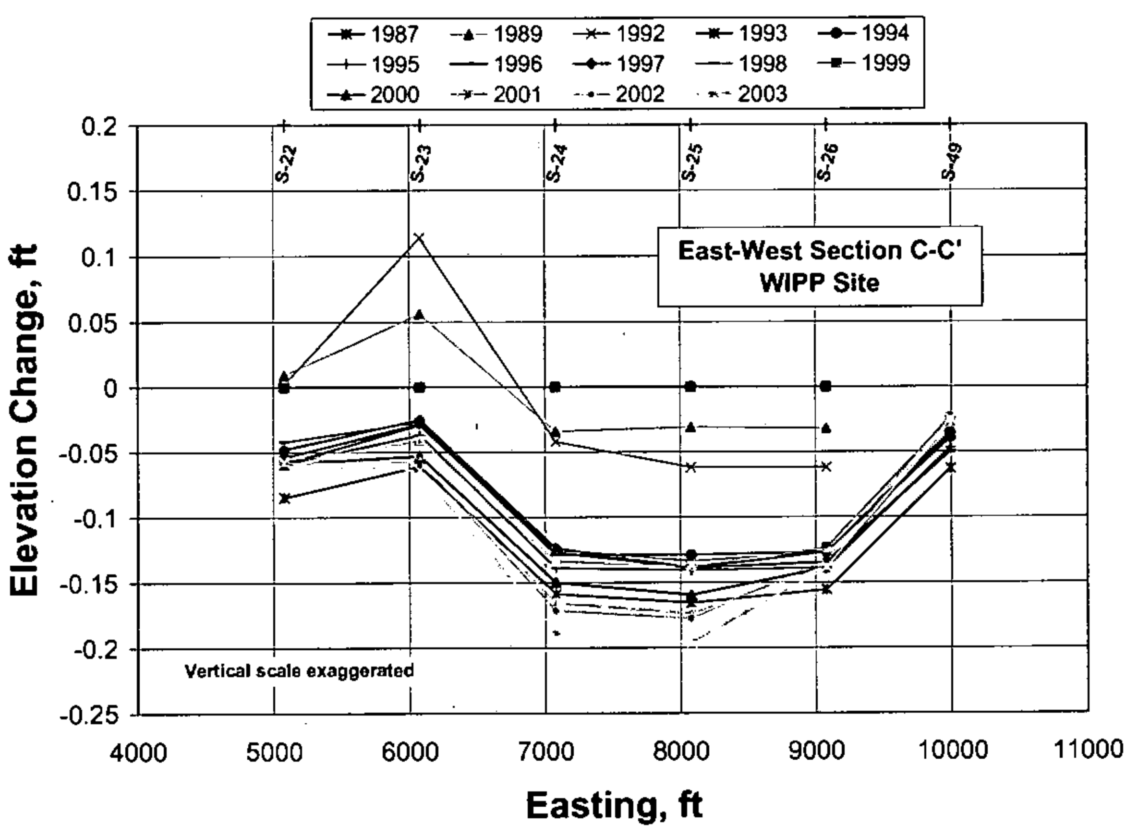

Figure 2.10. East-West subsidence profile C-C′.

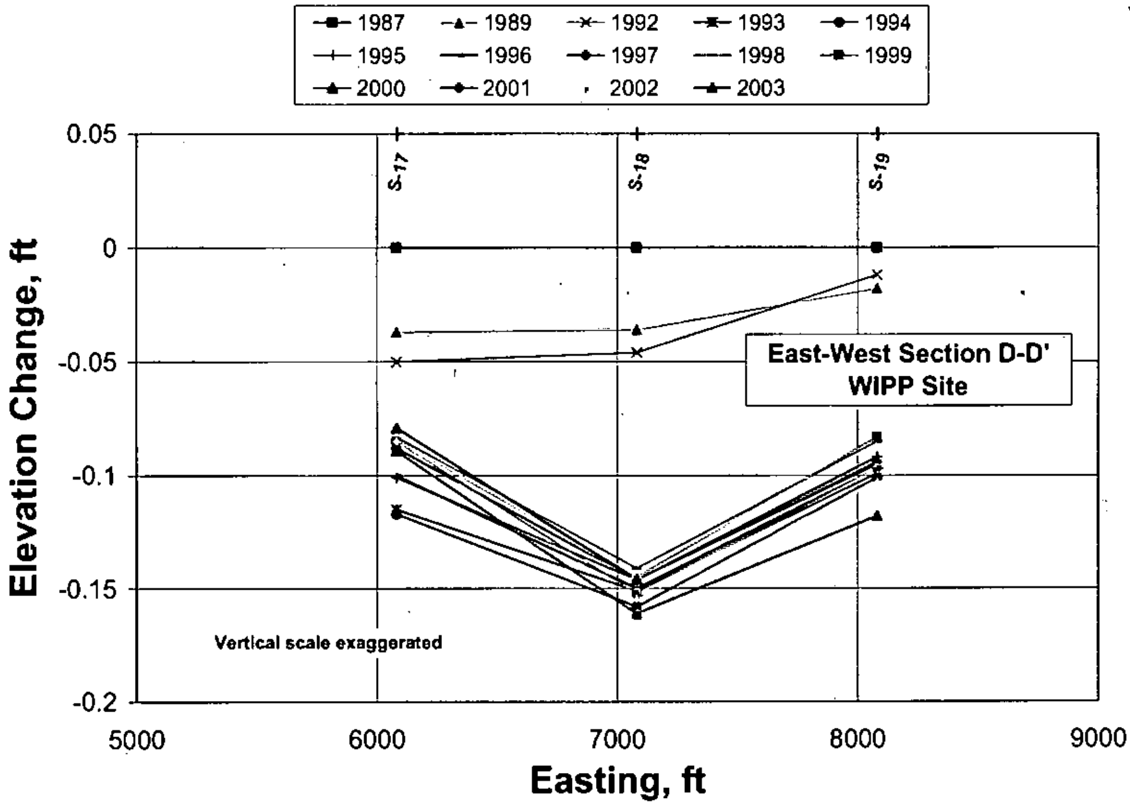

Figure 2.11. East-West subsidence profile D-D′.

The elevation changes of individual monuments shown in these figures are referenced to the elevations determined from the annual surveys that first incorporated the monument so, in some cases, direct temporal comparisons between pairs of monuments cannot be made. For example, only 29 monuments were included in the 1987 survey, while 50 and 65 monuments were included in the 1992 and 1996 surveys, respectively. Although direct comparisons cannot always be made, several observations are possible including:

1. In the previous assessment, the measured elevations of the monuments located between the Reference Monument, S-37, and the northern boundary of the WIPP footprint (Figure 2.8) appeared to be increasing with time rather than remaining constant, as would be expected in an area unaffected by underground operations. The 2003 survey results indicate that this trend has been reversed, i.e., the benchmark elevations in this region are now decreasing slightly. *Because the elevation of the reference monument has not been verified recently, it is recommended that the elevation of this monument be accurately determined during the next annual survey to investigate the cause for the "observed" elevation changes north of the repository footprint.*
2. The most significant subsidence (approximately - 0.20 ft) occurs directly above Panel 1 (Monuments S-24 and S-25), with slightly less subsidence (- 0.16 ft) near the Salt Handling Shaft (Monuments S-01 and S-03) and above the North Experimental Area (S-18).

3. The highest subsidence rates measured for the 2002-2003 surveys correspond to benchmarks located above Panels 1 through 3. These rates ranged from 5.2×10^{-3} m/yr at S-24 and S-30 to 8.5×10^{-3} m/yr at S-46 (above Panel 3).
4. The effects of subsidence extend away from the repository footprint approximately 1,000 to 1,500 ft (e.g., S-26, see Figures 2.2 and 2.10).
5. Generally, changes in elevation were largest for the 1992-1993 surveys but then were smaller in subsequent annual surveys. Exceptions are in the Panel 1 and Panel 2 areas where current data (2002-2003 annual surveys) suggest subsidence magnitudes have now exceeded their 1992-1993 levels probably as a result of the completion of Panel 2 mining and the initiation of Panel 3 mining. These higher magnitudes were expected and are not considered detrimental to repository performance.

Furthermore, total subsidence and subsidence rates are small, and are approximately at the resolution level of the survey accuracy. These minor amounts of subsidence and low subsidence rates are expected and are well within normal ranges. *Based on the survey data available, subsidence rates of the ground surface at the WIPP are low and below the* 1×10^{-2} *m/yr TV.*

Subsidence - 2003:

Trigger Value Derivation			
COMP Title:	Subsidence		
COMP Units:	Change in surface elevation in meters per year		
Related Monitoring Data			
Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value
Subsidence Monitoring Leveling Survey (SMP)	Elevation of 51 monitoring monuments	Decimal (meters)	—
SMP	National Geodetic Survey (NGS) results	Decimal (meters)	—
SMP	Change in elevation over year	Decimal (meters)	—
SMP	Total change in elevation since excavation of the WIPP	Decimal (meters)	—
COMP Derivation Procedure			
Survey data from annual WIPP Subsidence Monument Leveling are evaluated. Elevations of 51 monitoring monuments are compared to determine annual change.			

Related Performance and Compliance Elements				
Element Title	Parameter Type & ID or Model Description	Derivation Procedure	Compliance Baseline	Impact of Change
Subsidence	FEP [W2.023]	Predictions are of low consequence to the calculated performance of the disposal system – based on WID (1994) analysis and EPA treatment of mining.	Maximum total subsidence of 0.62 m above the WIPP.	Predicted subsidence will not exceed existing surface relief of 3 m – i.e., it will not affect drainage. Predicted subsidence may cause an order of magnitude rise in Culebra hydraulic conductivity (CCA Appendix SCR , Section 2.3.4) – this is within range modeled in the PA. Predicted WIPP subsidence is below that predicted for the effects of potash mining (0.62 m vs.1.5 m; EPA 1996).

Monitoring Data Trigger Values		
Monitoring Parameter ID	Trigger Value	Basis
Change in elevation per year	1.0×10^{-2} m per year subsidence	Based on the most conservative prediction by analyses referenced in the CCA.

2.3 Hydrological COMPs

As stated in the previous sections, the CCA lists ten monitoring parameters that the DOE is required to monitor and assess during the WIPP operational period. Two of these parameters are considered hydrological in nature and include:

- Changes in Culebra Water Composition
- Changes in Culebra Groundwater Flow

The SA has reviewed the data collected by the M&OC in 2002 under the Groundwater Surveillance Program (GSP). The GSP has two components:

- The Water Quality Sampling Program (WQSP)
- The Water-Level Monitoring Program (WLMP)

WQSP and WLMP data are reported in the Waste Isolation Pilot Plant Site Environmental Report Calendar Year 2002 (DOE 2003e) and WLMP data are also reported in monthly memoranda from the M&OC to the SA.

2.3.1 Change in Culebra Water Composition

Water Quality Sampling Program

Under the WQSP, WRES collected water samples twice (sampling rounds 14 and 15) in 2002 from seven wells, denoted WQSP-1 through WQSP-6 and WQSP-6a. WQSP-1 through WQSP-6 are completed to the Culebra Dolomite Member of the Rustler Formation and WQSP-6a is completed to the Dewey Lake Formation. Flow and transport in the Dewey Lake are not modeled explicitly in PA because the sorptive quality of the Dewey Lake is expected to contain any radionuclides that may reach the unit. Nevertheless, the Dewey Lake water quality is monitored because it might help to increase the understanding of the Dewey Lake hydrology. The water samples were analyzed in duplicate for major and minor elements and hazardous constituents per the WIPP Ground Water Monitoring Program Plan (GWMP; WID 1999).

The Culebra is not a source of drinking water, so Culebra water quality is not of concern in an immediate health sense. Instead, Culebra water quality is important because of what it implies about the nature of the flow system. Solute concentrations differ widely among wells across the WIPP site, reflecting local equilibrium, diffusion, and perhaps most importantly, slow transport. The conceptual model for the Culebra presented in the CCA and implemented in PA numerical models is that of a confined aquifer with solute travel times across the WIPP site on the order of tens of thousands of years. In such a system, no changes in water quality at an individual well outside the range of normal analytical uncertainty and noise should be observed during the WIPP operational phase of a few decades duration. If sustained and statistically significant changes in the concentrations of major ionic species (Na^+, Ca^{2+}, Mg^{2+}, K^+, Cl^-, SO_4^{2-}, HCO_3^-) were observed, this would imply that water was moving faster through the Culebra than was consistent with PA models. Stability of major ion concentrations, on the other hand, is consistent with and supports the SA's models. Thus, this evaluation of the water-quality data focuses on the stability of major ion concentrations. Based on these considerations, the TVs for Culebra groundwater composition is defined as a condition where both duplicate analyses for any major ion falls outside the 95% C.I.s for three consecutive sampling periods. When and if this criterion is met, the project will evaluate the sampling and analytical procedures to see if the apparent change in groundwater composition can be explained by procedural changes or irregularities. If the change appears to reflect conditions in the Culebra accurately, the SA will investigate what effects the changes might have on the conceptualization and modeling of the Culebra and, if appropriate, the model will be revised to be consistent with the new information.

In this COMP evaluation, stability is defined as a condition where the concentration of an ion remains within the 95% confidence interval (C.I.) (mean +/- two standard deviations) established from the baseline measurements at a well, assuming a normal distribution of concentrations. The baseline was revised in 2000, expanding from the first five rounds of sampling in the WQSP wells to the first ten rounds of sampling, which were performed between 1995 and 2000 before the first receipt of RCRA-regulated waste at WIPP. The baseline data are presented in the WIPP Resource Conservation and Recovery Act Background Quality Baseline Report (Crawley and Nagy 1998) and in Addendum 1 to that report (IT Corporation 2000). For the purposes of this evaluation, a small number of measurements have been eliminated from the baselines for WQSP-3, 5, 6, and 6a. The reasons for eliminating these values are discussed in detail in the COMPs assessment report for data collected in the year 2000 (SNL 2000c). The elimination of these values is always conservative in that it reduces the "stable" range of concentrations for the affected parameters.

A charge-balance error, defined as the difference between the positive and negative charges from the ions in solution divided by the sum of the positive and negative charges, was also calculated for each analysis (Freeze and Cherry 1979). Charge-balance errors are useful in evaluating the reliability of an analysis because water must be electrically neutral. Charge-balance errors are rarely zero because of inherent inaccuracy in analytical procedures, but a reliable analysis should not have a charge-balance error exceeding five percent (Freeze and Cherry 1979). Charge-balance errors in excess of five percent imply either that the analysis of one or more ions is inaccurate (most common) or that a significant ion has been overlooked (rare). The variation between the values obtained for the "sample" and "duplicate" analyses of individual ions is also considered. Generally speaking, this variation should be less than ten percent. Greater variation indicates a potential problem with one or both analyses. Analytical results and charge-balance errors for rounds 14 and 15 of sampling are presented in Table 2.7 with the 95% confidence intervals derived from the baseline data.

In the 1998 COMPs Assessment Report (SNL 2000b), it was noted that round 7 potassium concentrations exceeded the 95% confidence intervals (from five rounds of sampling) at WQSP-1, 2, 4, 5, and 6a. In the 1999 COMPs Assessment Report (SNL 2000c), it was noted that all potassium concentrations from rounds 8 and 9 from all seven WQSP wells exceeded the same 95% confidence intervals. In the 2000 COMPs Assessment Report (SNL 2001b), it was noted that the potassium concentrations in all of the WQSP wells except WQSP-6a continued to be high. Potassium concentrations were again high in all wells in 2001 (SNL 2002b). In the case of WQSP-3, potassium concentrations from rounds 1 through 7 appear to constitute a separate population from the concentrations from rounds 8 through 10, with no overlap of the 95% confidence intervals (1200 to 1730 versus 2060 to 3150 mg/L). Potassium concentrations from rounds 11 through 13 and 15 from WQSP-3 fall within the 95% confidence interval derived from rounds 8 through 10. Potassium concentrations from round 14 from WQSP-3 fall between the two 95% confidence interval populations. A similar situation is seen at WQSP-4 with respect to potassium, except the two populations comprise rounds 1 through 6 and 7 through 10 with slight overlap of the 95% confidence intervals (627 to 805 versus 784 to 1600 mg/L). Potassium concentrations from rounds 11 through 15 from WQSP-4 fall within the 95% confidence interval derived from rounds 7 through 10. Thus, the potassium analyses remain problematic. The greatest variation between concentrations of an ion between rounds 14 and 15 occurs for potassium in WQSP-3 and WQSP-5, and sulfate in WQSP-1 (see Table 2.7). The reasons for these variations are uncertain at this time.

Beginning with round 14, bromide concentrations are no longer determined as part of the WQSP.

Table 2.7. Rounds 14 and 15 ion concentrations and baseline 95% confidence Intervals.

Well I.D.	Sample	Cl^- Conc. (mg/L)	SO_4^{2-} Conc. (mg/L)	HCO_3^- Conc. (mg/L)	Na^+ Conc. (mg/L)	Ca^{2+} Conc. (mg/L)	Mg^{2+} Conc. (mg/L)	K^+ Conc. (mg/L)	Charge-Balance Error (%)
WQSP-1	Round 14	36600/32300	4270/**4010**	50/48	18400/19600	1620/1580	**1240/1220**	695/721	-1.6
	Round 15	35400/37800	5110/**5640**	49/51	*18600/15100*	1700/1620	1120/1040	681/691	**-10.8**
	95% C.I.	31100-39600	4060-5600	45-54	15850-21130	1380-2030	940-1210	322-730	
WQSP-2	Round 14	34500/33900	5570/5650	48/46	20240/20490	1662/1624	1093/1074	**759/797**	-0.2
	Round 15	36100/34100	*6310/5560*	**42**/44	15900/16500	1510/1450	1080/1040	**852/813**	**-11.4**
	95% C.I.	31800-39000	4550-6380	43-53	14060-22350	1230-1730	852-1120	318-649	
WQSP-3	Round 14	125000/126000	7540/7150	36/38	73200/75100	1500/1560	2270/2400	**1960/1950**	-2.1
	Round 15	128600/124800	7640/7270	32/33	77200/76500	1460/1420	2300/2280	2430/2210	-0.9
	95% C.I.	113900-145200	6420-7870	23-51	62600-82700*	1090-1620	1730-2500	2060-3150*	
WQSP-4	Round 14	**49700/50500**	6560/6400	42/40	*27200/31600*	1610/1590	1260/1200	1220/1230	-1.9
	Round 15	56400/53900	6960/6760	38/40	33900/35400	1530/1640	1110/1230	1030/1120	0.3
	95% C.I.	53400-63000	5620-7720	31-46	28100-37800	1420-1790	973-1410	784-1600*	
WQSP-5	Round 14	15900/15200	5230/5250	46/48	*8740/7750*	1010/1080	451/457	398/422	**-8.9**
	Round 15	14300/14100	4700/4730	50/48	**7660/7410**	928/947	426/443	*357/251*	**-8.9**
	95% C.I.	13400-17600	4060-5940	42-54	7980-10420*	902-1180	389-535	171-523	
WQSP-6	Round 14	**4990/4950**	4640/4600	46/46	3870/3860	738/735	**238/238**	221/223	-1.5
	Round 15	**5020/4940**	4720/4740	48/50	4210/3850	647/616	**234/239**	*231/205*	-1.7
	95% C.I.	5470-6380*	4240-5120*	41-54	3610-5380*	586-777	189-233*	113-245	
WQSP-6a	Round 14	*487/400*	1930/1940	106/104	253/254	573/**552**	151/154	7.27/7.49	-2.5
	Round 15	**419/417**	2090/2090	100/102	279/281	588/574	170/153	6.15/5.96	-2.1
	95% C.I.	433-764*	1610-2440	97-111	253-354	554-718	146-185	1.8-9.2	

Bold signifies outside 95% confidence interval
Italics signifies sample and duplicate analyses differ by more than 10%
*see text for baseline definition

WQSP-1

Concentrations of all major ions were within the 95% confidence intervals for round 14 sampling at WQSP-1 except for both magnesium analyses, which were high, and the sulfate duplicate analysis, which was low. Although high, the magnesium concentrations in round 14 were lower than in round 13 (SNL 2002b). Potassium concentrations in round 14 returned to fall within the 95% confidence interval at WQSP-1. For round 15, the results showed that the magnesium concentrations had returned to fall within the 95% confidence interval at WQSP-1. However, the duplicates for both sodium and sulfate were outside of the 95% confidence intervals (sodium is below and sulfate is above). Also, a difference of ~18% between the sodium sample and duplicate exists for round 15. This suggests that the duplicate analysis is in error. For round 15, an unacceptably high charge-balance error of –10.8% existed indicating an overabundance of anions. With the return of both potassium and magnesium to the 95% confidence intervals there is added confidence that the water quality at WQSP-1 is stable.

WQSP-2

Concentrations of all major ions were within the 95% confidence intervals for round 14 sampling at WQSP-2 except for potassium. Magnesium concentrations in round 14 returned to fall within the 95% confidence interval at WQSP-2 for both the analysis and the duplicate (Table 2.7). Potassium concentrations in round 14 continued to fall above the 95% confidence interval for both the analysis and the duplicate. The charge-balance error for round 14 is an acceptable –0.2%. For round 15, the results were similar to those for round 14 in that potassium concentrations were above the 95% confidence intervals. The charge-balance error for round 15 sampling was an unacceptable -11.4%. This large charge-balance error appears to be related to sodium concentrations significantly below their usual level. Round 15 marks the fifth consecutive sampling in which the observed potassium concentrations are above the 95% confidence interval, which means that the TV remains achieved. The preliminary results suggest that a new (higher) population for potassium concentration is being experienced, as identified in rounds 8 through 10 for WQSP-3. Therefore, the baseline and associated 95% confidence interval for potassium may need to be adjusted for WQSP-2. The SA is currently evaluating possible sources of the increased potassium levels that are being observed in several of the WQSP wells. Also, the round 15 sample and duplicate for sulfate differ by ~12%, with the sample value being higher than is typically observed and perhaps unreliable. The round 15 alkalinity concentration is also just below the 95% confidence interval, but a 1 mg/L deviation is not considered significant. Otherwise, at the present time, the water quality is believed to be stable at WQSP-2.

WQSP-3

For round 14 sampling at WQSP-3, both potassium concentrations were below the 95% confidence interval (Table 2.7). As discussed above, potassium concentrations from rounds 1 through 7 appear to constitute a separate population from the concentrations from rounds 8 through 10, with no overlap of confidence intervals (1200 to 1730 mg/L versus 2060 to 3150 mg/L). Potassium concentrations in WQSP-3 fell between the two separate confidence intervals (rounds 1 through 7 and rounds 8 through 10) for sampling round 14 but returned to the rounds 8 through 10 confidence interval for sampling round 15. Therefore, the potassium concentrations from round 15 are consistent with analytical results since round 8, but not before. For round 15 sampling, all other ion concentrations were within the 95% confidence intervals. The charge-balance error for rounds 14 and 15 were an acceptable –2.1% and –0.9%, respectively. At the present time, the water quality is believed to be stable at WQSP-3.

WQSP-4

For rounds 14 and 15 sampling at WQSP-4, potassium concentrations were again high (Table 2.7). As discussed above, potassium concentrations from rounds 1 through 6 appear to constitute a separate population from the concentrations from rounds 7 through 10, with only slight overlap of the 95% confidence intervals (627 to 805 mg/L versus 784 to 1600 mg/L). Therefore, potassium concentrations from rounds 14 and 15 are consistent with analytical results since round 7, but not before. All other ion concentrations from round 14 were within the 95% confidence intervals except the sodium analysis and chloride analysis and duplicate, which were all below the 95%

confidence interval. The round 14 sodium sample and duplicate analysis differ by ~16% suggesting that the sodium concentration in the sample is too low. The charge-balance error was an acceptable -1.9% for round 14 reported values. All ion concentrations from round 15 were within the 95% confidence intervals (see above for explanation on potassium concentrations), and the charge-balance error was an acceptable 0.3%. Sodium and chloride concentrations returned to fall within their respective 95% confidence intervals in round 15. At the present time, the water quality is believed to be stable at WQSP-4.

WQSP-5

For round 14 at WQSP-5, all ion concentrations were within the 95% confidence intervals except for the sodium duplicate that falls below the 95% confidence interval (Table 2.7). The round 14 sodium sample and duplicate differ by ~11% suggesting that the duplicate sodium concentration is too low. The charge-balance error for round 14 was an unacceptable –8.9%. For round 15, all ion concentrations were within the 95% confidence intervals except for both the analysis and the duplicate for sodium, which both fell below the 95% confidence interval. The round 15 potassium sample and duplicate differ by ~29% suggesting that the duplicate potassium concentration is too low. The charge-balance error for round 15 was an unacceptable –8.9%. The high negative charge balance errors suggest the sodium analyses discussed above were inaccurate. At the present time, the water quality is believed to be stable at WQSP-5.

WQSP-6

For rounds 14 and 15 at WQSP-6, all ion concentrations were within the 95% confidence intervals except for chloride and magnesium. Chloride concentrations were below the 95% confidence interval while magnesium concentrations were above the 95% confidence interval (Table 2.7). This marks four consecutive sampling rounds in which the chloride concentrations in WQSP-6 were below the 95% confidence interval, and three consecutive sampling rounds in which the magnesium concentrations were slightly above the 95% confidence interval. Thus, the TVs for both chloride and magnesium have been exceeded at WQSP-6. The round 15 potassium sample and duplicate differ by ~11% suggesting that one or both analyses are slightly in error. The charge-balance errors for rounds 14 and 15 were an acceptable –1.5% and -1.7%, respectively. The SA is currently evaluating possible sources of the changes in Culebra groundwater quality that are being observed in several of the WQSP wells. At the present time, with the exception of chloride and magnesium concentrations, the water quality is believed to be stable at WQSP-6.

WQSP-6a

For round 14 at WQSP-6a, all ion concentrations were within the 95% confidence intervals expect for the duplicates analyses for both chloride and calcium, which were below the 95% confidence interval (Table 2.7). The round 14 chloride sample and duplicate differ by ~18% suggesting that the duplicate chloride concentration is too low. The charge-balance error for round 14 was an - acceptable –2.5%. For round 15, all ion concentrations were within the 95% confidence intervals except for the chloride analysis and duplicate, which were below the 95% confidence interval. The charge-balance error for round 15 was an acceptable -2.1%. At the present time, the water quality is believed to be stable at WQSP-6a.

Summary

With the exception of WQSP-2, the water quality for all wells are stable and within the TV. As stated earlier, analytical error is believed to be the most probable cause for sporadic variations in water quality data. Because the WQSP-2 potassium concentration is above the 95% confidence interval for the fifth consecutive sample, potassium concentration data is under investigation by the SA. The preliminary results suggest that the baseline data for potassium may be suspect. However, the water quality at that well is believed to be stable.

Change in Groundwater Composition - 2003:

Trigger Value Derivation				
COMP Title:	Groundwater Composition			
COMP Units:	Various – mg/L pCi/L			
Related Monitoring Data				
Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value	
Groundwater Monitoring	Composition	Semi-annual chemical and radionuclide analysis	RCRA Background Water Quality Baseline	
COMP Derivation Procedure				
Annually evaluate ASER data and compare to previous years and baseline information				
Related Performance and Compliance Elements				
Element Title	Type & ID	Derivation Procedure	Compliance Baseline	Impact of Change
Groundwater conceptual model, brine chemistry, actinide solubility	Indirect	Conceptual models	Indirect – The average Culebra brine composition is not used.	Provides validation of the various CCA models, potentially significant with respect to flow, transport, and solubility and redox assumptions.
Monitoring Data Trigger Values				
Monitoring Parameter ID	Trigger Value	Basis		
Change in Culebra groundwater composition	Both duplicate analyses for any major ion falling outside the 95% confidence interval (see Table 2.7) for three consecutive sampling periods	The 95% confidence interval for a particular analyte defines the range of concentrations that 19 out of 20 analyses, on average, should fall within. Therefore, TVs should not be set so that a single analysis falling outside the 95% confidence interval is significant. In addition, analysis of solutes in the concentrated brines of the Culebra is not a routine procedure, and occasional analytical errors are to be expected, particularly when a new laboratory is contracted to perform the analyses (SNL 2002b).		

2.3.2 Changes in Groundwater Flow (Water Level)

Assessment of the COMP "Changes in Groundwater Flow" involves TVs derived from the steady-state freshwater heads estimated for Culebra flow modeling in the CCA. The Culebra transmissivity (T) fields that were subsequently used to simulate the transport of radionuclides through the Culebra were considered calibrated when, among other things, the modeled heads at 32 wells fell within the ranges of uncertainty estimated for steady-state freshwater heads at those wells. If monitoring shows that heads at these wells are outside the ranges used for T-field calibration (hereafter called the "CCA range"), the cause(s) and ramifications of the deviations must be investigated.

The freshwater head is the elevation of the column of freshwater (density = 1.0 g/cm^3) that would exert the same pressure at the midpoint of the Culebra as that exerted by the column of fluid actually in the well. Thus, once the ground-surface elevation at a well site is surveyed, determination of freshwater head requires two sets of information:

1) The height of the water column in the well above the midpoint of the Culebra.
2) The density of the water in that water column.

Under the WLMP in 2002, WRES made monthly water-level measurements in 33 Culebra wells (down from 41 in 2001 due to P&A activities and well obstructions), and quarterly in 13 "redundant" Culebra wells located on the same drilling pads as eight of the wells monitored monthly (down from 17 in 2001 due to P&A activities and well obstructions). Pressure-density surveys were performed in 29 Culebra wells in 1987 (Crawley 1988). Fluid-density data from other wells come from water samples collected over a range of years. WRES began an annual program of pressure-density surveys in all of the monitoring wells in 2000. Table 2.8 gives the results available at the current time (DOE 2003e).

Water levels were also measured in wells completed in horizons other than the Culebra. These other horizons are not currently monitored as COMPs and do not have TVs. The water-level measurements in these units do, however, provide information used in the development of the conceptual model of site hydrology. Water levels in the Magenta Member of the Rustler Formation were measured monthly in 16 wells. Water levels in the Los Medaños Member of the Rustler Formation and across the Rustler-Salado contact were measured monthly in one well. Monthly water levels were measured in two Dewey Lake wells, two Bell Canyon wells, and in one well in the Forty-niner Member of the Rustler Formation.

Table 2.8. Pressure-density survey results.

Well I.D.	Date	Formation	Density (g/cm^3)
AEC-7	2000	Culebra	1.0888
C-2737	7/12/02	Culebra	1.0013
DOE-1	5/18/01	Culebra	1.093
DOE-1	11/18/02	Culebra	1.0902
DOE-2	2000	Culebra	1.0554
H-1	2000	Culebra	1.0197
H-2b2	2000	Culebra	1.0117
H-3b1	10/9/01	Culebra	1.0051
H-3b2	6/4/01	Culebra	1.0334
H-3b2	11/7/02	Culebra	1.000
H-4b	6/4/01	Culebra	1.0154
H-5b	10/8/01	Culebra	1.0981
H-6b	5/16/01	Culebra	1.0371
H-9b	6/13/01	Culebra	1.000
H-9c	12/18/02	Culebra	1.0029
H-10c	9/26/02	Culebra	1.000
H-11b4	6/11/01	Culebra	1.061
H-11b4	11/19/02	Culebra	1.0638
H-12	2000	Culebra	1.0833
H-14	2000	Culebra	1.0421
H-17	6/11/01	Culebra	1.14
H-17	10/7/02	Culebra	1.135
H-19b0	6/5/01	Culebra	1.0620
H-19b2	10/4/02	Culebra	1.0632
H-19b4	2000	Culebra	1.0661
H-19b5	2000	Culebra	1.07
H-19b7	2000	Culebra	1.0612
P-15	2000	Culebra	1.0133
P-17	2000	Culebra	1.0912
WIPP-12	10/29/02	Culebra	1.0987
WIPP-19	2000	Culebra	1.0556
WIPP-19	10/22/02	Culebra	1.0506
WIPP-21	2000	Culebra	1.0759
WIPP-22	2000	Culebra	1.0699
WIPP-22	10/15/02	Culebra	1.0614
DOE-2	7/11/01	Magenta	1.0553
H-5c	10/8/01	Magenta	1.0045
H-6c	9/26/01	Magenta	1.003
H-11b2	5/31/01	Magenta	1.070
H-14	7/9/01	Magenta	1.0294
H-15	7/9/01	Magenta	1.0760
H-18	7/11/01	Magenta	1.0054
WIPP-18	7/12/01	Magenta	1.0423

Culebra Data

Table 2.9 provides a comparison of Culebra water levels in feet above mean sea level (ft AMSL) from December 2001 to December 2002 at the 33 wells monitored monthly (DOE 2003e). Water levels in 28 of the wells rose in 2002. In all but two of those wells, water levels rose by less than two feet. Water levels rose by 2.64 feet in C-2737 and by 2.71 feet in WIPP-30. The low and changing heads in CB-1 appear to reflect a problem with the well (perhaps plugged perforations combined with a leaking packer) and are not thought to reflect conditions in the Culebra. In May 2002, the water level in CB-1 was reduced via pumping. The water level in CB-1 continues to be monitored and remedial actions are being considered. In January 2001, the P-15 well was discovered to have holes in the casing near the surface, confirming the hypothesis given in the previous COMPs Assessment Report (SNL 2001b). As a result, P-15 was plugged and abandoned in February 2002. Incompetent casing cementation was confirmed in well P-18, as was speculated in the 2002 COMPs Assessment Report (SNL 2002b). Therefore, well P-18 was plugged and abandoned in February 2002. Additionally, wells H-9b and H-10b were plugged and abandoned in February and January 2002, respectively.

Water levels decreased in four wells in 2002. In all of these wells except CB-1, the water levels decreased by less than one foot. The significant decrease in the CB-1 water level is explained above.

Table 2.9 also compares the December 2002 freshwater heads to the CCA ranges for the 19 wells used in the generation of the CCA T fields that were monitored in 2002 (22 wells were compared in the 2002 COMPs Assessment Report (SNL 2002b) but three of these wells (H-9b, H-10b, and P-15) were plugged and abandoned in 2002). Freshwater heads in 17 of the 19 wells appear to be outside the CCA ranges at the end of 2002, all except CB-1 higher than expected. The heads at CB-1 can be discounted for the reasons discussed above, leaving 16 wells with unexpectedly high freshwater heads.

For 10 of these 16 wells (AEC-7, H-2b2, H-3b2, H-5b, H-6b, H-11b4, H-12, H-17, P-17, and WIPP-13), freshwater heads could be within the CCA range if a lower fluid density was used to convert the measured water levels to freshwater heads. The fluid densities used to calculate the freshwater heads in Table 2.9 are the most current available from the WRES annual program of pressure-density surveys. Therefore, the SA believes the heads in these 10 wells exceed the respective CCA ranges that were used in the generation of the T fields.

Table 2.9. Summary of 2002 Culebra water-level changes and freshwater Heads.

Well I.D.	12/01 W.L. (ft AMSL)	12/02 W.L. (ft AMSL)	2002 Change (ft)	12/02 FWH (ft AMSL)	CCA FWH Range (ft AMSL)	Outside CCA Range?
AEC-7	3038.29	3038.13	-0.16	3061.07	3055.1-3060.4	Y
C-2737	3014.27	3016.91	2.64	3016.91	N/A	N/A
CB-1	3274.28	2961.26	-313.02	2964.48	2986.9-2991.5	Y
DOE-1	2976.71	2978.10	1.39	3006.69	2992.5-3013.8	N
DOE-2	Recompleted as Magenta well (April 2001)				3061.7-3071.5	N/A
ERDA-9	3008.60	3009.83	1.23	3025.34	N/A	N/A
H-1	Plugged and abandoned (February 2001)				3017.1-3030.2	N/A
H-2b2	3037.60	3038.92	1.32	3041.28	3033.8-3040.0	Y
H-3b2	2998.94	3000.06	1.12	3011.45	2995.1-3007.5	Y
H-4b	3001.07	3002.01	0.94	3005.61	2988.2-2992.1	**Y**
H-5b	3028.57	3028.90	0.33	3073.83	3060.4-3069.6	Y
H-6b	3052.50	3054.24	1.74	3066.48	3054.5-3061.0	Y
H-7b2	2997.54	2997.45	-0.09	2997.36	2994.1-2996.1	**Y**
H-9b	2991.31	Plugged with cement during H-9c P&A (February 2002)			2973.4-2977.7	N/A
H-10b	2994.70	Plugged and abandoned (January 2002)			3015.4-3029.9	N/A
H-10c	N/A	3025.71	N/A	3025.71	N/A	N/A
H-11b4	2984.65	2984.17	-0.48	3004.24	2990.2-3003.3	Y
H-12	2969.63	2970.72	1.09	3008.08	2993.1-3001.0	Y
H-14	Recompleted as Magenta well (April 2001)				3007.9-3021.0	N/A
H-15	Recompleted as Magenta well (April 2001)				3005.2-3019.4	N/A
H-17	2961.97	2963.15	1.18	3012.57	2985.9-2991.8	Y
H-18	Recompleted as Magenta well (April 2001)				3055.4-3067.3	N/A
H-19b0	2989.73	2990.96	1.23	3012.81	N/A	N/A
P-15	3015.60	Plugged and abandoned (February 2002)			3008.5-3013.8	N/A
P-17	2983.35	2984.39	1.04	2998.63	2981.0-2985.6	Y
P-18	3164.05	Plugged and abandoned (February 2002)			N/A	N/A
WIPP-12	3032.15	3033.29	1.14	3070.20	3062.7-3070.2	N
WIPP-13	3057.08	3058.00	0.92	3068.59	3059.1-3068.2	Y
WIPP-18	Recompleted as Magenta well (April 2001)				3048.9-3062.7	N/A
WIPP-19	3039.83	3041.22	1.39	3079.15	N/A	N/A
WIPP-21	3016.10	3017.33	1.23	3041.56	N/A	N/A
WIPP-22	3030.12	3031.51	1.39	3062.70	N/A	N/A
WIPP-25	3060.43	3062.32	1.89	3059.23	3043.6-3050.2	**Y**
WIPP-26	3021.40	3023.01	1.61	3023.15	3013.1-3014.8	**Y**
WIPP-27	3082.10	3082.39	0.29	3088.49	3075.5-3080.1	**Y**
WIPP-29	2967.06	2967.20	0.14	2970.39	N/A	N/A
WIPP-30	3067.85	3070.56	2.71	3077.69	3060.4-3067.6	**Y**
WQSP-1	3053.61	3055.28	1.67	3072.04	N/A	N/A
WQSP-2	3059.45	3060.89	1.44	3080.70	N/A	N/A
WQSP-3	3011.42	3012.61	1.19	3069.86	N/A	N/A
WQSP-4	2987.17	2988.42	1.25	3013.44	N/A	N/A
WQSP-5	3002.59	3003.97	1.38	3011.05	N/A	N/A
WQSP-6	3015.51	3016.45	0.94	3020.19	N/A	N/A

Bold **Y** signifies determination is independent of density uncertainty
NA = not applicable; data from well not used in CCA T-field calibration or data unavailable

For the remaining six of the 16 wells (H-4b, H-7b2, WIPP-25, WIPP-26, WIPP-27, and WIPP-30), the measured water levels exceed the CCA range before being converted to freshwater head. In these cases, conversion to freshwater head using any feasible fluid density can only increase the deviation from the CCA range. WIPP-25, WIPP-26, and WIPP-27 are located in Nash Draw where they may be affected by discharge of effluent from potash mines and mills. Changes in heads in Nash Draw might then propagate to the other wells, but at the present time this is only speculation. WIPP-30 is in close proximity to the Nash Draw boundary as well as the identified northern Salado dissolution re-entrant, both of which make it susceptible, although probably to a lesser degree, to the same influences as WIPP-25, WIPP-26, and WIPP-27. Several of the 16 wells with high heads are on or near the offsite-transport pathway through the Culebra modeled for the CCA.

Although Culebra heads in excess of the respective CCA ranges are not likely to affect compliance calculations, the cause(s) of the change needs to be understood to provide confidence in our conceptual understanding of the Culebra. The SA began an investigation of possible causes of the high heads in 2000 (SNL 2001a). In 2002, the SA began formalizing an integrated hydrology program plan, in conjunction with both WRES and the DOE CBFO, that outlines the path forward with respect to this investigation. The Strategic Plan for Groundwater Monitoring at the Waste Isolation Pilot Plant (DOE 2003d) was published in early 2003 and is the authorization document for groundwater activities. The integrated hydrology program plan further details the completion of a number of strategically placed new Culebra wells as well as several wells replacing Culebra wells that have been lost to deterioration. The new wells will be sited in order to investigate possible sources of the rising Culebra heads as well as to fill gaps in existing Culebra information. The WIPP Integrated Groundwater Hydrology Program Plan (SNL 2003b) was completed in March 2003 and the SA in conjunction with WRES and DOE CBFO have initiated this plan by drilling and completing four new wells (SNL-2, SNL-9, SNL-12, and SNL-3) in the Culebra. Hydraulic testing and water quality sampling of these new Culebra wells is currently being conducted by the SA. Three additional Culebra wells are scheduled to be drilled and tested in FY04. Data collected from these new Culebra wells will provide information with respect to the, as yet, unexplained Culebra water-level rises and the variable water quality.

Data from Other Units

Table 2.10 provides a comparison of water levels from units other than the Culebra from December 2001 to December 2002. Water levels in the Magenta were variable in many wells due to well activities such as recompletion, sampling, and/or hydraulic testing. Groundwater sampling was conducted at H-11b2, H-15, H-14, H-18, DOE-2, WIPP-18, and C-2737 and well maintenance activities were conducted at H-3b1 and H-10a explaining the large variations in water levels in these wells. The remainder of the Magenta well water levels changed by less than 2 feet. One new Magenta well was monitored in 2002: H-9c was recompleted as a Magenta well in January 2002.

Table 2.10. Summary of 2002 water-level changes in units other than the Culebra.

Well I.D.	12/01 W.L. (ft AMSL)	12/02 W.L. (ft AMSL)	2002 Change (ft)
Magenta Wells			
C-2737	3144.96	3141.61	-3.35
DOE-2	3058.12*	3068.99*	10.87
H-2b1	3147.19	3146.74	-0.45
H-3b1	3150.55	3130.39	-20.16
H-4c	3144.33	3143.29	-1.04
H-5c	3157.29	3157.00	-0.29
H-6c	3064.84	3065.52	0.68
H-8a	3026.83	3026.94	0.11
H-9c	Completed in January 2002	3133.30*	N/A
H-10a	3162.18	3220.04	57.86
H-11b2	3127.85*	3127.91*	0.06
H-14	3102.73*	3107.69*	4.96
H-15	3113.26*	3113.06*	-0.20
H-18	3077.51*	3079.37*	1.86
WIPP-18	3113.12*	3141.09*	27.97
WIPP-25	3050.54	3052.09	1.55
Dewey Lake Wells			
H-3d	3073.96	3074.92	0.96
WQSP-6a	3198.11	3198.22	0.11
Los Medaños Well			
H-8c	2979.22	2979.81	0.59
Forty-niner Well			
H-3d	3091.64	Well obstructed as of February 2002	N/A
Bell Canyon Wells			
AEC-8	3043.70	3062.35	18.65
CB-1	3014.66	3014.51	-0.15

N/A = not available
* = measured by SNL

Water levels were stable within one foot in both of the Dewey Lake wells and in the Los Medaños/Rustler-Salado well (H-8c). Access to the Forty-niner water level was lost in February 2002 due to an unknown obstruction in well H-3d.

The Bell Canyon water level in AEC-8 increased by 18.65 feet in 2002, continuing a rise of unknown origin dating back to 1993. The cause of this rise is currently under investigation. Water-level monitoring of the Bell Canyon began again in well Cabin Baby-1 (CB-1) in September 1999 after a 13-year hiatus. The water level was stable in 2002. At the end of 2002, the water level was approximately five feet lower than it had been in 1986, which may be attributed to differences in the density of the fluid in the well related to drilling-brine contamination.

As originally reported in the 2001 COMPs assessment, freshwater heads in several Culebra wells continue to be above the ranges used in the CCA. An investigation program has been initiated by the SA to assess long-term changes in the Culebra water levels. The general investigation approach is described in the SNL test plan titled, *Examining Culebra Water Levels* (SNL 2001a). Preliminary findings indicate that Culebra water levels are generally rising across the entire monitoring region. Water-level data compiled from various sources and dating back to 1977 indicate that regional water levels were rising when Culebra monitoring began and that this trend continues today. This new information and the water level data generated since the CCA will be incorporated into the groundwater conceptual model used in the recertification PA. Specifically, new T-fields will be generated and used in PA model Culebra flow and transport. These recertification activities will result in a new compliance baseline and ranges for Culebra water levels. The recertification PA will account for the water level rises seen in the COMPs data.

Changes in Groundwater Flow - 2003:

<table>
<tr><th colspan="5">Trigger Value Derivation</th></tr>
<tr><td>COMP Title:</td><td colspan="4">Changes in Groundwater Flow</td></tr>
<tr><td>COMP Units:</td><td colspan="4">Inferred from water-level data</td></tr>
<tr><td colspan="5">Related Monitoring Data</td></tr>
<tr><td>Monitoring Program</td><td>Monitoring Parameter ID</td><td>Characteristics (e.g., number, observation)</td><td colspan="2">Compliance Baseline Value</td></tr>
<tr><td>Groundwater Monitoring</td><td>Head and Topography</td><td>Monthly water-level measurements; annual pressure-density surveys.</td><td colspan="2">Indirect</td></tr>
<tr><td colspan="5">COMP Derivation Procedure</td></tr>
<tr><td colspan="5">Annual assessment from ASER data.</td></tr>
<tr><td colspan="5">Related PA Elements</td></tr>
<tr><td>Element Title</td><td>Type & ID</td><td>Derivation Procedure</td><td>Compliance Baseline</td><td>Impact of Change</td></tr>
<tr><td>Groundwater conceptual model, Transmissivity fields</td><td>NA</td><td>NA</td><td>NA</td><td>Provides validation of the various CCA models - T-field assumptions and groundwater basin model.</td></tr>
<tr><td colspan="5">Monitoring Data Trigger Values</td></tr>
<tr><td>Monitoring Parameter ID</td><td>Trigger Value</td><td colspan="3">Basis</td></tr>
<tr><td>Change in Culebra Groundwater Flow</td><td>CCA range; see Table 2.9</td><td colspan="3">Annual comparisons with ranges of undisturbed steady-state freshwater heads used to calibrate Culebra T fields for CCA.</td></tr>
</table>

2.4 Waste Activity

To date, Panel 1 has been filled with waste and Panel 2 waste emplacement has progressed in one of its seven rooms. Panel 1 waste emplacement ceased in September of 2002. However, the entire panel was not utilized as originally planned. Rooms four, five and six were not used with the exception of the access drifts at one end of each room. In a submittal dated April 26, 2001 [Docket A-98-49, II-B-3, Item 19], the DOE requested that EPA approve a different utilization plan for Panel 1. The flexibility to vary the utilization of Panel I was important from both a worker safety and operational efficiency perspective. The rooms of Panel 1 were over 12 years old at the time of the proposed change. The natural processes of room closure had reduced the vertical clearance to the extent that re-mining would be necessary to provide sufficient headroom and acceptable floor conditions for waste to be emplaced as described in the CCA, i.e., three containers high. Based upon the analyses performed by SNL, the DOE concluded that this request was not a significant departure from the original design and that aspects of the repository system important to waste containment would not be affected or changed. The EPA agreed with DOE's conclusion in a letter dated August 7, 2001 [Docket A-98-49, II-B-3, Item 19], stating, "DOE's proposed alternative use of Panel 1 is compliant with terms and conditions of WIPP's certification." It should be noted that there is no RH-TRU waste disposed in either Panel 1 or 2. Waste emplacement in Panel 1 was completed and the explosion walls were constructed. Panel 1 final utilization is shown in Figure 2.12. Underutilizing the panel eliminated approximately 30% of the available area. As such, this panel's waste activity assessment is not representative of other panels in the repository. Panel 2 waste emplacement started during final Panel 1 emplacement. Figure 2.13 shows waste emplaced during the reporting period for Panel 2. Panel 2 is expected to be fully utilized.

As of June 30, 2003, a total of 44,413 containers (representing 13,173 m^3) of CH TRU are currently stored at WIPP. No RH waste canisters have been emplaced in WIPP. Table 2.11 details the numbers and volumes of the various container types.

Table 2.11 Container numbers and volumes

Container Type	Number of Containers	Volume (cubic meters)
55 gallon drums	23,828	5,003.9
SWB	1,631	3,066.3
Pipe overpacks	17,999	3,779.8
85 gallon overpack	2	0.6
SWB overpack	104	195.5
Dunnage	221	131.9
Total	44,413	13,172.5

Other issues have arisen that impacts this year's waste activity COMPs assessment. EPA has provided guidance to DOE (EPA 2002a) directing them to include (in the CRA) an assessment of random versus non-random waste emplacement based on emplacement practices and current emplacement schedules. EPA has also directed DOE to include the most recent 40 CFR 194.4(b)(4) information in the CRA (COMPs reports are a part of the 194.4(b)(4) report).

Therefore, a complete assessment of the actinide COMP must be included in the CRA and the impacts of non-random emplacement must be assessed. The CRA assessment may identify a new actinide COMP assessment process that will be used in the next COMPs assessment.

Radionuclide inventory information is contained in Table 2.12. A comparison of the tracked actinides and the total repository inventory used in the CCA is detailed in Table 2.13. No other activity related assessment has been made at this time.

As discussed in the Trigger Value Derivation Report, Waste Activity COMPs assessments are not performed after half the panel is filled since small quantities do not yield statistically valid assessments. There are no TVs for CH activity, only RH. There are no recognized reportable issues associated with this COMP. No changes to the monitoring program are recommended at this time. A detailed waste inventory assessment will be provided in the CRA. A new actinide COMP assessment process may be evaluated prior to the first COMPs assessment after the CRA.

Waste Location By Month
Panel 1

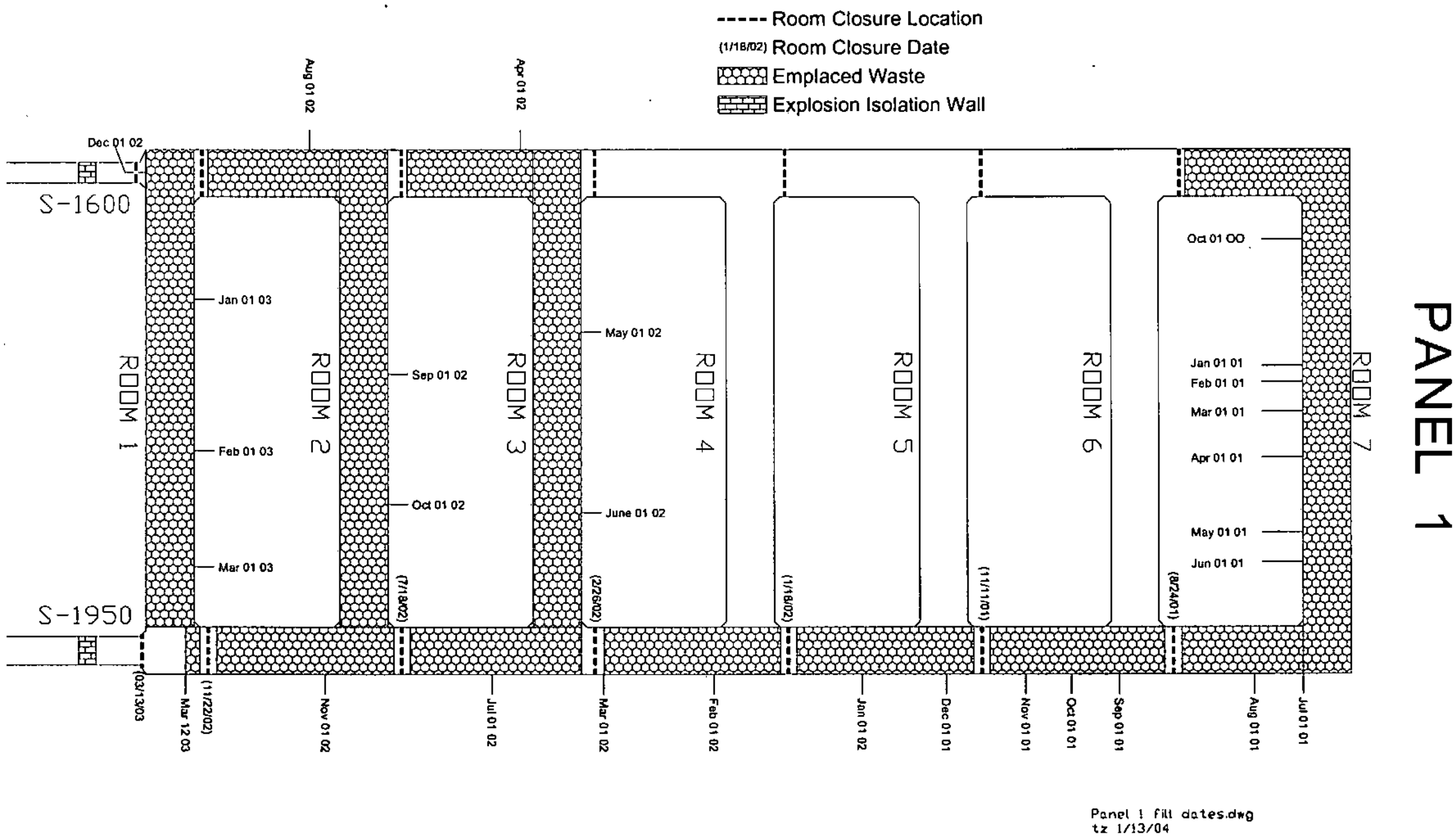

Figure 2.12 Panel 1 utilization

Waste Location By Month
Panel 2

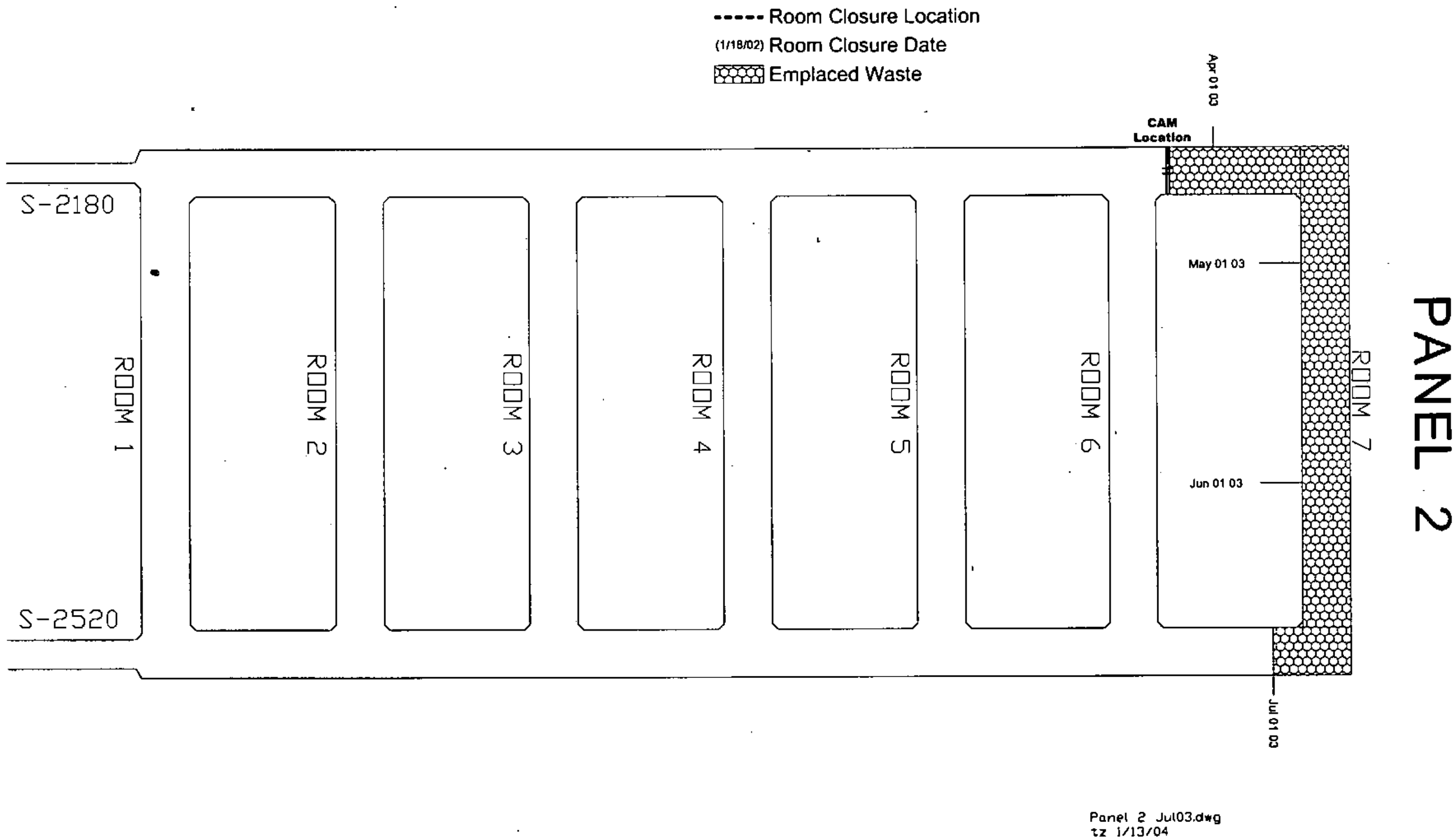

Figure 2.13 Panel 2 Utilization

Table 2.12 Radionuclide inventory information

Radiological Activity Inventory (curies)					
Radionuclide	Cumulative Activity in FY 2002 Annual Change Report	Reporting Period Activity	Total Activity as of June 30, 2003	Panel 1 Total	Panel 2 Total
^{227}Ac	3.6430E-04	1.8561E-03	2.2204E-03	6.6635E-04	1.5540E-03
^{241}Am	1.1612E+05	6.1822E+03	1.2230E+05	1.2016E+05	2.1384E+03
^{243}Am	4.6693E-03	4.5485E-01	4.5952E-01	1.3099E-02	4.4642E-01
^{60}Co	3.4700E-07	2.5024E-05	2.5371E-05	4.6696E-07	2.4904E-05
^{40}K	2.4657E-05	4.3406E-05	6.8063E-05	3.2699E-05	3.5364E-05
^{22}Na	5.3430E-06	3.1593E-02	3.1598E-02	5.3435E-06	3.1593E-02
^{237}Np	3.9646E-01	5.6382E-02	4.5284E-01	4.1511E-01	3.7734E-02
^{231}Pa	5.0402E-04	6.6244E-03	7.1284E-03	1.1926E-03	5.9358E-03
^{238}Pu	5.5253E+03	1.2659E+03	6.7912E+03	6.1858E+03	6.0543E+02
^{239}Pu	1.3434E+05	2.8822E+04	1.6316E+05	1.5198E+05	1.1178E+04
^{240}Pu	3.0255E+04	6.6154E+03	3.6870E+04	3.4288E+04	2.5820E+03
^{241}Pu	4.2491E+05	9.8134E+04	5.2304E+05	4.8203E+05	4.1011E+04
^{242}Pu	2.8772E+00	7.8342E-01	3.6606E+00	3.3183E+00	3.4235E-01
^{226}RA	7.8785E-06	1.2920E-07	8.0077E-06	7.8785E-06	1.2920E-07
^{230}Th	2.4100E-05	9.3810E-02	9.3834E-02	5.3370E-04	9.3300E-02
^{232}Th	2.6070E-06	4.2251E-05	4.4858E-05	1.4455E-05	3.0403E-05
^{233}U	2.4451E-01	1.8188E-01	4.2639E-01	4.1378E-01	1.2609E-02
^{234}U	1.1730E+00	1.2195E+00	2.3925E+00	1.5681E+00	8.2448E-01
^{235}U	1.1625E-01	2.5553E-02	1.4180E-01	1.3493E-01	6.8773E-03
^{238}U	6.1287E+00	1.8713E+00	8.0000E+00	7.5371E+00	4.6288E-01
^{90}Sr	0.0000E+00	7.5317E-01	7.5317E-01	3.8096E-05	7.5313E-01
^{137}Cs	3.2122E-04	6.1582E-01	6.1614E-01	5.0823E-04	6.1563E-01
Totals	**7.1116E+05**	**1.4103E+05**	**8.5219E+05**	**7.9467E+05**	**5.7518E+04**

Information from WRES, WWIS. Reporting period includes emplacement that occurred between 9-16-2002 and 6-30-2003

Table 2.13 Comparison of tracked radionuclide inventory to CCA inventory

Radionuclide CCA Table 4-10)	Non-Decayed Inventory as of June 30, 03	CCA Total Inventory at Closure	Percentage
^{241}Am	1.22E+05	4.48E+05	27.30%
^{238}Pu	6.79E+03	2.61E+06	0.26%
^{239}Pu	1.63E+05	7.95E+05	20.52%
^{240}Pu	3.69E+04	2.15E+05	17.15%
^{242}Pu	3.66E+00	1.17E+03	0.31%
^{233}U	4.26E-01	1.95E+03	0.02%
^{234}U	2.39E+00	5.08E+02	0.47%
^{238}U	8.00E+00	50.1	15.97%
^{90}Sr	7.53E-01	2.16E+05	0.00%
^{137}Cs	6.16E-01	2.24E+05	0.00%

Waste Activity - 2003:

Trigger Value Derivation				
COMP Title:	Waste Activity			
COMP Units:	Curies			
Related Monitoring Data				
Monitoring Program	Monitoring Parameter ID	Characteristics (e.g., number, observation)	Compliance Baseline Value	
WWIS	Radionuclide activity per container and volume	Curies per container. Container volume.	Appendix P of CCA Appendix BIR (DOE 1996) by waste stream.	
Waste emplacement records	Location of waste in panels	Coordinates and number of containers (or volume in cubic meters).	None.	
COMP Derivation Procedure				
Tabulation of waste activity in each panel. Total curie content of emplaced CH-TRU and RH-TRU waste. *[Total radionuclide inventories reported annually by WWIS]*				
Year 2003 COMP Assessment Value				
A comparison of emplaced and PA waste parameters is found in Table 2.13. No RH has been emplaced. Actinide totals and CPR totals are found in Appendix A of this document. EPA letters (EPA 2002a, 2002b and 2003) directed DOE to evaluate waste emplacement for Panel 1 and homogeneity issues in the CRA. Results of these ongoing activities will be used in the CRA and will redefine the COMP assessments process. EPA has acknowledged that the differences in Panel 1 waste inventory from CCA average characteristics are not significant, however EPA expects the CRA to examine the waste inventory impacts for emplaced and expected waste (EPA 2003).				
Element Title	Type and ID	Derivation Procedure	Compliance Baseline	Impact of Change
Radionuclide inventories	Parameter	Product of waste stream content and volume scaled up to the LWA limits.	Table PAR-41 and Table 4-8 of the CCA.	May affect direct brine releases for those radionuclides that become inventory-limited during a PA simulation.
Activity of waste intersected for cuttings and cavings releases.	Parameter	Function of waste stream volumes and activities	Figure 6-31 of the CCA	Cuttings are a significant contributor to releases. Therefore, an increase in activity of intersected waste is potentially significant.
WIPP-scale average activity for spallings releases	Parameter	Average of all CH-TRU waste only.	NA	Spallings are a significant contributor to releases. Therefore, an increase in average activity of intersected waste is potentially significant.

Monitoring Data Trigger Values		
Monitoring Parameter ID	Trigger Value	Basis
Waste emplacement records	Panel half-full	Check that PA assumptions about waste activity will remain valid as remainder of panel is filled and verify random emplacement assumptions.
Total emplaced RH-TRU waste activity	5.1 million curies	LWA emplacement limit reached. Administrative controls address these limits.

3 COMPs Assessment Conclusion

The operational period monitoring program designed to meet the Assurance Requirements of 40 CFR 191.14 and the terms of WIPP certification was initiated in 1999. This monitoring program is useful to further validate the assumptions and conceptual models that were used to predict WIPP performance and identify conditions that could potentially cause radioactive release above the allowable 40 CFR § 191.13 release limits. Since releases above these limits cannot occur during the operational period of WIPP, the monitoring program looks at other potential performance indicators of the disposal system and compares their behavior to PA performance expectations. Specifically, ten monitoring parameters are assessed and compared annually to PA expectations and assumptions. This is the last reporting period prior to submittal of the CRA. The CRA will contain the results of an updated PA that, upon acceptance from EPA, will become the new compliance baseline. As such, the compliance monitoring program will be reassessed and updated to reflect the conclusions of the new PA baseline. The results of this year's assessment are documented in this report and conclude that there are no COMPs data or results that indicate a reportable event or condition adverse to predicted performance.

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Wagner, Steve

From: Pfeifle, Tom W
Sent: Wednesday, June 23, 2004 10:10 AM
To: Wagner, Steve
Subject: RE: Delegation of signature authority

Steve,

The purpose of this email is to give you signature authority, in my stead, for signing the cover page of the 2003 COMPs Report, Rev. 1. I understand that changes made in this revision were primarily of an editorial nature.

-- tom pfeifle

-----Original Message-----
From: Wagner, Steve
Sent: Wednesday, June 23, 2004 9:24 AM
To: Pfeifle, Tom W
Subject: Delegation of signature authority

Hello Tom,
Steve Casey had comments on the COMPs report such that I had to revise it and publish rev. 1. I had to change things like the name of the DOE department in charge of compliance activities and reference to other DOE documents. I attached a redline of the report showing what I changed. Could you send me an email giving me signature authority for you so I can sign the cover page? Thanks and have a great week!
Steve Wagner

<< File: 2003 COMPs_rev 1_FINAL.doc >> SW 6-23-04