Recertification CARD Nos. 14/15
Content of Compliance Certification Application and
Compliance Recertification Application(s)

BACKGROUND (194.14 AND 194.15)

Section 194.15 states U.S. Environmental Protection Agency's (EPA or Agency) expectations for what should be in a compliance recertification application for the Waste Isolation Pilot Plant (WIPP). Much of the information requirements parallel the requirements of Section 194.14, which applied primarily to the original application. Because of the related nature of Sections 194.14 and 194.15, these sections are discussed together in this CARD. EPA's focus with this section is to require any compliance recertification application to include information on the changes to the disposal system and facilities since the previous certification or recertification. The information in this section is essentially updating the information in all aspects of the disposal system and waste related items. If items and assumptions have not changed, then EPA would not expect new information to be developed for those topics. It was EPA's intention that the 2004 Compliance Recertification Application (2004 CRA) should clearly reference and/or summarize such unchanged information.

For the 2004 CRA, EPA expected the U.S. Department of Energy (DOE or Department) to identify all systems and program changes implemented during the preceding five-year period. Any activity or assumption that deviated from what was described in the most recent compliance application would be considered a change. EPA also expected the 2004 CRA to summarize all changes that EPA reviewed and approved in the preceding five-year period (through modification of the certification or other processes). The Agency further expected the 2004 CRA to indicate where new baseline program elements have been established as a result of changes, and to show which parts of the application have been revised accordingly. These expectations were outlined in the Compliance Application Guidance (Docket A-93-02, Item II-B-29) and the Guidance to the U.S. Department of Energy on Preparation for Recertification of the Waste Isolation Pilot Plant with 40 CFR Parts 191 and 194 (Docket A-98-49, Item II-B3-14).

Commenters raised issues related to karst, although for the Compliance Certification Application (CCA) performance assessment EPA agreed that DOE appropriately ruled out karst as a feature that would occur at WIPP over the regulatory period. In this CARD, the Agency revisits the karst issue and the issues raised by the commenters. In addition to the discussion in 194.15(a)(1), Appendix 15-A responds to specific questions raised by commenters.

REQUIREMENT (194.14)

Section 194.14 requirements are listed in Appendix 14-A of this CARD. Baseline documentation for section 194.14 was established at the time of the original recertification and approved by EPA. See CCA CARD 14 for details of EPA's review and EPA's approval. Changes to section 194.14 topics areas since the original certification are required by Section 194.15 and discussed below in this CARD.

1998 CERTIFICATION DECISION (194.14)

EPA expected the Compliance Certification Application (CCA) to include, at a minimum, basic information about WIPP site and disposal system design. In general, DOE's characterization of the WIPP site and disposal system were discussed in Chapters 2 and 3 of the CCA (Appendices GCR, Hydro and MASS). Other characteristic, design, location and construction information was primarily provided in CCA Chapter 7 and Appendices BACK, DEL, PCS, and SEAL. EPA concluded that DOE adequately addressed geology, geophysics, hydrogeology, hydrology, meteorology, climatology, potential pathways, effects of waste and geochemistry of the disposal system and its vicinity and how these conditions are expected to change and interact over the regulatory time frame.

EPA thoroughly reviewed DOE's CCA and the additional information submitted by DOE, and determined that DOE complied with each of the requirements of Section 194.14, conditioned upon DOE's implementation of the most robust panel closure system design (designated as Option D) with a slight modification (ie., the use of Salado mass concrete instead of freshwater concrete).

A complete description of EPA's 1998 Certification Decision for Section 194.14 can be obtained from EPA Air Docket A-93-02, Items V-A-1 and V-B-2.

CHANGES IN THE CRA (194.14)

Baseline documentation for section 194.14 was established at the time of the original certification and approved by EPA. See CCA CARD 14 for details of EPA's review and EPA's approval. Changes to section 194.14 topics areas since the original certification are required by section 194.15 and discussed below in this CARD. Any changes since the CCA are documented in the CRA submitted by DOE and reviewed by EPA under section 194.15 requirements.

EVALUATION OF COMPLIANCE FOR RECERTIFICATION (194.14)

The intent for section 194.14, Content of Compliance Certification Application, was to provide the baseline information for the compliance application. In the CCA and supplemental information and the compliance performance assessment (the performance verification test or PAVT), DOE provided the baseline information on WIPP and important features, events and processes that could affect the disposal system's containment capabilities. The Option D panel closure requirement identified by EPA as a condition in the certification has been incorporated into DOE's performance assessments as required (see

2004 CRA CARD 23). Since DOE complied with the sections of 194.14 in the original certification, EPA finds that DOE complies with all sections of 194.14 for the 2004 CRA.

EPA did not receive any public comments on DOE's continued compliance with the requirements of Section 194.14.

RECERTIFICATION DECISION (194.14)

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.14.

REQUIREMENT (194.15(a)(1))

(a) "In submitting documentation of continued compliance pursuant to section 8(f) of the WIPP LWA, the previous compliance application shall be updated to provide sufficient information for the Administrator to determine whether or not the WIPP continues to be in compliance with the disposal regulations. Updated documentation shall include:

> (1) All additional geologic, geophysical, geochemical, hydrologic, and meteorologic information."

CHANGES IN THE CRA (194.15(a)(1))

Earthquake/Seismic Information

DOE updated information on earthquakes within 150 miles of WIPP. DOE identified that within 150 miles of WIPP, 14 earthquakes of Richter scale magnitude 3.0 or greater occurred between January 1, 1995, and September 30, 2002, the cutoff date for information for the PA. The largest was a 5.3 magnitude earthquake in Brewster County, Texas. For comparison, the largest earthquake identified in the CCA was 6.0 between 1926 and 1994. WIPP's design basis is for much larger earthquakes than that which has occurred in the immediate vicinity of WIPP (2004 CRA, Chapter 2). In response to an EPA question, DOE provided an updated Figure for the seismic events and a table listing the seismic events since 1926 (Docket A-98-49, Item II-B2-38).

Natural Resources

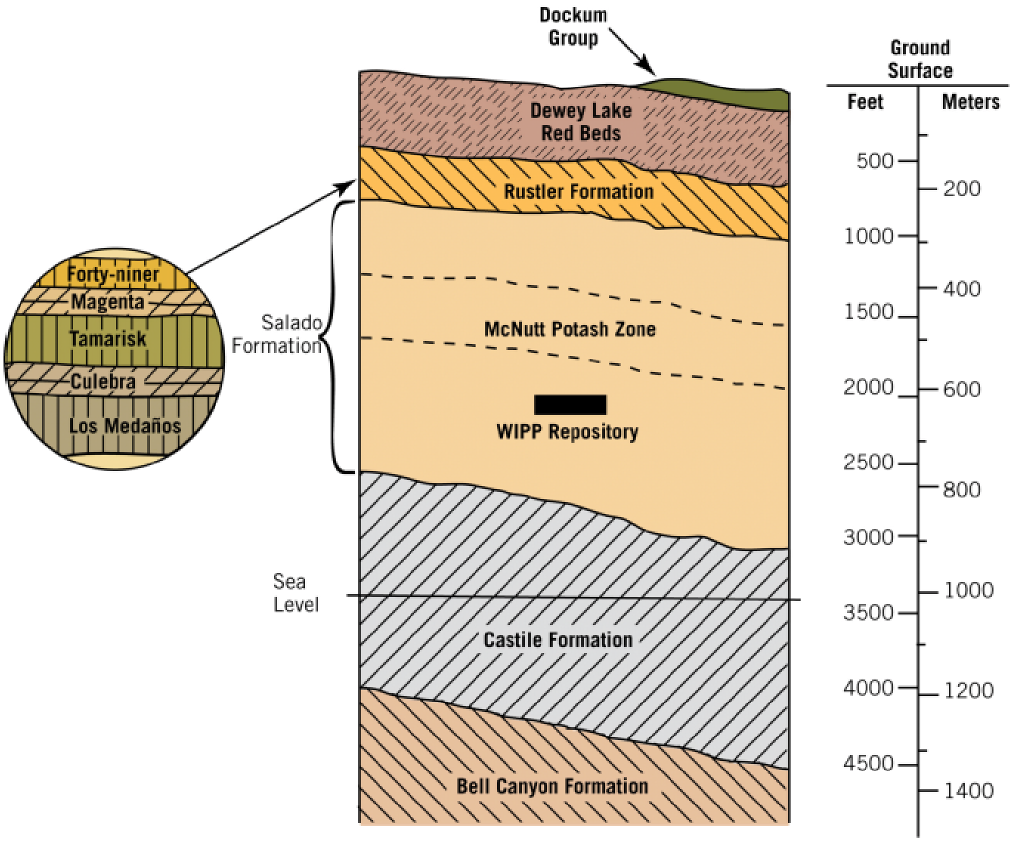
In the CCA much effort was devoted to identifying natural resource potential at the WIPP site. The major resources in the area are potash, oil and natural gas. DOE identified and EPA concurred that potash would not be mined above the waste area (CCA CARD 14) because the potash zone is considered to be barren above the waste area. This has not changed since the CCA. There is the possibility that oil and natural gas wells and associated fluid injection wells could affect the WIPP site and so remain part of the future WIPP scenarios. The deep drilling rate has increased to 52.2 boreholes per km^2 per 10,000 years from the 46.8 boreholes per km^2 per 10,000 years used in the original application. In response to comments from the public [Docket A-98-49, Item II-B2-39], EPA had DOE conduct an analysis on the effect of increased drilling at WIPP. The result indicates that WIPP would comply with the numerical release standards even if the current drilling rate doubled. In addition, there are new fluid injection wells in the vicinity of WIPP, however, the average injection rate has remained constant at 1,250 barrels of water per day/well. (Also see 2004 CRA CARD 23, Human Intrusion Technical Support Document (TSD) [Docket A-98-49 Item II-B1-10, CRA Section 45, CRA response to comments).

Hydrologic Issues

Geologic Model

At the WIPP site, the primary hydrologic unit of importance is the Rustler Formation because it directly overlies the Salado Formation. DOE stated that the units above the Salado (i.e. the Rustler, the Dewey Lake and the Santa Rosa) are classified as a single hydrostratigraphic unit for conceptual and computer modeling. The Rustler is of particular importance for WIPP because it contains the most transmissive units above the repository. In general, fluid flow in the Rustler is characterized by DOE as exhibiting very slow vertical leakage through confining layers and faster lateral flow in conductive units. Of the five members of the Rustler at the WIPP, the Culebra and the Magenta are considered conductive units, and the Los Medaños (formally Unnamed Lower Member), the Tamarisk, and the Forty-niner are considered confining units. Figure 15-1 is a stratigraphic column that shows the sequence of rocks at the WIPP. Table 15-1 summarizes selected hydrologic properties of the Rustler Formation.

Figure 15-1. Geologic Strata at the WIPP site.



In the CCA, EPA generally accepted DOE's characterization that the Culebra is a fractured dolomite with non-uniform properties, both horizontally and vertically (CCA CARD 14). The Culebra exhibits matrix (interparticle to vugular, and intercrystalline) and fracture (micro to macro) porosity. Flow within the Culebra occurs primarily within fractures, although flow also occurs within vugs where they are connected by fractures and, to some extent, within interparticle porosity where this porosity is higher. Flow in the Culebra is dominantly lateral and southward, although there are localized variations in the flow direction. (2004 CRA Figures 2-37a and 2-37b are contour maps of the equivalent freshwater hydraulic heads in the Culebra. The ground water flow direction is at approximately right angles to the contour lines.) DOE identifies that the Culebra transmissivity exhibits a bimodal distribution (2004 CRA Appendix PA, Attachment TFIELD). In areas where the Culebra dolomite has transmissivity less than 4 x 10^{-6} m^2/s ($10^{-5.4}$ m^2/s), the Culebra is considered to be dominated by single (matrix) porosity. Above this transmissivity the Culebra is believed to have dual porosity so that fractures and the dolomite matrix are important.

Table 15-1. Selected Rustler Formation Hydraulic Properties

Rustler Member	Hydraulic Conductivity1	Transmissivity	Thickness
Forty-niner	1 x 10^{-13} to 1 x 10^{-11} m/s (anhydrite)	8 x 10^{-8} to 8 x 10^{-11} m^2/s	13 to 23 m

[1] Lower numbered negative exponents indicate faster flow.

	1×10^{-9} m/s (mudstone)		
Magenta	$1 \times 10^{-8.5}$ to $1 \times 10^{-4.5}$ m/s	4×10^{-4} to 1×10^{-9} m^2/s	7 to 8.5 m
Tamarisk	1×10^{-13} to 1×10^{-11} m/s	$< 2.7 \times 10^{-11}$ m^2/s	26 to 56 m
Culebra	$1 \times 10^{-7.5}$ to $1 \times 10^{-5.5}$ m/s	1×10^{-3} to 1×10^{-9} m^2/s	4 to 11.6 m
Los Medaños	6×10^{-15} to 1×10^{-13} m/s	2.9×10^{-10} to 2.2×10^{-13} m^2/s	29 to 38 m

DOE stated that the Culebra is the most transmissive hydrostratigraphic unit at the WIPP site. The Magenta is the second most transmissive unit. New hydraulic data obtained for the Culebra and the Magenta confirms the range for transmissivity used in the CCA. Magenta well H-19b1, located just southeast of the site center, had a higher transmissivity (0.38 ft^2/ day or 4.1×10^{-7} m^2/s) than the previous “highest” transmissivity well, H-6a, located within the WIPP LWA boundary. The Magenta transmissivity at H-6a was reported in CCA Appendix Hydro to be 0.3 ft^2/day (3.2×10^{-7} m^2/s). DOE points out, however, that in all locations where both Culebra and Magenta wells have been tested, “the transmissivity of the Magenta is much lower than that of the Culebra” (Beauheim and Ruskauff, 1998).

The Culebra transmissivity characteristics appear to be zonal with higher transmissivity found in Nash Draw and lower transmissivity found to the east of the WIPP site boundary. In between these areas the Culebra transmissivity is variable. DOE postulates that this spatial transmissivity distribution is due to post-depositional processes and geologic controls (2004 CRA. Chapter 2, p. 2-107). Geologic controls are now believed to include overburden thickness, dissolution of the upper Salado, and the occurrence of halite in the mudstone Rustler units above and below the Culebra (ibid). DOE uses the observation of a bimodal distribution of transmissivity and these geologic controls in the development of the transmissivity fields used to calculate releases from the Culebra (2004 CRA, Chapter 2.2.1.4 and Appendix PA, Attachment TFIELD).

Changes in Water Levels

As part of DOE’s monitoring program, DOE is required to monitor the water levels in the Culebra. DOE monitors the Culebra in a network of over 30 wells. DOE also monitors a limited number of Magenta wells. In both units DOE has seen water level changes, but the source of the changes is unknown. DOE’s investigation of the water level changes has focused on the Culebra because it is identified as the primary potential pathway for groundwater releases at WIPP. The water level has generally tended to increase, although there was a noticeable increase in the rate in the late 1990s in some wells with a just as dramatic drop in the early 2000s (see for example 2004 CRA, Figure 2-36) for some wells. This increase was observed at the time of the CCA but became more widespread after DOE submitted the CCA. DOE notes, however, that the head distribution in the Culebra still indicates that the flow is generally in the same direction as previously reported. There are several theories to explain the water level increases, including potash mining and petroleum industry brine injection. Water level changes as a response to precipitation is not considered to be a viable theory because wells do not respond to precipitation events.

Change in Culebra Radionuclide Travel Time

Compared to the CCA, the 2004 CRA performance assessment (and in the performance assessment baseline calculations or PABC2) predicts a longer time for a particle to travel through the groundwater to the WIPP site boundary. DOE attributes the longer travel times to a reduced—relative to the CCA—hydraulic gradient from the north to the south across the site. This is primarily due to differences in how the Culebra water levels (heads) were determined in the CCA and the 2004 CRA. For the CCA head estimates, modelers had to contend with the Culebra water level responses to WIPP shaft construction and large-scale pumping tests at the WIPP site and different stages of responses for different wells. The modelers were thus forced to use heads measured in different years, thus adding uncertainty. For the 2004 CRA head estimates, DOE used only head data measured in 2000.

In addition, DOE believes there are other factors that play into longer travel times (2004 CRA, Appendix PA, Attachment TFIELD, page 127):

> "In the case of the [transmissivity] T fields unaltered for the effects of mining, the longer travel times are caused by a shift of relatively high Ts from the southeastern to the southwestern portion of the WIPP site relative to the CCA T fields. In the case of the T fields altered for full and partial mining, the longer travel times are the combined result of the westward shift of high Ts discussed above and a change in the definition of the areas to be mined that resulted in less water entering the Culebra on the WIPP site."

Inclusion of mining in the northern zone, that DOE had omitted previously, enhances the effect of mining on the transmissivity. The increased area of higher transmissivity due to mining is expected to divert more flow around the WIPP site, reducing the importance of any high transmissivity zones in the WIPP site (Docket A-98-49, Item II-B2-59). Thus, multiple factors are responsible for longer travel times, but the use of contemporaneous data with a lower gradient probably explains the longer travel time for the PABC when compared to the PAVT.

Retardation of Radionuclides (Distribution Coefficients or Kds)

Radionuclides may reach the Culebra member of the Rustler Formation because of brine flow through a borehole that intersects the waste in the repository. Radionuclides introduced into the Culebra may then be transported through natural groundwater flow. Predictions of transport and release of radionuclides through the Culebra are affected by sorption onto minerals along this potential pathway. Accordingly, DOE developed single-parameter distribution coefficients (K_ds) to express a linear relationship between sorbed and aqueous concentrations of the radionuclides (2004 CRA, Chapter 6, Section 6.4.6.2.1). No additional sorption experiments have been carried out since the CCA and PAVT. However, in support of the 2004 CRA, DOE did reanalyze the data and correct some minor errors to the values used in the PAVT. The changes resulted in minor reductions in the amount of retardation that would be expected.

Water in the Air-Exhaust Shaft

In 1995 DOE first identified water in the WIPP exhaust shaft at a depth of about 80 feet and began an investigation into the source of the water (2004 CRA Chapter 2.2.1.4.2.2). DOE drilled 12 wells around the site surface facilities. [See map on page 2-128 in 2004

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[2] EPA required DOE to conduct a second performance assessment, called the PABC. The PABC is discussed more thoroughly in the PABC TSD (Docket A-98-49 Item II-B1-16). A summary of changes is included in this CARD at section 194.15(a)(7).).

CRA Chapter 2.2.1.5] Water was typically encountered around 50-60 feet below the ground surface. One of the 12 wells was dry. Another 27 holes were hand-augured to a depth of 14 feet, and no water was detected in any of these boreholes.

DOE identified that the highest water levels in the test wells were near the salt water evaporation pond (2004 CRA Figure 2-40, ibid). The water flows from this high water level outward to other areas, including the exhaust shaft. No evidence of karst (large voids) was found in the 12 wells drilled through the Santa Rosa and into the Dewey Lake Formations.

DOE believes that the source of the water is from (1) runoff of rainfall into and infiltration from the retention ponds located to the south of the WIPP surface facilities, and (2) infiltration of saline waters from the salt storage area, the salt storage evaporation pond, and perhaps remnants of the drilling and tailings pit used during the construction of the WIPP salt shaft.

Karst

DOE reviewed the available site characteristic information pertaining to karst during the analysis for the original CCA and summarized relevant information in 2004 CRA, Chapter 2, section 2.1.6.2. Karst development is formed in rocks susceptible to dissolution, such as carbonates and evaporates, both of which are present at and around WIPP. In the region around WIPP, DOE identified that Nash Draw was developed, in part, through dissolution and contains karst features. However, DOE determined that the karst environment in Nash Draw does not extend to the WIPP site. EPA's analysis of the information available at the time of the CCA came to the same conclusion (CCA CARD 14 and CCA Response to Comments (Docket A-93-02, Item V-C-1)).

Due to public interest in the issue, DOE reanalyzed existing information related to karst, including specific topics of interest to commenters. DOE's study3 (Lorenz, 2005, Docket A-98-49, Item II-B2-53) concluded that "outside of Nash Draw, definitive evidence for the development of karst in the Rustler Formation near the WIPP site is limited to the horizon of the Magenta Member in drillhole WIPP-33." WIPP-33 is about 1 kilometer (0.6 miles) west of the WIPP Land Withdrawal Boundary. The overall conclusion of the report is that the evidence provided by proponents of karst does not withstand scrutiny, and extrapolation of the known karst features in Nash Draw eastward to the WIPP site is unwarranted (Docket A-98-49, II-B2-53).

Current climatologic and meteorological conditions in the vicinity

WIPP is located in the desert southwest with limited annual precipitation (< 11.1 inches on average from 1995 through 2002). With some exceptions, limited precipitation has been the norm since the retreat of the last ice sheet around 10,000 years ago. DOE provided information on the climate for the CCA with updated information provided on recent climatic

[3] EPA considers the Lorenz 2005 report a technical response to our request for more information related to karst; EPA does not believe this document is part of our completeness determination. It is a technical document reviewed as part of the Agency's final technical review related to the recertification.

conditions in annual reports (2004 CRA, Chapter 2.5.2). The 2004 CRA, Table 2-14 and Figures 2-49 through Figure 2-56 provide recent meteorological information. DOE did not alter the CCA assumptions about future climate in the performance assessment.

EVALUATION OF COMPLIANCE FOR RECERTIFICATION (194.15(a)(1))

Earthquake/Seismic Information

DOE provided information on recent earthquakes in 2004 CRA, Chapter 2. DOE concluded that any recent seismic activity is consistent with previous conclusions. Therefore, DOE did not need to change any analyses or calculations for the 2004 CRA related to the recent seismic data. EPA finds DOE's information to be adequate.

Natural Resources

DOE has done due diligence in keeping abreast of the drilling activities through the Delaware Basin Monitoring Program and has appropriately captured the drilling events that would affect the drilling rate used for the PA. In addition, DOE's analysis indicates that even a doubled drilling rate would not affect performance. Since the volume of fluids injected, per well, have remained the same since the CCA, EPA agrees that no additional consideration of this is necessary. No new information has arisen that would change the potash zone impact on the WIPP site. EPA finds this information to be adequate.

Hydrologic Issues

Geologic Model

EPA reviewed DOE's development of the transmissivity (T) fields (Docket A-98-49, Item II-B1-16) and concludes that it is adequate for the intended purpose of establishing base T fields for PA. However, while the geologic model provides a reasonable explanation of the transmissivity on the eastern and western areas around WIPP, there is enough variability in the data to reduce the model's predictive capability in the central region around the site. Nevertheless, the approach used to develop and implement the T fields using the MODFLOW and PEST computer codes is an improvement over the T field development process used in the CCA. EPA finds DOE's treatment of this topic to be adequate.

Changes in Water Levels

EPA agrees with DOE that the water levels in the Culebra and other units are most likely due to anthropogenic sources. Natural recharge can be eliminated because there is no response in well data to precipitation events. Because of the confined nature of the Rustler Formation units and the fact that the pumping tests in the Culebra indicate that pressure changes can be propagated throughout the vicinity of WIPP, the change in water levels is most likely due to natural resource extraction or fluid injection somewhere in the vicinity of WIPP. If this is the reason for the changes in water levels, then it would stop once the resource related activity ceased and its impact will be short term. Thus, the water level changes are believed to be a transient phenomenon. DOE has modified the transmissivity field to account for the changes in the water level rise since the CCA and incorporated the changes in the performance assessment. In addition, DOE is required to monitor the Rustler water levels, so any changes in water levels can be incorporated into future PAs. EPA finds DOE's approach to the water level changes to be adequate.

Change in Culebra Radionuclide Travel Time

EPA reviewed DOE's information in the 2004 CRA and supplemental information (Docket A-98-49, Item II-B2-35, response to comment G-7; Docket A-98-49, Item II-B2-59), and agrees with DOE that the reduction in the measured hydraulic gradient accounts for most of the increase in travel time. EPA finds that the longer travel times to be reasonable and based on appropriate data and modeling.

Retardation of Radionuclides (Distribution Coefficients or K_ds)

No additional sorption experiments have been carried out since the CCA and PAVT in support of the 2004 CRA. Based on the K_d ranges provided for the PAVT, the changes are small and all changes result in more conservatism, i.e., small K_d values, which should result in less sorption. The values used in the 2004 CRA PABC are acceptable because no new experimental sorption data are available, the changes to the K_d ranges are minor and conservative, and these results have been previously reviewed by the Agency (Docket A-98-49, Item II-B1-3). EPA finds this to be adequate.

Water in the Air-Exhaust Shaft

Beginning around 1995, DOE detected water flowing into the air exhaust shaft. Proponents of karst point to this water inflow as evidence of shallow karst at the site. DOE investigated this water inflow, which continues today. DOE drilled wells around the WIPP surface facilities, hit water around 50-60 feet below ground surface, and identified that the highest levels of water are around the salt evaporation pond and that water flows toward the exhaust shaft. DOE did not find any karst related features in the wells drilled for the characterization.

EPA reviewed the 2004 CRA and the supporting documents (Docket A-98-49, Item II-B1-18) and found DOE conducted a reasonable and thorough study of the source of the water inflow. EPA believes that DOE's explanation of infiltration from the WIPP facility adequately accounts for the water movement, and does not show evidence of karst.

Current climatologic and meteorological conditions in the vicinity

DOE updated the recent meteorological conditions in 2004 CRA, Chapter 2 to include the most recent meteorological conditions. These updates did not require changes in the modeling of future climate. DOE's treatment of the topic is adequate.

Karst

Background and Summary

In comments to EPA on the 2004 CRA, some members of the public continue to assert that the geologic characterization of the subsurface surrounding the WIPP repository does not adequately identify the presence of karst. As a result of these concerns, EPA evaluated information on the potential for the presence of karst at WIPP and the possible impacts on the long-term containment of waste for WIPP. For recertification, EPA conducted a thorough reevaluation of geologic and hydrologic information related to karst. Most of the information reviewed was developed at the time of the CCA, however, DOE continued to collected or analyzed data since the submission of the CCA. In addition, commenters identified documentation (e.g., the "Hill report" in Docket A-98-49, Item II-B3-76) that they wanted included in the review.

If substantial and abundant interconnected karst features were present at WIPP, such features could create a pathway that could increase the speed at which releases of radionuclides travel away from the repository through the subsurface to the accessible environment. Nash Draw, an elongate, dog-boned shaped depression located west of the WIPP site is know to contains karst features. Its origin is believed to be due to a combination of erosion and dissolution during past wetter climates ~500,000 or so years ago (Bachman, 1985).

The WIPP site does not appear to have been subjected to pervasive dissolution that would form karst as commenters claim. The data indicate that Nash Draw and the WIPP site are essentially two separate hydrologic systems under the current climate, have been that way for some time, and would be expected to remain relatively independent into the future. Precipitation events at the WIPP do not immediately, if at all, recharge the underlying units and the lack of runoff does not indicate karst below. Any significant recharge to the geologic units at the WIPP site appears to be the result of distal processes and/or from infiltration that takes thousands of years to reach the Rustler Formation. Precipitation events in Nash Draw, may result in noticeable effects in Nash Draw as might be expected in a karst environment. But, responses in Nash Draw provide little, if any, information about the WIPP site or the ability of WIPP to contain radionuclides.

Many of the arguments for karst that the commenters have made are the same or similar to those made during the original certification decision. In the 1998 certification decision, EPA concluded that dissolution is not an ongoing pervasive process at the WIPP site and therefore, karst feature development would not impact the containment capabilities of the WIPP for at least the 10,000-year regulatory period (CCA CARD 14). EPA's recertification review again comes to the same conclusion that karst will not affect WIPP's performance. Appendix 15-A of this CARD addresses some specific questions raised by commenters.

The Agency also requested that DOE/Sandia National Laboratories (SNL) conduct a separate analysis of the potential for karst and address issues raised by commenters. Major issues reviewed in the report (Lorenz, 2005) are: insoluble residues, negative gravity anomalies, specific well results, and recharge and discharge issues. This effort reaffirmed the previous analysis that karst processes had been active outside the WIPP site in Nash Draw, but not at the WIPP site. The report also concluded that many of the assertions made by proponents of karst at the WIPP site "tend to mix data, to take data out of context, and to offer theory as fact and to continue to offer misconceptions in the face of evidence."

Conceptual Understanding of Karst at and Around WIPP

As part of the effort to review the evidence for karst, EPA also made a site visit to re-examine the evidence of karst around the WIPP site and in nearby Nash Draw (Docket A-98-49, Item II-B3-93). EPA prepared a technical support document that discusses EPA's in-depth review of the karst issue (Docket A-98-49, Item II-B1-15). From this review, EPA has developed a better conceptual understanding of the disposal system and surrounding area.

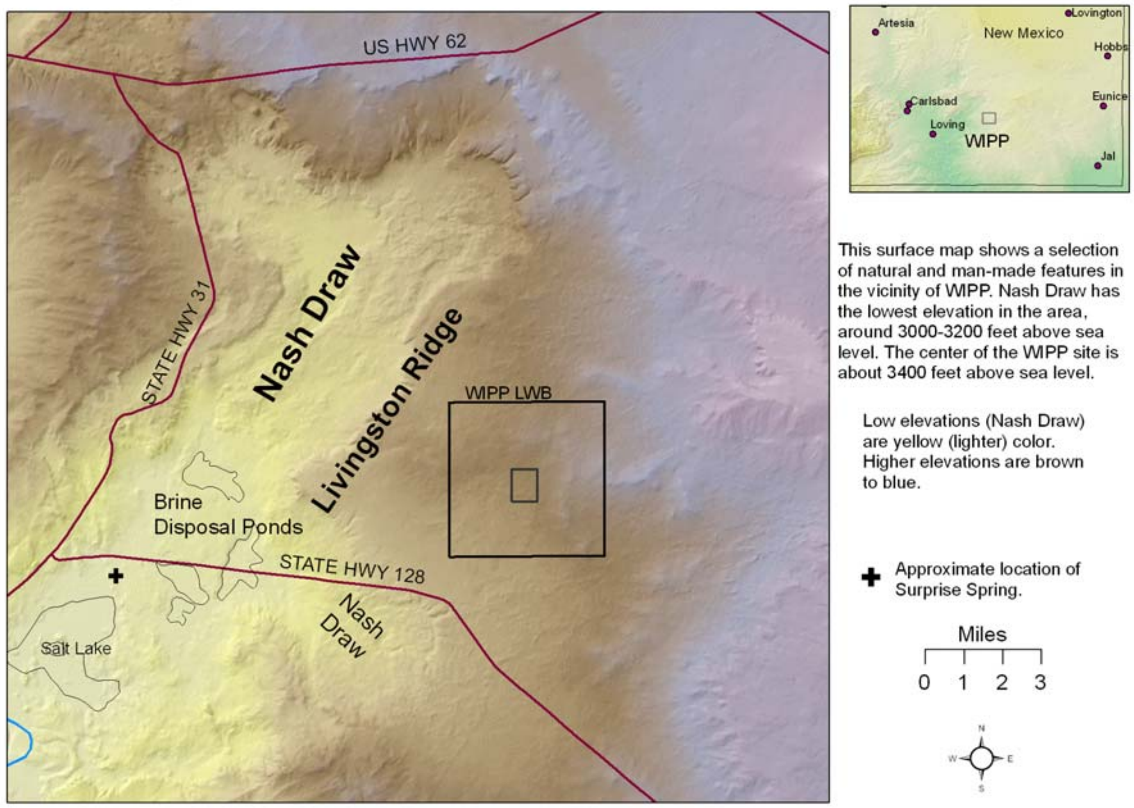
Because EPA's release requirements apply to the site, our primary interest is what happens at the WIPP site, that is, within the land withdrawal boundary (LWB), because the LWB defines the accessible environment. However, to get a better understanding of the WIPP site, it is useful to look at the area around the WIPP site. The land surface at the WIPP site generally slopes to the south and southwest. There is a topographic high, Livingston Ridge, northwest of the site, which is adjacent to Nash Draw, a topographic depression, further west (Figure 15-2).

Karst at Nash Draw

Around 12 million years ago, the Delaware Basin experienced regional tilting so that the rock layers are tilting down (dip) to the east. According to Bachman (1985) (CCA, Reference 26, Docket A-93-02, REFLST1), streams, represented by the Gatuña Formation, conducted water to what is now Nash Draw. Water possibly followed the regional strike, and with the combination of erosion and dissolution and associated collapse, formed Nash Draw. The tilting of the beds combined with erosion and dissolution brought the Rustler Formation to the surface or near the surface in Nash Draw today. However, this process did not have the same effect at the WIPP site where the Rustler Formation is currently more than 500 feet below the ground surface and 1,000 feet above the repository. WIPP is thus located in a region (e.g., Delaware Basin) where karst exists, however, the WIPP LWB does not appear to have undergone erosional and dissolution processes like Nash Draw, even though some proponents of karst believe it has (e.g., Phillips, 1987 in A-93-02, Item II-H-33).

Figure 15-2. The WIPP Site is to the East of Nash Draw and Topographically Higher Than Nash Draw. Response to Precipitation Events at Surprise Springs Reflect Flow in Nash Draw, but not at the WIPP Site, Which is Over 8 Miles From the Land Withdrawal Boundary.

Digital Elevation Map of WIPP and Nash Draw



The erosion and dissolution that created Nash Draw also created caverns and ponds. These appear to be supplied primarily by potash effluent from operations north of Nash Draw, although local precipitation can contribute to maintaining them. Also, Nash Draw contains diverted drainage, vanishing streams and the open sinkholes that capture them. Phreatophytes (plants with deep root systems, e.g., cottonwoods) indicating groundwater discharge areas are common in parts of Nash Draw. Because the water table is high in Nash Draw, the integrated system in Nash Draw can respond quickly to precipitation events.

It is possible that the Salt Lake and brine disposal ponds in Nash Draw represent the Rustler heads in central Nash Draw; if one extrapolates the Magenta head data from around Livingston Ridge into Nash Draw, the Nash Draw pond water levels appear to match what would be expected based on well data. Thus, there may be a transition zone at Nash Draw where at least the Magenta (which is stratigraphically and topographically higher than the Culebra) becomes unconfined where it is present. It appears to EPA that the Culebra transitions to an unconfined aquifer in the southern part of Nash Draw where it appears that the Culebra is near the surface and responds to irrigation practices (Lorenz, 2005, p. 85).

<u>Karst at the WIPP Site</u>

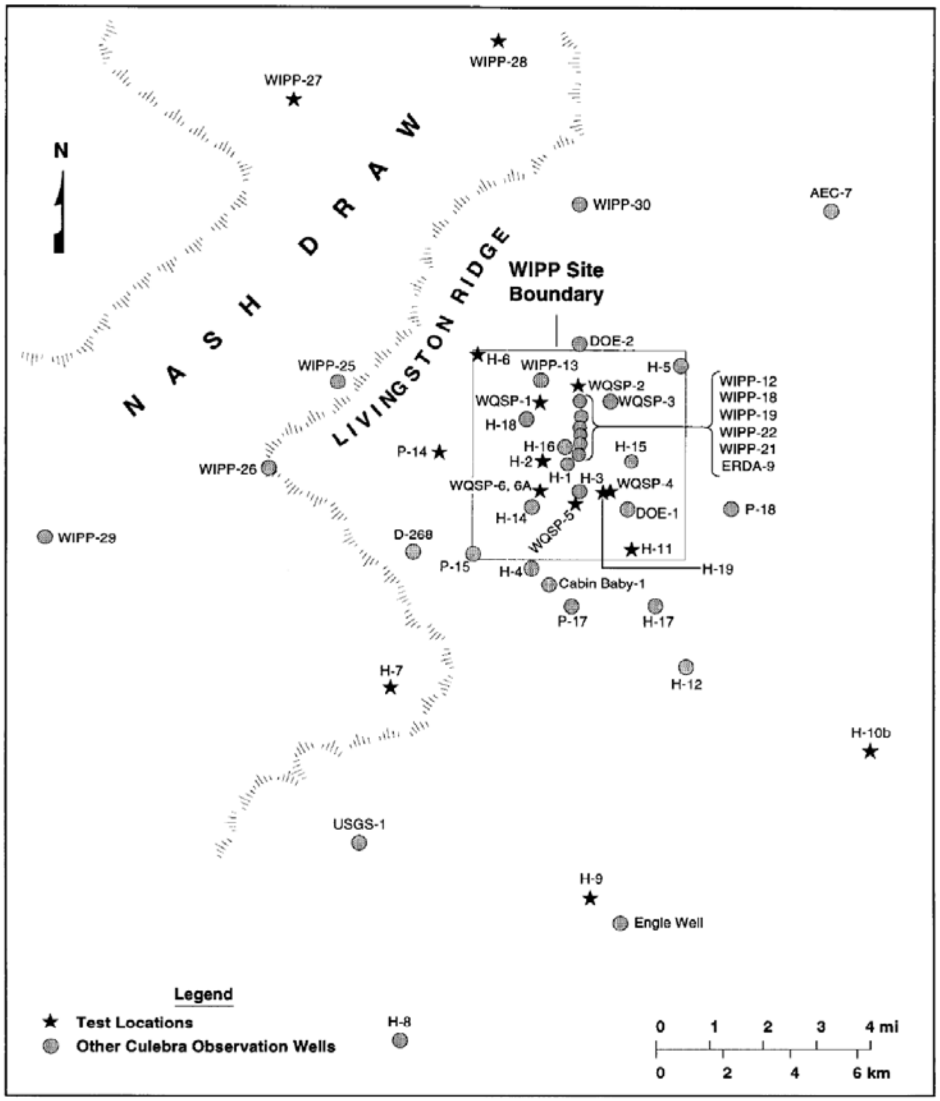
In contrast, the surface at the WIPP site—several hundred feet higher than the floor of Nash Draw—is characterized by sand dunes, caliche, and no discernable drainage systems. The dominant upland vegetation is a grassland shrub mix typical of eolian (wind blown) regions of the southern High Plains climatological region. Shrubs characteristic of the Chihuahuan desert are also observed. These species are also adapted to high evapotranspiration rates, which limit infiltration and recharge in these areas. Research into recharge in the desert southwest indicates that recharge through the floors of basins, such as at the WIPP site, is unlikely in the current climate because vegetation and evaporation alone can circumvent recharge (Walvoord et al, 2004).

The Rustler Formation above the waste area is over 500 feet below the ground surface and overlain by the Dewey Lake Formation, and in some places the Gatuña Formation, the Santa Rosa Formation over the eastern half of the site, and the widespread Mescalero caliche. In parts of the site, the Dewey Lake contains a sulfate cement that appears to retard downward movement of water (2004 CRA Chapter 2.2.1.4.2.1). These units are absent in Nash Draw. In the original certification decision, the Agency observed that the Mescalero caliche is almost continuous over the WIPP site. Because caliche only develops in arid areas with little vertical recharge, the presence of the Mescalero caliche indicates that there has been an arid climate and very low recharge conditions over a long period of time at the WIPP site (CCA CARD 14). The caliche, in combination with shifting sand dunes and vegetation and high transpiration, can explain the lack of surface runoff evidence, such as surface drainage channels, near the WIPP site.

<u>Karst and Hydrologic Data</u>

DOE has studied the WIPP site and vicinity for over thirty years (see Figure 15-3 for locations of Culebra well tests). New data is collected annually. In addition to the geologic studies, numerous pump test tests have been done, including large scale pumping tests (e.g., Beauheim and Ruskauff, 1998) and other analyses. DOE has provided these data and analysis results in the 2004 CRA and other reports. These data and their analyses provide information over large areas and form the basis for the performance assessment modeling and much of the discussion presented here. For example, in the 2004 CRA, DOE identified that the Culebra transmissivity is a function of overburden thickness—the deeper the Culebra, the lower the transmissivity (2004 CRA, Appendix PA, Attachment TFIELD). Superimposed on the depth are geologic factors such as the location relative to the margin of upper Salado dissolution and to halite in the M3/H3 interval of the Tamarisk.

Figure 15-3. **Locations of Culebra well tests.**



The Magenta and Culebra appear to have little real-time connection to one another as claimed by some commenters. Numerous pumping tests show that the Magenta and Culebra are independent of one another (Beauheim and Ruskauff, 1998; Meigs et al, 2000; 2004 CRA Chapter 2, section 2.2.1.4.1.2). Pump tests in the Culebra elicit no response from the Magenta. Even at WIPP-25 in Nash Draw, a pumping test conducted in 2004 indicates that the Magenta and Culebra are hydraulically isolated from one another (Lorenz, 2005, p. 63). This is typical for all pump tests performed. In addition water chemistry differences also point to lack of connections between the two units.

Hydrologic pumping tests do not indicate the presence of karst. By interrogating large volumes of water in a fractured system, these large scale pumping tests negate the need to have wells everywhere as some commenters suggest. In pump tests, the Culebra exhibits double porosity. The interpretation of the data is that pump tests initially capture fluid from

fractures and then fluid comes from the rock matrix. DOE has not seen evidence of continuous high inflows from “underground rivers” caused by karst development

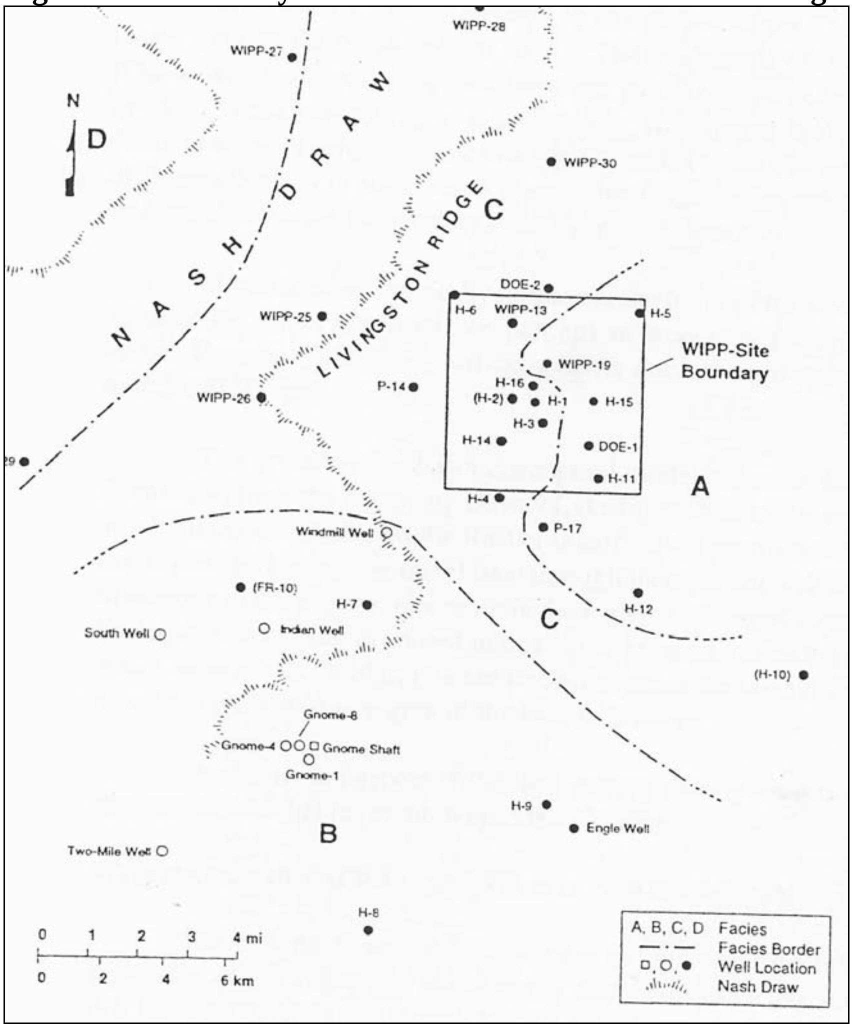
Ground water flow in the Culebra generally flows from the north to the south at the WIPP site and from the northeast to the southwest in Nash Draw. The Magenta ground water flows generally east to west across (see 2004 CRA, Chapter 2, page 2-122) the WIPP site and in Nash Draw, the Magenta appears to flow to the southwest. Thus, Nash Draw and the WIPP site exhibit groundwater flow differences in addition to the other differences discussed above. A major implication of this is that flow in Nash Draw is primarily along the axis of Nash Draw—from northeast to southwest. Therefore, flow in northern and central Nash Draw is primarily limited to inputs from within Nash Draw (e.g., potash effluent) and points north.

Corbet (1997) has inferred a recharge area for the Rustler south and west of the site in the southeastern part of Nash Draw with corresponding flow to the southeast, away from Nash Draw. This area corresponds to the hydrochemical Facies B of Siegel et al (1991) which has the lowest total dissolved solids in region around WIPP. This is one example where Corbet (1997) used the groundwater basin modeling to reasonably integrate the hydrogeochemistry of Siegel et al. (1991).

In the ground water basin model, the eastern part of the system is characterized by extremely slow horizontal and vertical flow, with high salinity (Facies A) (Figure 15-4). In the middle of the WIPP site (Facies C), the lateral flow is slightly faster, but still slow. Corbet (1997) estimates that it would take 20,000 years for water to flow across the WIPP site in Facies C. Vertical flow (specific discharge) would be 0.01 to 0.03 m/1000 years. The water in both facies have had long residence times and interacted with the anhydrite and halite in the system, thus reducing their reactivity and ability to dissolve rock under current climate or in the last several thousand years. Limited age dating of water at the WIPP site also indicates that the Culebra water is old (2004 CRA, Chapter 2, section 2.2.1.4.1.2). Flow is driven by recharge to the system over 8,000 years ago, especially greater than 14,000 years ago, during glacial times and the system is still equilibrating to that climate regime. The model indicates that only about 2 mm/yr recharge is necessary to produce the flow that we see today. This corresponds well to the research on recharge that shows it to be limited (Campbell et al, 1996; Hogan et al, 2004) in the WIPP region.

EPA believes that, on a regional scale, the groundwater basin model done by DOE reasonably predicts the current ground water flow regime and the geochemistry of the site.

Figure 15-4. Four Hydrochemical Facies in the Culebra Siegel et al. 1991



EPA also reviewed the commenter's allegations that a data point at the H-3 well had been falsified and led to an incorrect characterization of the Magenta Dolomite. Commenters stated that CCA, Appendix GCR (p. 6-53) indicated that the Magenta at well H-3 has high transmissivity that DOE does not account for in its modeling. Based on our understanding of the geohydrology in the area, evidence provided by DOE in its Magenta Transmissivity fact sheet and the raw data and graphs, and the fact that the CCA Appendix GCR data point is not confirmed by subsequent testing, EPA believes that the CCA Appendix GCR data point is an error. The remainder of the data indicates that the Magenta has generally low transmissivity—lower than the Culebra. The Magenta Dolomite has high transmissivity in Nash Draw, but the geologic processes that formed Nash Draw are different than what has transpired at the WIPP site. Thus, EPA still believes that the Culebra Dolomite is the more transmissive unit, and that it is appropriate to consider the Culebra Dolomite as providing the pathway that would lead to the most releases.

<u>Conclusions Related to Karst</u>

The hydrologic data, combined with geochemical and geologic information, and modeling, indicate that the WIPP site has not been subject to karst formation processes and the assumption of karst is not an appropriate representation of expected site conditions during the 10,000 year regulatory time period. DOE reviewed the information on karst in the performance assessment process and excluded karst features from the performance assessment calculations in the CCA and 2004 CRA and PABC. EPA has again reviewed data related to karst at WIPP and finds DOE appropriately excluded the effects of karst from the performance assessment calculations. The Lorenz report (Docket A-98-49, Item II-B2-53) and the EPA Karst TSD (Docket A-98-49, Item II-B1-15) provide a thorough discussion of the major issues as does EPA's response to comments in the 1998 Certification Decision (Docket A-93-02, Item V-C-1).

Our understanding of the disposal system indicates that the WIPP site characteristics are distinct from Nash Draw such that extrapolations of karst in Nash Draw have little bearing on the WIPP site. Recharge characteristics and resulting discharge are one example of misrepresentation of the data by commenters. Precipitation events that occur in Nash Draw affect Nash Draw but appear to be independent of the WIPP site. The use of Surprise Spring in Nash Draw (see Figure 15-2) as an indicator of karst at WIPP is inappropriate. Surprise Spring is over 8 miles from the WIPP LWB. With the northeast to southwest flow in Nash Draw and a water table that is near the surface, Surprise Spring discharges are only a result of precipitation events that affect Nash Draw. In contrast at the WIPP site, well head data shows no response to precipitation events.

Based on the discussion above, EPA's Karst TSD (Docket A-98-49, Item II-B1-15), Lorenz's report, and other information in the CCA, 2004 CRA, and EPA's original certification response to comments, the following reasons summarize why EPA does not believe that karst will be a pervasive process at WIPP that would affect WIPP's ability to contain radionuclides:

- Low precipitation, high evapotranspiration reduces the potential for infiltration
- Sulfate cement boundary in Dewey Lake toward the south and west
- Depth of Rustler is greater in the LWB than in Nash Draw and where WIPP-33 is located; this will reduce the possibility of reactive water reaching the Magenta and especially the Culebra
- Lack of response of water levels to precipitation events indicates no zones of measurable recharge in the Magenta and Culebra
- Hydrologic data indicate confined aquifers at the WIPP site, implying limited vertical recharge
- Ground water basin modeling indicates recharge is at a distance from the site
- Age of ground water appears to be old

- Lack of Magenta hydrologic response when Culebra is pump tested

- When Culebra is pump tested there is no evidence that "underground rivers" are present; in pump tests, the Culebra exhibits double porosity.

RECERTIFICATION DECISION (194.15(a)(1))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.15(a)(1).

BACKGROUND (194.15 (a)(2))

DOE provided monitoring data, analyses and results primarily in Wagner (2003) (Docket A-98-49, II-B2-38); 2004 CRA, Chapter 2 and 7.2; 2004 CRA, Appendix DATA; and 2004 CRA, Appendix MON 2004. The monitored parameters are listed in Table 15.2 (from CCA CARD 42, Table 42.2), reproduced here. In addition, EPA has kept abreast of this process since the CCA decision and done annual inspections of the parameter monitoring program to verify that DOE's process and monitor programs are adequate. EPA found DOE's parameter monitoring program and their response to changes in parameters to be in continued compliance with this requirement. For additional discussion of monitoring issues, see 2004 CRA CARD 194.42. Also, see 2004 CRA CARD 194.23-Models and Computer Codes for details related to the 2004 CRA PA calculations.

Table 15.2 – Monitored Parameters	
Geomechanical Parameters- -Creep closure, -Extent of deformation, -Initiation of brittle deformation, and -Displacement of deformation features.	**Waste Activity Parameter*-** -Waste Activity **Subsidence Parameter-** -Subsidence measurements
Hydrological Parameters*- -Culebra groundwater composition and -Change in Culebra groundwater flow direction.	**Drilling Related Parameters*-** -Drilling rate and -The probability of encountering a Castile brine reservoir.
*Parameters exhibiting changes since the CCA approval.	

REQUIREMENT (194.15(a)(2)

(a) "In submitting documentation of continued compliance pursuant to section 8(f) of the WIPP LWA, the previous compliance application shall be updated to provide sufficient information for the Administrator to determine whether or not the WIPP continues to be in compliance with the disposal regulations. Updated documentation shall include:

(2) All additional monitoring data, analyses and results.

CHANGES IN THE CRA (194.15(a)(2)

DOE documented monitoring relevant changes since the CCA in Wagner 2003; 2004 CRA, Chapters 2 and 7.2; 2004 CRA, Appendix DATA; 2004 CRA, Appendix MON 2004, and other parameter monitoring related documents.

EVALUATION OF COMPLIANCE FOR RECERTIFICATION (194.15(a)(2))

EPA reviewed Wagner 2003; 2004 CRA, Chapters 2 and 7.2; 2004 CRA, Appendix DATA; 2004 CRA, Appendix MON 2004, and other parameter monitoring related documents. EPA also confirmed that DOE has not modified any of the parameter selection arguments or conclusions since the original CCA, nor have the parameter monitoring programs been changed.

DOE determined that even though some monitor parameters have changed, no new parameters need to be added nor did the parameter monitor programs need to be modified. DOE did not change any argument or conclusion that justified why a parameter was considered significant or insignificant for the 2004 CRA, nor did DOE change their pre-closure or post-closure program plans or activities.

EPA did not receive any public comments on DOE's continued compliance with the requirements of Section 194.15(a)(2).

RECERTIFICATION DECISION (194.15(a)(2))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49) as well as 2004 CRA CARDs 23 and 42, EPA determines that DOE continues to comply with the requirements for Section 194.15(a)(2).

REQUIREMENT (194.15(a)(3))

(a) "In submitting documentation of continued compliance pursuant to section 8(f) of the WIPP LWA, the previous compliance application shall be updated to provide sufficient information for the Administrator to determine whether or not the WIPP continues to be in compliance with the disposal regulations. Updated documentation shall include:

(3) All additional analyses and results of laboratory experiments conducted by the Department or its contractors as part of the WIPP program

CHANGES IN THE CRA (194.15(a)(3))

Supercompacted Waste

DOE requested (Docket A-98-49, Item II-B2-15) EPA's approval for the disposal of supercompacted waste from INL. EPA required DOE to conduct several analyses of the effect of the denser waste form and higher amounts of cellulosic, plastic, and rubber materials (CPR) (see Docket A-98-49, Items II-B2-22 through B2-26 and Items II-B2-28 and II-B2-29). EPA's review of the subject culminated in an approval of the emplacement of the supercompacted waste in the WIPP and a requirement to keep the magnesium oxide safety factor at least 1.67 for the remainder of the panels (Docket A-98-49, Item II-B3-68).

STTP Experiments

DOE conducted source term test plan (STTP) experiments to provide data on the concentrations of actinides, actinide-containing colloids, complexing agents, and other chemical reactants in simulated WIPP brine in contact with candidate backfill materials and actual transuranic (TRU) wastes (Docket A-98-49, Item II-B1-3). DOE indicated that the results of experiments had no relevance to WIPP conditions, because of the high carbon dioxide overpressure and relatively low pH (2004 CRA, Appendix PA, Attachment SOTERM-4.8). The Environmental Evaluation Group (EEG) contended that the experiments were relevant and indicated the presence of nesquehonite, a form of magnesium oxide that would have contributed to higher actinide solubility than DOE used in the PA. The Agency reviewed the results of the STTP experiments and EEG's concerns and determined that the experiment with MgO was not relevant to repository conditions because of the high carbon dioxide partial pressure (See Docket A-98-49, Item II-B1-3, for a summary and additional references).

EVALUATION OF COMPLIANCE FOR RECERTIFICATION (194.15(a)(3))

EPA approved the supercompacted waste in a previous action (Docket A-98-49, Item II-B3-68), and the STTP experimental results were not applicable at WIPP, and therefore were not used in the WIPP performance assessment.

EPA did not receive any public comments on DOE's continued compliance with the requirements of Section 194.15(a)(3).

RECERTIFICATION DECISION (194.15(a)(3))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.15(a)(3).

REQUIREMENT (194.15(a)(4))

(a) "In submitting documentation of continued compliance pursuant to section 8(f) of the WIPP LWA, the previous compliance application shall be updated to provide sufficient information for the Administrator to determine whether or not the WIPP continues to be in compliance with the disposal regulations. Updated documentation shall include:

> (4) An identification of any activities or assumptions that deviate from the most recent compliance application

CHANGES IN THE CRA (194.15(a)(4))

DOE made changes to several specific activities and assumptions, and to several categories of items. These items are grouped in Table 15-3, but discussed primarily in other CARDS and Technical Support Documents (TSDs).

Table 15-3. List of Activities and Assumptions That Deviate from the CCA and PAVT.

Item	DOE	EPA Decision
Early closure of panel 1	DOE requested to close Panel 1 before completely filling all the rooms with waste	EPA approved the change (Docket A-98-49, Item II-B3-44).
Parameters and computer codes	DOE updated some parameters and computer codes since the CCA and PAVT.	EPA found the parameter changes to be reasonable. See CARD 23 and related technical support documents (Docket A-98-49, Items II-B1-6, II-B1-7, II-B1-8, II-B1-12, and II-B1-16).
Disposal system conceptual model and implementation	The disposal system conceptual model was changed and underwent a peer review.	DOE's conceptual model peer review was adequate and DOE appropriately implemented the change in PA. See 2004 CRA CARDs 23, 27.
Replacement of spallings release model with DRSPALL	DOE replaced the CCA spallings model with a new spallings model that was peer reviewed.	DOE's conceptual model peer review was adequate and DOE appropriately implemented the change in PA. See 2004 CRA CARDs 23 and 27.
MODFLOW and PEST	DOE replaced the previous ground water flow model and the model used to establish Culebra transmissivity fields.	DOE's change was an improvement over the CCA approach. See 2004 CRA CARD 23, the technical support document for section

Item	DOE	EPA Decision
		23 (Docket A-98-49, Items II-B1-8 and II-B1-16) and the discussion in 2004 CRA CARD 15 section (a)(1).
Move to clay seam G	DOE requested EPA to allow DOE to move the waste area roof and floor up ~2.5 meters to clay seam G.	EPA approved this change in a letter (Docket A-98-49, Item II-A3-24)
MgO amount	DOE reduced the amount of MgO by taking out the mini-sacks.	EPA approved the change in a letter (Docket A-98-49, Item II-B3-15)
Option D panel closure	EPA required DOE to install Option D of the CCA listed options.	Option D is included in the PABC.
Waste inventory update	DOE revised its estimate of waste volumes and radioactivity.	EPA reviewed the 2004 CRA information and supplemental information provided by in response to EPA's requests. EPA approved the updated inventory for use in the PABC. See the discussion in 2004 CRA CARD 24, the inventory review technical support document and the PABC review technical support document (Docket A-98-49, Items II-B1-9 and II-B1-16).
Chemistry changes, including gas generation rate change, effect of organic ligands on actinide solubility, actinide solubility, actinide solubility uncertainty changes	DOE updated some aspects of the actinide solubility	EPA's review identified some issues with DOE's waste chemistry changes. These were resolved and included in the PABC. See 2004 CRA CARD 24 and related technical support documents (Docket A-98-49, Items II-B1-3 and II-B1-15).

Item	DOE	EPA Decision
Methanogenesis		EPA's review identified some issues associated with DOE's methanogenesis assumptions. See the discussion in 2004 CRA CARD 24 and its Technical Support Document (A-98-49, Item II-B1-3).

EVALUATION OF COMPLIANCE FOR RECERTIFICATION (194.15(a)(4))

EPA's review of these changes is presented in multiple CARDs and TSDs. In addition, the changes were incorporated in the PABC (see CARDs 23 and 24; Docket A-98-49 Items II-B1-3, II-B1-10, II-B1-11, II-B1-15, II-B1-16, II-B1-17). EPA found DOE changes adequate and appropriately implemented in the 2004 CRA performance assessments.

EPA did not receive any public comments on DOE's continued compliance with the requirements of Section 194.14(a)(4).

RECERTIFICATION DECISION (194.15(a)(4))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.15(a)(4).

REQUIREMENT (194.15(a)(5))

(a) "In submitting documentation of continued compliance pursuant to section 8(f) of the WIPP LWA, the previous compliance application shall be updated to provide sufficient information for the Administrator to determine whether or not the WIPP continues to be in compliance with the disposal regulations. Updated documentation shall include:

> (5) A description of all waste emplaced in the disposal system since the most recent compliance certification or re-certification application. Such description shall consist of a description of the waste characteristics and waste components identified in §§194.24(b)(1) and 194.24(b)(2)

CHANGES IN THE CRA (194.15(a)(5)

DOE updated this information for emplaced waste at the WIPP, waste stored at the waste generator sites, and waste anticipated to go to WIPP. This is discussed in multiple locations in the 2004 CRA, including Chapter 4, Appendix DATA, and Attachment F: Transuranic Waste Inventory Update Report, 2003, and Appendix TRU Waste. This information is further updated for the PABC in the PABC Inventory Report (Docket A-98-49, Item II-B2-60).

EVALUATION OF COMPLIANCE FOR RECERTIFICATION (194.15(a)(4))

In DOE's updated waste inventory information (Docket A-98-49, Item II-B2-60), DOE kept the same categories of waste used in the CCA, so that the major changes were changes to waste volumes. The radioactivity of the waste is estimated to decrease from the CCA, the contact-handled TRU waste volume is greater than in the CCA, while DOE estimates that there is more remote-handled waste in the inventory than there is allowable space in WIPP. Prior to the submission of the 2004 CRA, DOE requested to dispose of supercompacted waste. After a thorough analysis, EPA allowed this waste in the performance assessment.

In addition, DOE proposes to dispose of some wastes from the Hanford waste site tank farms and what is known as K-Basin sludges. EPA allowed this material in the performance assessment since DOE may be able to demonstrate that it is TRU waste. DOE has proposed a public process to address the classification of the Hanford tank waste before DOE requests approval for disposal at WIPP. EPA identified that DOE appropriately provided the waste information and that the waste inventory is adequately included in the PABC. EPA's inventory review is discussed, at length, in 2004 CRA CARD 24 and the Technical Support Document for 194.24: Review of the Baseline Inventory used in the Compliance Recertification Application and the Performance Assessment Baseline Calculation (Docket A-98-49, Item II-B1-9).

RECERTIFICATION DECISION (194.15(a)(5))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49) as well as EPA's review discussed 2004 CRA CARD 24, EPA determines that DOE continues to comply with the requirements for Section 194.15(a)(5).

REQUIREMENT (194.15(a)(6))

(a) "In submitting documentation of continued compliance pursuant to section 8(f) of the WIPP LWA, the previous compliance application shall be updated to provide sufficient information for the Administrator to determine whether or not the WIPP continues to be in compliance with the disposal regulations. Updated documentation shall include:

> (6) Any significant information not previously included in a compliance certification or re-certification application related to whether the disposal system continues to be in compliance with the disposal regulations

CHANGES IN THE CRA (194.15(a)(6))

As part of the completeness review, EPA realized that the 2004 CRA PA calculations did not meet regulatory requirements that addressed uncertainty (40 CFR Part 194.34). EPA therefore required DOE to conduct another performance assessment. DOE conducted this additional performance assessment, termed the performance assessment baseline calculations (PABC). This PA replaces the 2004 CRA PA for compliance purposes. A summary of the PABC review, including changes in the PABC from the 2004 CRA PA, is provided below and more in depth in Technical Support Document for Section 194.23: Review of the 2004 Compliance Recertification Performance Assessment Baseline Calculation (PABC Review TSD) (Docket A-98-48, Item II-B2-15). The changes can be grouped into two major categories: waste inventory and modeling assumptions. Parameters were changed to accommodate these changes.

Waste Inventory

During its review of the 2004 CRA inventory, DOE uncovered several discrepancies and changed situations regarding the baseline inventory. Concurrent with the DOE review of the 2004 CRA inventory, EPA's independent review raised questions regarding completeness and technical adequacy of the 2004 CRA inventory. Based on its review, EPA required that the baseline inventory be revised for the PABC. Changes to the inventory between the 2004 CRA and the PABC include the following:

- Removal of double-counted waste streams at Hanford-RL
- Inclusion of pre-1970 buried waste streams from INEEL
- Adjustment of the volume and fissile grams equivalents of an important LANL waste stream
- Correction of all other errors detected in DOE and EPA audits of 2004 CRA inventory

In addition, EPA required that emplacement materials be added to the quantities of CPR in the baseline inventory. EPA verified that all changes to inventory parameters used in the PABC were correctly implemented (Docket A-98-49, Item II-B1-16). Based on its review of the process by which the 2004 CRA and PABC inventories were developed and implementation of EPA's required changes for the PABC inventory, the Agency concluded that the PABC baseline inventory was adequate for use in the performance assessment.

Modeling Assumptions

Microbial degradation of CPR may influence WIPP repository performance because of their effects on repository chemistry and gas generation. As a result of the Agency's review of the 2004 CRA, DOE changed the modeling of microbial degradation processes for the PABC. The 2004 CRA CARD 24 and the PABC review (Docket A-98-49 Item II-B1-16) describe the results of the Agency's review of these changes. Because of additional information developed since the PAVT related to microbial presence in diverse environments and microbial viability, the Agency found that the probability of significant microbial degradation of cellulosics should be increased in PA. The Agency therefore specified and DOE implemented a change in the microbial degradation probability for CPR materials from the probability of 0.5 used in the PAVT to 1.0 in the PABC. For the PABC, there was a 0.75 probability of degradation of cellulosics alone, with a 0.25 probability of degradation of plastics and rubber materials, as well as cellulosics. Consequently, microbial degradation of cellulosics was assumed to occur in all vectors in the PABC.

Because of the presence of abundant sulfates in brine and solid phases [anhydrite, $CaSO_4(s)$] in the Salado Formation, the Agency also specified that the PABC should include the assumption that excess sulfate in the repository would prevent the microbial degradation of CPR via the reaction that produces methane (methanogenesis). Therefore, for the PABC, all CPR degradation was assumed to take place via denitrification and sulfate reduction reactions, which resulted in the production of one mole of carbon dioxide (CO_2) for each mole of organic carbon consumed. During the review of the 2004 CRA PA, the Agency noted that additional experimental data were available since the PAVT related to microbial gas generation rates and requested that DOE assess the potential effects of these data on PA. DOE used the additional data to revise the gas generation rates. The revised approach assumed rapid initial gas generation followed by much slower, long-term rates. The Agency reviewed DOE's evaluation of the microbial gas generation rates and implementation of the revised microbial degradation probability and gas generation rates and found them to be appropriately implemented in the PABC.

The Agency also verified that methanogenesis was not included in the PABC – an assumption unchanged since the PAVT. As a result of these changes in microbial gas generation probability and rates, modeled repository pressures were lower for the PABC than for the PAVT. These lower repository pressures caused decreased spallings releases. However, direct brine releases (DBR) increased in the PABC relative to the PAVT due to changes in solubility discussed below and because lower gas pressures allowed for higher brine saturations in the repository.

Some aspects of the actinide solubility calculations and the development of uncertainty distributions were changed for the PABC (Docket A-98-49, Item II-B1-16). The methodology for modeling +III, +IV, and +V actinide solubilities using the Fracture-Matrix Transport (FMT) code remains unchanged since the PAVT. However, the thermodynamic database used by FMT was updated, including data for actinide solid phases and aqueous species and inclusion of data necessary for calculating the effects of organic ligands on actinide solubilities. The concentrations of organic ligands used in the solubility calculations were based on estimated inventory amounts of acetate, citrate, EDTA and oxalate and the minimum amount of brine required for DBR.

Since the PAVT, the Salado Brine formulation used in the solubility calculations changed from Brine A to GWB. Based on published data available since the PAVT, the Agency specified use of an increased fixed uranium(VI) concentration in the PABC (10^{-3} M) instead of the lower concentration (8.8×10^{-6} M) plus an estimated uncertainty range used in the PAVT. At the Agency's direction, DOE used the revised FMT thermodynamic database and available measured solubilities to develop new uncertainty ranges for the +III, +IV, and +V actinide solubility calculations for the PABC. These changes were reviewed by the Agency and found to be adequately documented and technically acceptable. The new data regarding complexation of actinides by organic ligands indicated that organic ligands could significantly affect the solubilities of the +III actinides. Because of the increased solubilities and associated uncertainties predicted for the PABC, DBR replaced spallings as the second-most important release mechanism at higher probabilities, behind cuttings and cavings. At low probabilities for the PABC, DBR becomes the most important release mechanism.

In the PAVT, 2004 CRA PA, and PABC, the Culebra member of the Rustler Formation is conceptualized as a horizontal, confined aquifer of uniform density. For fluid flow, the Culebra is assumed to be a heterogeneous porous medium with spatially varying transmissivity (T). A heterogeneous velocity field is used for radionuclide transport, but all other rock properties are conceptualized as constant (homogeneous) across the model domain. The Culebra is assumed to have two types of porosity; a portion of the porosity is associated with high-permeability features where transport occurs by advection, and the rest of the porosity is associated with low-permeability features where flow does not occur and retardation occurs by physical processes (diffusion) and chemical processes (sorption). This type of conceptual model is commonly referred to as double-porosity.

The key factors controlling fluid flow in the Culebra are the hydraulic gradient, transmissivity distribution, and porosity. In the Culebra conceptual model, the spatial distribution of transmissivity is important. In its review of the 2004 CRA, EPA determined that the approach taken by DOE to modify the transmissivity fields to include the effects of mining was not acceptable, not consistent with our regulation, and required a revised approach for the PABC. In developing transmissivity fields for the 2004 CRA, DOE had assumed a one-mile exclusion zone from potash mining around existing oil and gas wells. In the PABC, the potash mining area was assumed to involve all mined and unmined potash resources regardless of proximity to oil or gas wells.

The increase in transmissivity due to mining increases the relative flow rate through the mining zones, with a corresponding decrease in flow through the non-mining zones. This decrease in flow through the non-mining zones produces longer travel times for the mining scenarios. Comparing the full-mining scenarios of the PABC analysis to the CCA and 2004 CRA calculations, the median travel times are approximately 2.53 and 1.14 times longer, respectively. By eliminating the exclusion zone around the existing oil and gas wells, DOE has addressed the Agency's concern regarding the mining scenario. EPA has determined that this change has been properly implemented in the PABC.

Flow in the Salado is computed by the BRAGFLO code, which simulates brine and gas flow in and around the repository. BRAGFLO includes the effects of processes such as gas generation and creep closure. Outputs from the BRAGFLO simulations describe the conditions (pressure, brine saturation, porosity) and flow patterns (brine flow up an intrusion borehole and out anhydrite marker beds to the accessible environment) that are used by other software to predict radionuclide releases. EPA noted a number of necessary technical changes and corrections to the 2004 CRA. Additionally, EPA stated that a number of modeling assumptions used in 2004 CRA have not been sufficiently justified and that alternative modeling assumptions must be used. The issues and changes for the PABC that effect the BRAGFLO\NUTS portion of WIPP PA include:

- Inventory information was updated

- Parameters describing the bulk compressibility and residual gas saturation for the marker bed materials were changed to constants

- Changes to the parameter describing the probability of microbial gas generation in the repository were made

- Methanogenesis is no longer assumed to be the primary microbial gas generation reaction

- Microbial gas generation rates were revised to be consistent with, long-term laboratory experimental results

- The LHS software was revised.

The Agency concludes that changes to the computer codes for modeling Salado Formation flow and transport have been properly implemented, as have changes in conceptual models and model parameters. The Agency finds that the approach taken by DOE for the modeling the Salado is acceptable.

<u>Releases from the PABC</u>

Direct releases are defined as solid and liquid materials removed from the repository and carried to the ground surface through intrusion boreholes at the time of drilling. Direct releases occur in WIPP PA through cuttings and cavings releases, DBR, and spallings releases. Cuttings and cavings are the solid materials removed from the repository and carried to the ground surface by drilling fluid during the process of drilling a borehole that intersects the repository. Cuttings are the materials removed directly by the drill bit, and cavings are the materials eroded from the borehole walls by shear stresses from the circulating drill fluid. The contribution of mean cuttings and cavings releases to total mean radionuclide releases for the PABC are similar to the PAVT. Direct brine releases occur when contaminated brine originating in the repository is driven up an intrusion borehole to the ground surface by repository gas pressure.

Because of the increased actinide solubilities and associated uncertainties used in the calculations, and higher brine saturations caused by lower gas generation rates, the contribution of DBR to total mean direct radionuclide releases for the PABC was greater than for the PAVT. Spallings releases occur when solid waste is ejected through an intrusion borehole by repository gas pressures that exceed the estimated 8 MPa hydrostatic pressure of the drilling fluid. Spallings releases calculated for the PABC were lower than those calculated for the PAVT. This reduction in calculated spallings releases was caused in part by revisions to the spallings model. In addition, lower long-term microbial gas generation rates resulted in lower PABC spallings releases because of the prediction of lower repository pressures than the PAVT. Table 15-4 lists the results from the PABC, the 2004 CRA PA, and the CCA PAVT.

Table 15-4. CCA PAVT, CRA-2004, and CRA-2004 PABC Statistics on the Overall Mean for Total Normalized Releases (in EPA Units) at Probabilities of 0.1 and 0.001, All Replicates Pooled. From Table 6-1 of DOE's PABC report (Docket A-98-49, Item II-B2-60).

Probability	Analysis	Mean Total Release	90th Quantile Total Release	Lower 95% CL	Upper 95% CL
0.1	CCA PAVT	1.237E-1	1.916E-1	1.231E-1	1.373E-1
	CRA-2004	9.565E-2	1.571E-1	8.070E-2	1.104E-1
	CRA-2004 PABC	8.770E-2	1.480E-1	8.471E-2	9.072E-2
0.001	CCA PAVT	3.819E-1	3.907E-1	2.809E-1	4.357E-1
	CRA-2004	5.070E-1	8.582E-1	2.778E-1	5.518E-1
	CRA-2004 PABC	6.006E-1	8.092E-1	5.175E-1	6.807E-1

CL = Confidence Limit

There were no releases from transport up the shaft in the PABC and no disturbed releases through the anhydrite interbeds. Undisturbed releases through the anhydrite interbeds in the PABC were as much as 11 orders of magnitude smaller than the typical disturbed releases, and were therefore not significant contributors to total normalized releases.

Because cuttings, cavings, direct brine, and spallings releases account for an overwhelming majority of the total releases, the calculated total releases are most sensitive to uncertainties in the parameters governing these release mechanisms. In both the PAVT and the PABC analyses, total normalized releases were most sensitive to uncertainty in waste shear strength (WTAUFAIL), which is a key parameter governing cavings volumes. In the PABC, direct brine releases supplant spallings as the second-most important contributor to total releases and even surpass cuttings and cavings at low probabilities. The second most important variable in the PABC analysis is WSOLVAR3, a solubility multiplier added to the PABC analysis to represent uncertainty in solubilities for all actinides in the +3 oxidation state.

DOE made changes in the WIPP parameters for the PABC to accommodate the changes discussed above. The Agency reviewed the procedural adequacy of changes made to the parameter database for the PABC as well as the technical adequacy of all parameter database changes made since the PAVT. The review (Docket A-98-49, Item II-B1-16) showed that the parameters used in the PABC were technically acceptable and appropriately documented.

EVALUATION OF COMPLIANCE FOR RECERTIFICATION (194.15(a)(6))

DOE adequately responded to EPA's requests by including EPA requirements in the

PABC. EPA's main review of the PABC is provided in the PABC review document (A-98-49, Item II-B1-16) with additional discussion in CARDs 23 and 24. Based on our review, EPA finds that DOE adequately implemented EPA's required changes in the PABC. The PABC calculations show that the repository meets the numerical standards at 40 CFR 191.13 as well as the compliance assessment requirements for the undisturbed case.

EPA did not receive any public comments on DOE's continued compliance with the requirements of Section 194.15(a)(6).

RECERTIFICATION DECISION (194.15(a)(6))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.15(a)(6).

BACKGROUND (194.15(a)(7))

During the course of the completeness and technical review of the 2004 CRA, the Agency submitted numerous requests to DOE for additional information. The docket categories in which these can be found are listed below.

REQUIREMENT (194.15(a)(7))

(a) "In submitting documentation of continued compliance pursuant to section 8(f) of the WIPP LWA, the previous compliance application shall be updated to provide sufficient information for the Administrator to determine whether or not the WIPP continues to be in compliance with the disposal regulations. Updated documentation shall include:

> (7) Any additional information requested by the Administrator or the Administrator's authorized representative."

CHANGES IN THE CRA (194.15(a)(7)

During the course of the completeness and technical review of the 2004 CRA, the Agency submitted numerous requests to DOE for additional information. The docket categories in which these can be found are listed below.

The information submitted by DOE and commenters, and developed by EPA can be found in the following categories for EPA Air Docket A-98-49.

1. QA Audits/Inspections, and their approvals -- **Category II-A1.**

2. WC Audits/Inspections, and their approvals -- **Category II-A4.**
3. Background/support documents (i.e., TSD's, fact sheets) -- **Category II-B1.**
4. Correspondence/information submitted by DOE (including responses to EPA requests, e.g., 2004 CRA completeness and technical issues) -- **Category II-B2.**
5. Correspondence/information sent to DOE by EPA (including completeness and technical requests for additional information) -- **Category II-B3.**
6. 2004 CRA CARDs -- **Category V-B2.**

EVALUATION OF COMPLIANCE FOR RECERTIFICATION (194.15(a)(7)

The information provided by DOE is reviewed by DOE in the CARD and Technical Support Documents related to the particular topic. DOE responded to all requests for information made by EPA.

RECERTIFICATION DECISION (194.15(a)(7)

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.15(a)(7).

REQUIREMENT (194.15(b))

(b) "To the extent that information required for a re-certification of compliance remains valid and has been submitted in previous certification or re-certification application(s), such information need not be duplicated in subsequent applications; such information may be summarized and referenced."

CHANGES IN THE CRA (194.15(b))

DOE provided information in a format similar to that provided for the CCA. This included a main volume with appendices. DOE did summarize topics and provided new information where appropriate. DOE did consolidate some appendices relative to the CCA

and did not submit appendices which did not change (e.g., the Geological Characterization Report of Appendix GCR).

EVALUATION OF COMPLIANCE FOR RECERTIFICATION (194.15(b))

DOE provided relevant information from the CCA and updated information in the 2004 CRA and in response to EPA's requests, including a new performance assessment.

EPA did not receive any public comments on DOE's continued compliance with the requirements of Section 194.15(b).

RECERTIFICATION DECISION (194.15(b))

Based on a review and evaluation of the 2004 CRA and supplemental information provided by DOE (FDMS Docket ID No. EPA-HQ-OAR-2004-0025, Air Docket A-98-49), EPA determines that DOE continues to comply with the requirements for Section 194.194.15(b).

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APPENDIX 14-A
REQUIREMENTS (194.14)

§ 194.14 Content of compliance certification application.

Any compliance application shall include:

(a) "A current description of the natural and engineered features that may affect the performance of the disposal system. The description of the disposal system shall include, at a minimum, the following information:

(1) The location of the disposal system and the controlled area;

(2) A description of the geology, geophysics, hydrogeology, hydrology, and geochemistry of the disposal system and its vicinity and how these conditions are expected to change and interact over the regulatory time frame. Such description shall include, at a minimum:

(i) Existing fluids and fluid hydraulic potential, including brine pockets, in and near the disposal system; and

(ii) Existing higher permeability anhydrite interbeds located at or near the horizon of the waste.

(3) The presence and characteristics of potential pathways for transport of waste from the disposal system to the accessible environment including, but not limited to: Existing boreholes, solution features, breccia pipes, and other potentially permeable features, such as interbeds.

(4) The projected geophysical, hydrogeologic and geochemical conditions of the disposal system due to the presence of waste including, but not limited to, the effects of production of heat or gases from the waste."

(b) "A description of the design of the disposal system including:

(1) Information on materials of construction including, but not limited to: Geologic media, structural materials, engineered barriers, general arrangement, and approximate dimensions; and

(2) Computer codes and standards that have been applied to the design and construction of the disposal system."

(c) "Results of assessments conducted pursuant to this part."

(d) "A description of input parameters associated with assessments conducted pursuant to this part and the basis for selecting those input parameters."

(e) "Documentation of measures taken to meet the assurance requirements of this part."

(f) "A description of waste acceptance criteria and actions taken to assure adherence to such criteria."

(g) "A description of background radiation in air, soil and water in the vicinity of the disposal system and the procedures employed to determine such radiation."

(h) "One or more topographic map(s) of the vicinity of the disposal system. The contour interval shall be sufficient to show clearly the pattern of surface water flow in the vicinity of the disposal system. The map(s) shall include standard map notations and symbols, and, in addition, shall show boundaries of the controlled area and the location of any active, inactive, and abandoned injection and withdrawal wells in the controlled area and in the vicinity of the disposal system."

(i) "A description of past and current climatologic and meteorologic conditions in the vicinity of the disposal system and how these conditions are expected to change over the regulatory time frame."

(j) "The information required elsewhere in this part or any additional information, analyses, tests, or records determined by the Administrator or the Administrator's authorized representative to be necessary for determining compliance with this part."

APPENDIX 15-A

In the original Compliance Certification Application performance assessment, EPA agreed that DOE appropriately ruled out karst as a feature that would occur at WIPP over the regulatory period (see CCA CARD 14 and CCA response to comments). However, in the 2004 CRA, commenters again raised issues related to karst. Appendix 15-A responds to selected questions raised by commenters. In the 2004 CRA, DOE again omits karst features in the performance assessment. As discussed in the main body of CARD 15, EPA again agrees with DOE that karst features can be omitted from the performance assessment.

Topic	Commenter Concern	EPA Response
H-3	CCA Appendix GCR data point shows there is high transmissivity indicative of karst in the Magenta at the H-3b1 location. Commenters believed DOE falsified a data point from the well to hide karst and make the Magenta appear less transmissive than what DOE claims.	Based on multiple measurements over time, DOE believes the transmissivity of the Magenta at well H-3 to be between 0.1 and 0.2 ft^2/day. The H-3 well of CCA Appendix GCR (p 6-53), now known as H-3b1, reported 360 gallons in 6 hours being pumped during its first Magenta testing in 1977. This could be indicative of very high transmissivity. However, DOE has measured much lower transmissivity in later tests in the same well. EPA reviewed the data (Docket A-98-49, Item II-B3-90) and agrees with DOE in its Magenta Transmissivity Fact sheet that the original testing was in error. DOE provided a chronology of the well testing that indicated the well testers used the H-3 (now known as H-3b1) well to measure both Magenta and Culebra water levels. Initial measurements showed that the Culebra and Magenta appeared to have nearly the same water levels in this well. After the Culebra water levels were initially measured, the two formations were separated by a removable plug (production injection packer or PIP). The Magenta water levels were measured after the PIP was installed and water levels similar to the Culebra water levels were recorded. The PIP apparently failed and allowed Culebra water to flow and combine with the Magenta water. After the PIP was modified to allow Culebra water to move through tubing in the packer, water levels in the Magenta and Culebra eventually stabilized at much different levels. Five months after the disputed test, the Culebra water level stabilized around 407 feet below ground surface (bgs) and the Magenta water level stabilized at around 248 feet below ground surface. Subsequent measurements and testing have indicated that the water levels in the Culebra and Magenta have maintained separate levels, unlike the initial measurements, and that pumping tests in other wells identify a lack of communication between the two units.

Topic	Commenter Concern	EPA Response
		During the 1995 and 1996 H-19 Culebra pumping test, the H-3b1 Culebra zone responded to pumping while the Magenta showed no change. In addition, transmissivity tests in 1979 and 1989 corroborate the low transmissivity (0.1 and 0.2 ft^2/day) in the Magenta at this well. This information indicates to EPA that there were testing problems with the initial test in 1977 and that later tests confirmed much lower transmissivity in the Magenta at H-3. Thus, EPA's interpretation is that well H-3 indicates that karst processes have not created high transmissivity at H-3, and that the commenters' claim of falsified data is erroneous and ignores subsequent data collected at the well.
H-6	H-6 has a similar head in the Magenta and Culebra, indicating karst and communication between the two units.	At H-6, the Magenta and Culebra do have similar measured water levels. At H-6, hydrologic data, however, indicate that the Culebra and Magenta are clearly not well connected despite the similar heads. During the WIPP-13 multipad pumping test, approximately 18 ft of drawdown was observed in H-6a and H-6b, both completed in the Culebra, while no response was observed in H-6c completed to the Magenta (Beauheim 1987--CCA Reference 42). Culebra and Magenta water qualities at H-6 are also distinctly different (Randall et al. 1988). With respect to Snow's assertion that heads are equal in the Magenta and Culebra at Wells H-6, WIPP-13, WIPP-33, and WIPP-25, Beauheim (EPA Air Docket A-98-49, Item B2-64) (p.3) points out that for WIPP-13 and WIPP-33, no Magenta measurements have ever been performed at WIPP-13, and no monitoring of either the Culebra or Magenta was performed before WIPP-33 was plugged and abandoned, so Snow's assertion of equal heads at those two wells is baseless.
WIPP-13	Evidence at WIPP-13 indicates karst.	Lorenz (2005) notes that the drillhole at WIPP-13 penetrated a normal stratigraphic section with only localized, apparent brecciation of a thin sulfate bed within the Tamarisk mudstone unit. Beauheim 1987 (CCA Reference 42) concludes that the Culebra exhibits double-porosity, with higher permeability and lower storage in the fractures and rock matrix primary porosity with lower permeability and higher storage. No response was seen in Magenta wells, including H-6 just to the northwest of WIPP-13. Lorenz 2005 (p. 109) observes that the breccias found in WIPP-13 could be interpreted in several different ways. The lower interval is most easily explained as a limited zone of dissolution adjacent to the water-bearing Culebra, whereas the upper interval is probably of syndepositional origin.

Topic	Commenter Concern	EPA Response
		Some of the well-test data may be ambiguous, but they are not suggestive of karst-type flow of the Rustler waters. EPA agrees that no karst-type flow exists at WIPP-13 and the double-porosity model adequately characterizes ground-water flow at the well.
WIPP-13, WIPP-14 and gravity anomalies	Hill (1999, pp. 37–40; 2003, p. 205) asserts that negative gravity anomalies indicate the presence of karst across the WIPP site. Most of Hill's discussion revolved around the WIPP gravity survey (Barrows et al. 1983).	Hill 1999 (Docket A-98-49 Item II-B3-76, pp. 37–40) cites the Barrows et al. 1983 report as showing four "sharp" negative gravity anomalies that are "consistent with" solution caverns, although only the WIPP-14 and WIPP-33 anomalies were discussed and attributed to subsurface karsting by Barrows et al. 1983. Barrows et al. 1983 calculated that the depth to the top of the "causative structure" that is responsible for the WIPP-14 gravity anomaly is shallow, not more than 225 ft below the surface. This depth puts the inferred deficiency in mass, i.e., karst, within the Dewey Lake Formation, reported to lie between the depths of 141-639 ft in this hole (SNL and USGS 1981). This does not correlate to the two zones (300–400 ft, and 650–750 ft) where Barrows et al. calculated the presence of mass deficiencies from the density logs, or with the concept of karst development being in the Rustler formation. Barrows et al. 1983 noted that seismic data at the WIPP site above the Castile Formation "are considered too unreliable to map" (Barrows 1983, p. 16), yet later in the report (p. 57) used this shallow seismic data in the vicinity of WIPP-14 to infer that "a seismic time syncline [is] coincident with the [shallow] negative gravity anomaly. Both the seismic time syncline and the negative anomaly are explained by lateral velocity and inferred density variations comparable to those observed in uphole velocity surveys." WIPP-14 was sited to investigate the possibility that a circular surface topographic depression, about 700 ft in diameter, 10 ft deep, and located above the axis of a much larger gravity anomaly, is large enough to have collected sufficient water to create a major sinkhole. Hill (1999) suggests that the conversion of anhydrite to gypsum in certain beds, and a calculated mass deficiency related to that conversion, indicate karst in the subsurface even though the hole did not penetrate or recover evidence for karst. Lorenz 2005 (p. 110) responds with the following discussion: "Most of the units above the Rustler were cored in WIPP-14, but only the top and bottom of the Rustler Formation itself

Topic	Commenter Concern	EPA Response
		were cored, as intended (see Appendix B, page 1; Sandia National Laboratories and D'Appolonia Consulting Engineers, 1982). The lithology penetrated by the rest of the hole was reconstructed from cuttings and the geophysical logs. The core and logs from the WIPP-14 drillhole document a normal stratigraphic section at this location, i.e., the stratigraphic tops have not been displaced relative to their expected depths projected from nearby control points, and bedding is in a normal, flat-lying attitude (Sandia National Laboratories and D'Appolonia Consulting Engineers, 1982; Bachman, 1985). The daily drilling reports and the geologist's lithologic log record no unusual lost-circulation or fluid-entry zones, and core recovery percentages were consistently high. The geophysical logs run in the hole also indicate normal lithologies, normal depths, and no anomalous hole diameters." The hydrostructural units at the WIPP site, most notably the irregularities observed at WIPP-14, were investigated by drilling and for hydrologic system attributes. The geophysical logs for this interval show a normal signature as observed in hundreds of other wells (near and far). Furthermore, the presence of "underground rivers," either hydrologically or lithologically, has not been directly shown by these drill holes, or other drill holes into the Culebra or Magenta hydrogeologic units. Hill (1999) suggests that two other gravity anomalies at and near WIPP also indicate the locations of subsurface karst. These locations are around the WIPP-13 and H-3 drillholes. Hill 1999 (p. 48) states that, "both WIPP-13 and H-3 are located within negative gravity features (sinkholes?)." Lorenz 2005 (p. 78) noted that the Rustler strata cored in both these holes show some disruption, possible indications of dissolution but more plausibly interpreted as syndepositional (i.e., at the time of deposition) disruption, because they are overlain by undisrupted strata with primary depositional structures. Although Holt and Powers 1988 inferred some stratigraphic displacement of the angular sulfate fragments encountered in the WIPP-13 core just below the contact with the A-3 sulfate of the Tamarisk, they also reported two thin anhydrite beds and a polyhalite bed to the east in a stratigraphically equivalent halite bed. Lorenz concluded that this angular fragment can as easily represent a stratigraphically in-place remnant of one of these thin units, as Holt and Powers 1988 and

Topic	Commenter Concern	EPA Response
		Powers and Holt 2000 described how the polyhalite, and presumably the upper anhydrites, converge with the base of A-3 westward from the depositional center of the unit. In addition, Lorenz believes that the shaft mapping shows a thin sulfate bed in this stratigraphic position, with a breccia and conglomerates at the base of A-3 and overlain by an erosional surface. Lorenz concluded that both holes encountered normal stratigraphic successions, and the cored breccias are too thin and too deep to have affected the gravity survey. EPA finds Lorenz's conclusion to be reasonable.
Lack of surface runoff	Lack of surface runoff indicates karst is present at the WIPP site.	The lack of surface runoff does not indicate karst is present at the WIPP site. Hill 1999 (p. 40–42) suggests that (1) because the WIPP site "is characterized by almost no surface runoff," despite 12 inches of annual precipitation, and (2) because the chloride mass balance techniques used by Campbell et al. (1996) suggested that infiltration of water through the soil is not the major source of recharge into the Rustler Formation ["…our data do not support direct infiltration through the overlying soil as the major source of aquifer recharge…", page 164], that therefore, recharge of the subsurface Rustler units must be through surface runoff that flows primarily into sinkholes, and that therefore must be sinkholes and an associated subsurface karst system at the WIPP site. On page 80, Lorenz (2005) presented a series of arguments for the lack of surface runoff at the WIPP site which are summarized as follows. The poor development of surface drainage over the WIPP site is due to the absence of requirements for such a drainage network. The low rate of precipitation, the presence of sandy surficial deposits that quickly soak up precipitation, the low dip of the strata that does not funnel drainage in any particular direction, and the shifting of dune sands that blocks drainage as it develops, combine to prevent an organized drainage system from forming in this area. It is not necessary to postulate a complex process of stream capture by an organized system of sinkholes and subsurface drainage to explain this pattern.

Topic	Commenter Concern	EPA Response
		To EPA, the evidence provided by Campbell et al, 1996 corroborates other data from similar areas (Hogan et al, 2004) that recharge does not occur through basin floors as at WIPP. The Campbell et al 1996 and other data indicate that the high evapotranspiration (evaporation and use by vegetation) reduces the potential for any recharge. Thus the combination of vegetation and sandy surficial soils are sufficient to prevent runoff in this arid climate.
Water in the exhaust shaft	The water flowing in the exhaust shaft is due to the presence of karst at the WIPP site.	Beginning around the time of the submission of the CCA, DOE detected water flowing into the air exhaust shaft; no water had been previously detected since shafts were excavated. Some commenters point to this water inflow as evidence of karst at the site. DOE has investigated this water inflow, which continues today. DOE has drilled wells around the WIPP surface facilities, hit water around 50-60 feet below ground surface, and identified that the highest levels of water are around the salt evaporation pond and that water flows toward the exhaust shaft. DOE did not find any karst related features in the wells drilled for the characterization. EPA believes that DOE's explanation of infiltration from the surface facility adequately accounts for the water movement, and does not require the invocation of karst.
Salinity/ground water geochemistry variations	Salinity/ground water geochemistry variations indicate karst at WIPP Phillips 1987, p. 282	DOE's hydrochemistry model recognizes four different ground water geochemical zones that differ in geochemical characteristics, recharge rates, and recharge locations. This interpretation allows for very slow vertical infiltration to the Culebra through overlying beds, although the primary "source" of ground water will be lateral flow from recharge areas north of the site. EPA believes the groundwater basin model provides a realistic representation of site conditions because it conceptualizes slow, downward infiltration of meteoric water. In the review of the CCA, EPA examined all data pertaining to ground water flow in the Rustler, and believes DOE's <u>total</u> conceptualization adequately described system behavior for the purposes of performance assessment. [Docket: A-93-02, Items V-B-3, Section IV.C.1.i and V-B-7, Section 3.0] Corbet (1997) expands this by integrating the hydrochemical facies delineated by Siegel et al. (1991), with that of the hydrogeology to assess groundwater flow and recharge

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		characteristics. The groundwater flow, characterized as confined and dual-porosity, is slow with no evidence of rapid groundwater flow conduits or chemistry changes, and no evidence of vertical connection to adjacent aquifers. Hill (1999) believes that total dissolved solids (TDS) variations indicate karst. EPA does not agree. The Culebra wells (H-1, H-2, and H-3) identified by Hill are all within the Culebra Facies C identified by Siegel. Facies C has a TDS range of 10,000 to 80,000 mg/l. Further, H-3, the well identified by commenters as a location that strongly exhibits karst, has had TDS measured at over 50,000 mg/l. If fast recharge due to karst were occurring at that location, EPA believes that at the WIPP site, one would expect the TDS value to be much lower. EPA finds the ground water basin model to provide a more reasonable explanation of the TDS variation than Hill's explanation.
Fractures in the Salado will be continuous	Continuous vertical fractures will exist from the waste area to the Rustler Formation, enhancing radioactive releases at WIPP.	One commenter speculates that vertical fractures will connect the repository with the overlying Culebra dolomite, a distance in excess of several hundred meters. However, DOE's and other experimental and modeling studies do not support these claims. Disturbed Rock Zone (DRZ): The commenter implies that an extended disturbed rock zone forms around mined rooms and that these fractures will then be extended by high gas pressures propagating up to the Culebra. A limited DRZ does form and it is accounted for in the performance assessment; however, it's extent into the salt is not far. The DRZ has been characterized by visual, geophysical and permeability measurements (Borns and Stormont, 1988). Based on 12 holes cored in Room Q and associated sonic velocity measurements, it was shown that a "DRZ of less than 2 meters developed along the wall is typical for WIPP openings"(Hansen, 2003). In earlier investigations conducted by Holcomb and Hardy (2001), the maximum area of extension of DRZ was 2 meters. In the corner of the Room Q alcove, the DRZ only extended 1 meter and there were many areas where damage was not noticed. Dale and Hurtado (1998) have confirmed that the undisturbed formation around the WIPP Air intake shaft is less than 3 meters. Fractures: The commenter also speculates that development of long vertical fractures will start and then propagate due to excavation of the repository and higher gas pressure.

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		Extensive experimental and simulation work was done to understand the fracture characteristics in the WIPP environment. In experiments, fracturing took place when the fluid pressure in MB 139 exceeded the assumed total local in-situ stress (14.8MPa, local vertical stress 12.4 MPa) normal to the fracture plus the tensile strength of the rock. These studies also established that the fractures will follow the path of least resistance, and are typically guided by weak horizontal zones and the preferred orientation in the direction of preexisting fractures, so that the fractures will be horizontal, not vertical.. Wawersik and others (1997) proposed that “both upward growth of horizontal fractures out of the interbeds, especially MB139, and a change in fracture orientation from horizontal to vertical are unlikely if the preexisting weakness planes in MB 139 (typical under the existing WIPP excavations) continued to act as regionally pervasive fracture guides.” DOE used measurement data to develop a fracture model that is incorporated into the performance assessment. The fracture model assumes that existing fractures will be expanded laterally in response to high gas pressures. EPA extensively reviewed the fracture model and found it to be adequate (CCA CARD 23). Salt Creep: Located over 650 meters below the surface, the WIPP halite is under vertical pressure and creeps to redistribute stresses. Experiments at WIPP show that any opening/cavity in the salt, including fractures, will be eliminated by salt creep over a short time. Creep occurs due to plastic deformation and increases with the depth of the cavity. The rate of closure depends upon other factors, too; however, an approximate 1% reduction in volume per year can be used as a guide for the WIPP environment. Halite creep will thus close and eliminate fractures. EPA concludes that long, sustained vertical fractures to the Culebra or the accessible environment proposed by the commenter are unrealistic. Current fractures around the waste area excavation appear to be no more than about three meters in length. If additional fracturing were to occur, due to high repository pressures, then the fractures would be expected to propagate horizontally in the anhydrite marker beds where there are pre-existing fractures, not vertically into intact halite. From these data EPA concludes that the

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		DRZ is limited in scope and fractures would not propagate vertically hundreds of meters to the Culebra.
Limited number of wells miss the karst	DOE has not drilled enough wells to identify karst. Only two wells have been placed where karst might exist.	The Culebra is characterized as being a fractured medium with the fractures having multiple orientations, including horizontal. The dual-porosity conceptual model accounts for fractures. The presence of fractures is explicitly modeled in transport calculations in the PA. Although the well bore diameter is on the order of inches, a well-pumping test interrogates large enough volumes of rock, via the fracture network so that if large voids or "underground rivers" were present, the pumping tests would have a good chance of identifying such features. That is, because the wells access fractures, the information from a limited number of wells can characterize a relatively large footprint. EPA believes that there are enough pumping tests in the Culebra to have identified if karst features were present. However, the data from the Culebra pumping tests are reasonably interpreted as being dual porosity.
Caliche and recharge	Caliche at WIPP will allow water to infiltrate into the Rustler.	Phillips (1987) conducted field work at and around WIPP in the 1980s when there was not nearly as much site characterization information as there is today. In that study, Phillips considered the Mescalero caliche, a soil formed in the WIPP area, to be a karst forming carbonate. Thus, any dissolution of the caliche by his definition must be evidence of karst. This provides an initial preconceived supposition that there is karst at WIPP. From his work in shallow trenches, Phillips estimated that 15% of the caliche has been dissolved or disrupted and that this allows water to move into openings and recharge the Rustler. However, if only 15% of the caliche is missing, then conversely about 85% of the caliche is still there to generally reduce infiltration. EPA believes that the caliche does not prevent all water from infiltrating but it greatly reduces the infiltration. The caliche does, however, indicate that the area has been arid and has been for quite some time. When combined with the sands, low precipitation, high evaporation rates, and the presence of vegetation, only limited infiltration would be expected.
Analysis of caliche as an	Surficial trenching by Phillips (1987) indicates karst in the subsurface	Phillips (1987; Docket A-93-02, Item II-H-33) used shallow trenches in the surface at and around the WIPP site to demonstrate that there is karst in the subsurface. He claimed that he identified several locations with collapsed caliche where he "reasonably assumed"

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indicator of subsurface karst		that there was karst below, even though he did not have the information in the subsurface to support the claim. WIPP-14 is a well location in which Phillips believes his trenching shows subsurface karst: "the WIPP-14 topographic depression is underlain by a structural depression in the caliche surface…." In the subsurface, however, geophysical logs in WIPP-14 indicate a normal signature although commenters have contended that an interval around 81 ft is a mud-filled cavern (CCA CARD 14; Beauheim et al., 2000). For the CCA, EPA examined geologic data in and around the WIPP site, and has recognized that topographic depressions are present immediately north of the WIPP site, in the WIPP-14 area. Although DOE did not provide an explicit explanation of WIPP-14, they identified only a minor topographic depression, and that "there is no evidence of collapse at the surface [at WIPP-14]." [Docket: A-93-02, Item II-G-1, Ref. 26, pp. 25 and 26] DOE also stated that "WIPP-14 contained no subsurface cavities." [ibid., p. 25] Without direct evidence of cavernous porosity and subsequent collapse of overlying beds that would be associated with a karst origin of this feature, this interpretation is consistent with available data. There is no evidence that potential dissolutional features are the result of ongoing karst processes that would result in cavernous porosity and solution pipeways and caves. In the CCA, commenters mentioned the presence of "mud" at WIPP-14 and EPA considered that unlikely. DOE states [Docket: A-93-02, Item II-G-1, Ref. 26, p. 26] that "the stratigraphic succession at WIPP-14 is comparable to that in other drillholes." The Santa Rosa sandstone occurs from 15.4 to 141.0 feet below ground surface (bgs), and the Dewey Lake Redbeds occur from 141.0 to 638.7 feet bgs. Remaining strata are comprised of the Rustler Formation from 638.7 feet bgs to the top of the Salado at 951.6 feet bgs. "Mud" is not identified, but perhaps the commenter is referring to units such as the Unnamed Lower Member, or the Rustler-Salado contact area. [Appendix BH, p. 51 of the CCA] Given that there is a stratigraphic succession similar to other boreholes, it is difficult to

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		reconcile Phillips' surface trench work to the actual subsurface data. Lorenz (2005) also addresses this issue in a reasonable analysis. EPA's interpretation of Phillips (1987) trenching in the caliche, is that the trenching identifies that the caliche is widespread, but is disrupted in areas. EPA does not believe that the shallow trenching provides evidence of widespread karst below the surface or any information about the subsurface. The use of the shallow trenching information to extrapolate hundreds of feet below ground surface is not inappropriate and unreasonable.
Recharge	Recharge data and observations around WIPP indicate karst is present. (Also see Surprise Spring discussion.) Phillips, 1987; p. 283 Rustler is recharged by rainwater then Rustler flow fluctuates with rainfall	Hill (1999) (p. 44 and Appendix A) suggests that records of rainfall near the WIPP site from September of 1986 through December of 1988 can be correlated with discharge variations at the Malaga Bend springs. Discharge from these numerous and obscure springs in the alluvium at and below the riverbed was calculated by subtracting flow in the Pecos River measured at gauging stations below the springs from river discharge measurements made above them. Hill (1999) speculated a 90- to 94-day lag-time response between precipitation in the area east of Carlsbad and discharge pulses at Malaga Bend in five out of eight cases, "suggestive of a possible connection" between the WIPP site and Malaga Bend. Hill did not discuss the numerous other rainfall spikes in the records that are not associated with river discharge peaks, and she did not try to correlate the volume of rainfall with volume of spring discharge. She also noted, but did not account for, the fact that Pierce Canyon, south of the WIPP site and the only large drainage point east of the Pecos for miles around, also empties into the river between the two gauging stations. Hill (1999) acknowledged that her study was poorly controlled and that it might not be statistically meaningful, since it did not account for factors such as irrigation, Pecos flood pulses, or industry water withdrawals at Nash Draw, and because it made no differentiation between precipitation over Nash Draw (where sinkhole catchment of drainage is known) and precipitation over the WIPP site where she was trying to prove the connection. She nevertheless justified the study with the statement that "The purpose of the above exercise is to show that actual measurements of recharge/discharge should be made in any serious attempt of studying karst at the WIPP site" (Hill 1999, p. 47), and although she did not in

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		fact do this herself, the reader is ultimately left with the impression that in Hill's opinion, the data support the presence of karst in the Rustler at the WIPP site. However, what little definitive data exist suggest that recharge, flow, and discharge within the Rustler Formation are relatively rapid within the confines of Nash Draw, but that the same aquifer horizons exhibit different characteristics to the east, under the WIPP site. At the WIPP site there are several indicators that support a system of slow groundwater flow: a high degree of mineralization of the formation waters, lower measured hydraulic conductivities, and isotopic studies. The potentiometric head data suggest that flow in the Rustler members is slow at WIPP and that it would flow to the south (Culebra) and west (Magenta). The data suggest that if a karst conduit system exists in the Rustler Formation, it is confined to the Nash Draw area. EPA believes that while some recharge from local precipitation may occur in Nash Draw, EPA finds Hill's findings to be speculative and the Nash Draw information should not be extrapolated beyond Nash Draw. An important aspect of the recharge issue is that commenters (e.g., Phillips, 1987) have stated Rustler Formation recharge occurs at WIPP with the implication that there is enough recharge capable of creating karst. If it were the case that significant recharge was occurring in the Rustler at WIPP, one would expect to see a response in the well data. However, no response in water levels occurr at WIPP attributable to precipitation. This indicates to EPA that either 1) no recharge is occurring today or the 2) what recharge is occurring is small and would not be sufficient to dissolve the Rustler after infiltrating to it, and would not be sufficient to support flow in an "underground river" as commenters claim there is at the WIPP site.
Surprise Spring	Surprise Spring in Nash Draw is connected to the WIPP site and is evidence of karst at WIPP.	Commenters refer to Phillips' (1987) observation that there was a rapid response of Surprise Spring to a large 1985 rainfall event and proves karst exist at the WIPP site. Surprise Spring is located near the Salt Lake, toward the western side of Nash Draw and is over 8 miles from the western side of the LWB. EPA and DOE acknowledge that Nash Draw has karst like features. Thus, it is not unreasonable to assume that a large rainfall event would create flow in Nash Draw. *However, that has no bearing on the WIPP site*

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		and any attempt to connect a response in Nash Draw to the WIPP site is unreasonable. As discussed in this CARD (2004 CRA CARD 15), EPA's understanding of the WIPP/Nash Draw system is that the two areas are vastly different in their hydrogeologic character. While Nash Draw has karst like features and the Rustler is near the surface, at WIPP the Rustler is hundreds of feet below the surface. While Nash Draw areas appear to respond rapidly to precipitation events, no responses are seen in the well data for the Magenta and Culebra Dolomites at the WIPP site. Thus, the observation of rain water well response at Surprise Spring has no bearing on the WIPP site.
Coercion of scientists	Commenters claim that WIPP project scientists have been silenced on the karst topic.	EPA is basing its conclusions on karst on the available data. The available data indicates to us that there is karst around WIPP (e.g., Nash Draw), but there is no evidence to suggest that karst would affect the performance of WIPP during the regulatory period. EPA has no comment on past management practices at WIPP by Sandia National Laboratories, DOE or the USGS and there are sufficient data available for EPA to conclude that karst will not affect the performance of WIPP.
Magenta should be modeled	Commenters believe that the Magenta Dolomite should be modeled as a radionuclide transport pathway at WIPP in PA.	DOE has identified that the Culebra and Magenta Dolomites of the Rustler Formation could be pathways for radionuclide transport in the case of a drilling intrusion. However, the Culebra exhibits higher transmissivity than the Magenta everywhere within the WIPP Land Withdrawal Boundary. EPA has reviewed the evidence for high Magenta transmissivity at the well H-3 (now called H-3b1) and found it to be incorrect (see discussion on the H-3 information above). EPA does not believe that karst is present in the Magenta within the Land Withdrawal Boundary. Although the Magenta is not currently excluded from receiving fluids from the repository, the Magenta and Culebra Dolomites are parameterized in the PA such that more fluid would enter the Culebra and only transport is considered in the Culebra. DOE believes, and EPA concurs, that since the Culebra has a higher transmissivity than the Magenta, the use of the Culebra as a pathway would contribute to more releases than if both the Culebra and the Magenta were modeled. In addition to requiring a more pressurized flow up the borehole to the Magenta since it is above the Culebra, the radionuclide concentration would be shared between the Culebra and the Magenta, which would decrease releases.

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		Since the Magenta is considered to have flow through the rock matrix and not fractures, there would be a much greater chance for radionuclide retardation than in the Culebra, which does have fracture flow in addition to the matrix. Combined with low transmissivity and long radionuclide travel times, the inclusion of the Magenta as focus of radionuclide transport would split the radionuclide amounts into two rock units, thus retaining more radionuclides within the Land Withdrawal Boundary than is currently modeled. This would reduce predicted releases, therefore EPA believes it is appropriate to focus release into the Culebra in PA modeling.
Inadequate characterization of karst at WIPP	Commenters claimed during the CCA and continue to claim that DOE has not adequately characterized karst at the site for compliance purposes.	EPA disagreed with this in the certification decision and continues to disagree with this claim (CCA CARD 14). In the CCA, EPA found that DOE adequately identified that the two major groundwater bearing units at the WIPP site are the Culebra and Magenta Dolomites Members of the Rustler Formation. To support this characterization, DOE provided a table of hydraulic properties of the hydrologic units at WIPP, a portion of which has been reproduced in this CARD in Table 15-1. DOE conducted basic studies of geology (e.g., CCA Appendix GCR) and tested numerous wells and continues to conduct geologic and hydrologic studies. The Culebra is of particular interest because it is the most transmissive, saturated unit above the WIPP repository. The two primary types of field tests used to characterize the flow and transport characteristics of the Culebra are hydraulic tests and tracer tests. Extensive testing of the Culebra has been performed at 43 well locations to determine its hydraulic properties. The hydraulic testing consists of pumping, injection, and slug testing of wells across the study area. The most detailed hydraulic test data exist for the WIPP hydropads. The hydropads generally comprise a network of three or more wells located within a few tens of meters of each other. Long-term pumping tests have been conducted at hydropads H-3, H-11, and H-19 and at well WIPP-13 (Beauheim 1987b; 1989; Beauheim et al. 1995; Meigs et al. 2000). A map of these locations is provided in Figure 15-3 of this CARD. These pumping tests provided transient pressure data at the hydropad and over a much

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		larger area. Tests often included use of automated data-acquisition systems, providing high-resolution (in both space and time) data sets of pump test results. In addition to long-term pumping tests, slug tests and short-term pumping tests have been conducted at individual wells to provide pressure data that can be used to interpret the transmissivity at that well (Beauheim 1987a). Additional short-term pumping tests have been conducted in the WQSP wells (Beauheim and Ruskauff 1998). Detailed cross-hole hydraulic testing has been conducted at the H-19 hydropad (Beauheim 2000). It appears to EPA that commenters ignore the wealth of historical information collected (at the site in the 1990s and recently) and focus on isolated old data, such as one H-3 data point from 1977. Other examples include water in the exhaust shaft, and pumping test data. As described in this table of responses and elsewhere in this CARD, DOE has conducted site characterization to reasonably explain the water in the shaft, and this drilling did not encounter karst at the above ground WIPP facility. Commenters do not appear to acknowledge this new information. DOE has conducted a number of well pump tests that provides a strong basis for concluding that the Culebra is a dual-porosity system and not karst-like in nature. Commenters have not accounted for this data.

APPENDIX 15-A REFERENCES

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