Department of Energy
Carlsbad Field Office
P. O. Box 3090
Carlsbad, New Mexico 88221
MAR 1 8 2013

Mr. John E. Kieling, Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303

Subject: Notification of a Class 3 Permit Modification to the Hazardous Waste Facility Permit, Permit Number: NM4890139088-TSDF

Dear Mr. Kieling:

The purpose of this letter is to provide the New Mexico Environment Department with a Class 3 Permit Modification Request (hardcopy and compact disc) for the following items:

- Panel Closure Redesign
- Repository Reconfiguration
- Volatile Organic Compound Monitoring Program Changes

We certify under penalty of law that this document and all attachments were prepared under our direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on our inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of our knowledge and belief, true, accurate, and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have questions regarding this submittal, please contact George T. Basabilvazo at (575) 234-7488.

Sincerely,

//Signatures on File//

José R. Franco, Manager
Carlsbad Field Office

M.F. Sharif, Project Manager
Nuclear Waste Partnership LLC

Enclosure

cc: w/enclosure

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CBFO:OESH:GTB:ANC:13-0718:UFC 5487.00

Class 3 Permit Modification Request

Item 1: Modification to the WIPP Panel Closure

Item 2: Repository Reconfiguration of Panels 9 and 10

Item 3: Revise Volatile Organic Compound (VOC) Target Analyte List and Other Changes to the VOC Monitoring Program

Waste Isolation Pilot Plant
Carlsbad, New Mexico

WIPP Permit Number - NM4890139088-TSDF

March 2013

Overview of the Permit Modification Request

This Class 3 Permit Modification Request for the Waste Isolation Pilot Plant (**WIPP**) Hazardous Waste Facility Permit (**Permit**) Number NM4890139088-TSDF contains 3 items. This PMR is being submitted by the U.S. Department of Energy Carlsbad Field Office and Nuclear Waste Partnership, collectively referred to as the Permittees, in accordance with the WIPP Permit Part 1, Section 1.3.1. (20.4.1.900 New Mexico Administrative Code incorporating Title 40 Code of Federal Regulations §270.42(d)). Modifications to the Permit are requested for the following items:

1. Modification to the WIPP Panel Closure

2. Repository Reconfiguration of Panels 9 and 10

3. Revise Volatile Organic Compound (VOC) Target Analyte List and Other changes to VOC Monitoring Program

Each of these items affects separate aspects of the design and operation of the WIPP underground facility; however, they may affect common areas of the Permit text. The proposed changes, including the redline strikeout of the Permit text, are addressed separately within each item of this Class 3 package. These changes do not reduce the ability of the Permittees to provide continued protection to human health and the environment.

Item 1

Class 3 Permit Modification Request

Modification to the WIPP Panel Closure

Waste Isolation Pilot Plant
Carlsbad, New Mexico

WIPP Permit Number - NM4890139088-TSDF

March 2013

Table of Contents

Acronyms and Abbreviations

ATWIR	Annual Transuranic Waste Inventory Report
CBFO	Carlsbad Field Office
CFR	Code of Federal Regulations
CPR	cellulosics, plastics, and rubber
DOE	Department of Energy
DRZ	disturbed rock zone
HWDU	Hazardous Waste Disposal Unit
MDL	method detection limit
NMAC	New Mexico Administrative Code
PCS	panel closure system
Permit	Hazardous Waste Facility Permit
PMR	Permit Modification Request
ppmv	parts per million by volume
QA/QC	Quality Assurance/Quality Control
SMC	Salado Mass Concrete
TRU	transuranic
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant
WPC	WIPP Panel Closure

Overview of the Permit Modification Request

This document contains a Class 3 Permit Modification Request (PMR) for the Hazardous Waste Facility Permit (Permit) at the Waste Isolation Pilot Plant (WIPP), Permit Number NM4890139088-TSDF hereinafter referred to as the WIPP Permit.

This PMR is being submitted by the U.S. Department of Energy (DOE),Carlsbad Field Office and Nuclear Waste Partnership LLC, collectively referred to as the Permittees, in accordance with the Permit Part 1, Section 1.3.1 (20.4.1.900 New Mexico Administrative Code [NMAC] (incorporating Title 40 Code of Federal Regulations (40 CFR) §270.42)). This modification proposes a revision to the approved closure plan. These changes do not reduce the ability of the Permittees to provide continued protection of human health and the environment.

The Permittees have organized this PMR to support this request, and the following information specifically addresses how compliance has been achieved with Permit Part 1, Section 1.3.1. All direct quotes are indicated by italicized text.

The proposed modifications to the text of the WIPP Permit have been identified using red text and a double underline for new text and a ~~strikeout~~ font for deleted information.

1. 20.4.1.900 NMAC (incorporating 40 CFR 270.42(c)(1)(i)) requires the applicant to describe the exact change to be made to the Permit conditions and supporting documents referenced by the Permit.

This modification requests the following changes:

- Revision to the panel closure system (PCS) design as specified in the document entitled *Design Report for a Panel Closure System at the Waste Isolation Pilot Plant* (see Attachment C).
- Revision of some panel closure design requirements.
- Deletion of the hydrogen and methane monitoring.
- Revision to clarify applicability of ongoing disposal room volatile organic compound (VOC) monitoring (i.e., closed room VOC monitoring).
- Revision to the panel closure schedule in Table G-1.
- Editorial corrections to Permit text regarding panel closure.

Revision to the PCS Design

This modification request proposes to amend the closure plan in Permit Attachment G by revising the PCS. These proposed changes include the following:

- Replace the Detailed Design Report for an Operation Phase Panel Closure System in Attachment G1
- Add new Attachment G1, Appendix D, with the technical specifications for the WPC design
- Add new Attachment G1, Appendix E, with the design drawings for the WPC design
- Delete Attachment G1, Appendix G, that contains the technical specifications for Option D
- Delete Attachment G1, Appendix H, that contains the design drawings for Option D

The approved PCS, known as “Option D,” requires emplacing a 12-foot explosion-isolation wall and emplacement of a 26-foot monolith composed of Salado Mass Concrete (SMC). The new PCS, referred to as the WIPP Panel Closure (WPC), consists of two barriers (i.e., either two standard bulkheads or one standard bulkhead and one block wall, if a block wall was previously constructed in the panel) and emplacement of a minimum of 100 feet of run-of-mine salt between the two barriers. The major components of each system are summarized in the following table:

Option D	WPC
12-foot Explosion Isolation Wall 26-foot SMC Monolith	Two Barriers – i.e., either two standard bulkheads or one standard bulkhead and one block wall, if a block wall was previously constructed in the panel 100-feet of salt between the two barriers

The WPC first requires an inner barrier (either a bulkhead or block wall for Panels 1, 2, and 5) in the panel access drift close to Room 1 to provide isolation from the emplaced waste during construction of the rest of the WPC. Next a minimum of 100 feet of run-of-mine salt is emplaced to fill the drift from top to bottom and side to side. Finally, an outer accessible barrier (i.e., a bulkhead) is installed. The final configuration consists of the emplaced run-of-mine salt located between the two barriers.

A minimum length of 100 feet for the run-of-mine salt was selected based on engineering judgment that a backfill length that is 7 to 10 times the panel entry height would provide adequate flow resistance. The panel entry height is nominally 13 feet; therefore, 7 to 10 times this height corresponds to approximately 90 to 130 feet. A nominal distance of 100 feet was chosen to meet this guideline.

The WPC functions as an effective closure system through salt creep and convergence around the emplaced run-of-mine salt. Initially, numerical modeling predicts that the settling rate of the emplaced run-of-mine salt will exceed the salt convergence rate of the drift. This will result in the formation of a gap between the roof of the drift and the run-of-mine salt. This gap is expected to form within the first two years of installation. Subsequently, closure of the gap and compression and consolidation of the run-of-mine salt occurs. After 23 years, the gap is no longer present and the originally emplaced run-of-mine salt has become transformed into something resembling the properties of intact salt (i.e., increased density, lower permeability and higher resistance to air flow). Therefore, the WPC improves and strengthens as it ages, in contrast to other more complex designs like Option D that would tend to deteriorate with age.

While the gap is present in the WPC, resistance to air flow, which includes resistance to flow of VOCs, from the panel is provided mainly by the outer accessible bulkhead. Some minimal maintenance of the outer accessible bulkhead will be required to ensure that it provides the necessary air flow resistance during the time period that the gap is closing. This minimal maintenance may consist of reinforcing and replacement of components (i.e., flexible flashing) or it may consist of installation of a new bulkhead in front of the previous bulkhead. The inner barrier (i.e., either the in-bye bulkhead or block wall) which is not accessible after construction of the WPC, is not credited with any air flow resistance because the effective life of the inner barrier is less than the duration of the gap. Refer to the revised Permit Attachment G1 in Appendix B of this modification for a more thorough discussion of the WPC and associated gap formation and closure.

This modification primarily entails replacing the Option D specifications and drawings with the WPC specifications and drawings. The WIPP Permit was the standard used to determine the adequacy of the WPC. The Permittees have determined that the WPC meets the terms of the Permit. The evaluation of the WPC and its level of protectiveness is provided in the Design Report for a Panel Closure System at the Waste Isolation Pilot Plant, October 2012 (see Appendix C).

<u>Revision of Some Panel Closure Design Requirements</u>

Some of the design requirements specified in Permit Attachment G, Section G-1e(1) are proposed for deletion or revision.

<u>Deletion of the Hydrogen and Methane Monitoring</u>

The Hydrogen and Methane Monitoring Plan (Permit Attachment N1) is proposed for deletion, including any associated references and citations. Affected Permit sections are:

- Permit Part 4, Section 4.6.5
- Permit Attachment N1

<u>Revision to Clarify Applicability of Ongoing Disposal Room VOC Monitoring</u>

Editorial text is being proposed to clarify requirements to perform ongoing disposal room VOC monitoring. Affected Permit sections are:

- Permit Part 4, Section 4.4.3
- Permit Attachment N, Section N-3a(3)

<u>Revision to the Panel Closure Schedule in Table G-1</u>

Table G-1 is proposed for revision to update actual and anticipated dates. Note 2 is proposed for revision to clarify the point of closure start. Notes 5 and 6 are proposed for consolidation into Note 5.

<u>Editorial Corrections to Permit Text Regarding Panel Closure</u>

Editorial changes are proposed, as necessary, to correct and clarify Permit text associated with panel closure.

The Table of Changes (Appendix A) and the redline strikeout in this modification describe each change that is being proposed.

2. 20.4.1.900 NMAC (incorporating 40 CFR 270.42(c)(1)(ii)), requires the applicant to identify that the modification is a Class 3 modification.

The proposed modification is classified as a Class 3 Permit Modification in accordance with 20.4.1.900 NMAC (incorporating 40 CFR 270.42(d)(1)) which states:

> "(d) Other modifications, (1) *In the case of modifications not explicitly listed in Appendix I of this section, the Permittees may submit a Class 3 modification request to the Agency*…"

The permittees are requesting that this modification be managed under the Class 3 process since the Permittees were unable to identify a similar item justifying a different classification in Appendix I.

3. 20.4.1.900 NMAC (incorporating 40 CFR 270.42(c)(1)(iii)) requires the applicant to identify why the modification is needed.

__Revision to the PCS Design__

In early 2001, the Permittees began evaluating installation of Option D as specified in the WIPP Permit in anticipation of Panel 1 closure. Concerns were identified related to the erratic results obtained from several test pours of the SMC formulation specified in the WIPP Permit. The evaluation team concluded that there were significant opportunities for implementing an alternative design, which would:

- meet the performance standard for protectiveness;
- be less impactive to facility operations; and
- have a higher certainty of successful installation.

In early 2002, the Permittees began the process of developing an alternative PCS. The Permittees began preparing the engineering redesign, supporting documents, and assessments necessary to support a revised PCS. In 2007, the Permittees initiated hydrogen and methane monitoring to gather data to establish whether generation of these gases actually occurs and if so, determine more realistic accumulation rates in filled panels. It was anticipated that more realistic accumulation rates may lead to panel closure designs that are less complex than the Option D design.

Permit Attachment G, Section G-1e(1) specifically allows the Permittees to collect data on the behavior of the wastes and mined openings, or proposing a modification to the Closure Plan in the future and seeking a permit modification for a panel closure design different from Option D.

The Permittees are proposing just such a modification to the Closure Plan and seeking a panel closure design different from Option D with the submittal of this PMR for reasons described below.

Higher Certainty of Success while Meeting the Performance Standards

Option D requires the use of unproven construction materials, in that the SMC formulation specified by the Permit was developed specifically for use in a very different application (the WIPP shaft seals), and has never been successfully poured in a quantity larger than 5 cubic yards (5-yards). Each of the 4 cells associated with each Option D monolith will be approximately 120-yards. Consequently, there is a much greater uncertainty in the successful use of SMC as required for Option D in the current Permit Closure Plan than with the WPC being proposed in this PMR.

Protectiveness

The WIPP Permit was the standard used to determine the adequacy of the WPC. The Permittees have determined that the WPC meets the terms of the Permit. The evaluation of the WPC and its level of protectiveness is provided in the Design Report for a Panel Closure System at the Waste Isolation Pilot Plant, October 2012 (see Appendix C). The Permittees have determined that the WPC has a higher likelihood of success than the Option D PCS and will assure protection of workers, human health, and the environment during the operating, closure and post-closure phases of the WIPP facility.

Less Impactive to Facility Operations

A compelling reason to seek this permit modification is that installation of the WPC will be less impactive to facility operations, i.e., surface operations, waste disposal in the WIPP underground, and mining and excavation activities. The following table identifies how the WPC design is less impactive.

Comparison of Option D to WIPP Panel Closure

Item	Option D	WIPP Panel Closure (WPC)
Special Materials	Quartz aggregate must be transported from outside the WIPP facility.	Run-of-mine salt available at the WIPP facility.
Staging	SMC must be batched aboveground for installation.* Only concrete blocks for the explosion-isolation wall may be pre-staged in the underground.	All construction materials may be pre-staged in the underground.
Forms	Multiple sets of heavy steel forms must be constructed in the confined area of the panel access and exhaust drifts.	Standard bulkhead forms are readily constructed. No special forms are required.
Storage	Large quantities of aggregate, cement, fly ash and other materials must be stored aboveground prior to use.	Minor above ground storage required.
Handling/Installation	SMC must be batched aboveground and bulk, wet concrete transported underground for installation.	No concrete is required.
Salado Mass Concrete	Difficult to obtain correct mix to meet construction specifications in the WIPP Permit under constraints of underground installation.	SMC not required.
Time to Install	Installation estimated to be 14 months per panel, assuming no failed monolith cells.	Installation will be less than or equal to 180 days per panel.

* Although the WIPP Permit provides an option for underground batching, concerns related to water use and increased activity in the underground have all but eliminated this option.

The WPC will also significantly reduce the use of the waste hoist over both the extended construction time for a single Option D, and consequently the life of the facility. Once a pour begins for an individual cell of Option D, dedicated use of the waste hoist is required until the pour is complete. This extended use of the hoist could cause operational delays and create conflicts with waste management activities.

Less Risk

It is commonly accepted that less time, transportation, handling, and reduction in complexity translates to lower risk to workers. Two factors are involved in qualitatively estimating the risk reduction associated with installation of the proposed PCS. One factor is the time the workers spend transporting, handling, and installing. The other factor is the complexity of the construction project. As part of the redesign process, the Permittees prepared installation schedules for the Option D PCS and WPC. The underground construction activities for Option D are estimated to require approximately 14 months. The comparable period for construction of the WPC is less than or equal to 180 days.

The Permittees also reviewed the complexity of the construction project associated with Option D versus construction of the WPC. The WPC construction project uses common materials and techniques, reducing the number of workers required to be in the proximity of the project.

Less Expensive

It is expected that the installation cost associated with the WPC would be negligible, and therefore less expensive than the Option D closure, for the following reasons:

- Run-of-mine salt, the primary construction material, will be readily available due to planned mining activities in the underground at no extra cost.

- Equipment and supplies used to build bulkheads are maintained at the WIPP facility for routine application.

- Construction of the WPC will use existing mining personnel and equipment, instead of subcontractor personnel as would be the case for Option D.

Any cost reduction associated with the WPC, with respect to Option D, is not a driver for the proposed change, but is identified here as an additional benefit that may be realized with adoption of the change.

As part of the redesign process, comparable cost estimates were prepared by the Permittees for Option D (October 7, 2002 Permit Modification Request: Closure Plan Amendment). The cost for Option D was estimated to be approximately three times the cost for the explosion-isolation wall. The construction cost for the two explosion-isolation walls installed into Panel 5 in 2011 was $1.44 million.

Summary

The Permittees have identified the following advantages associated with installation of the WPC which include:

- less time to install;
- less material transportation to the site;
- less staging of materials at the surface;
- less complex activity in the underground;
- no construction of special forms;
- no placement of bulk, wet SMC in the underground;
- reduction of risks to workers;
- higher certainty of success without reducing protectiveness;
- retain mine salt in the underground for use in the closure;
- less costs; and,
- use of mined salt consistent with waste minimization objectives.

Revision of Some Panel Closure Design Requirements

The panel closure design requirements specified in Permit Attachment G, Section G-1e(1) are proposed for revision as follows:

1. *the panel closure system shall contribute to meeting the environmental performance standards in Permit Part 4, Section 4.6.2. by mitigating the migration of VOCs from closed panels*

   The PCS can mitigate the migration of VOCs from closed panels and thus contribute to compliance with applicable VOC environmental performance standards. The PCS cannot, of and by itself, achieve compliance with VOC standards since the PCS will not be able to mitigate VOC migration from the active panel at any point in time. Therefore, compliance with VOC performance standards will be achieved through mitigation of VOC migration from closed panels with the PCS and management of waste emplacement activities in the active panel. Mitigative measures are implemented as needed based on Repository VOC Monitoring results. The requirement was revised to clarify that the PCS will contribute to compliance, but, under some circumstances may not by itself assure compliance.

2. *the panel closure system shall consider potential flow of VOCs through the disturbed rock zone (DRZ) in addition to flow through closure components*

   No change made to this requirement.

3. *the panel closure system shall perform its intended functions under loads generated by creep closure of the tunnels*

   No change made to this requirement.

4. *the nominal operational life of the closure system is 35 years*

   No change made to this requirement

5. *the panel closure system may require minimal maintenance per 20.4.1.500 NMAC (incorporating 40 CFR 264.111)*

   This requirement was changed because the PCS may require some minimal maintenance to the accessible bulkhead during the initial part of its operational life. Minimal maintenance may include reinforcing and replacement of bulkhead components (such as flexible flashing) or it may consist of installation of a new bulkhead in front of the previous bulkhead.

   The requirement was also changed to reference applicable regulatory citations – i.e., 20.4.1.500 NMAC (incorporating 40 CFR 264.111). Changing this design requirement allows for maintenance to be performed, as necessary, on the accessible bulkheads of the PCS. 40 CFR 264.111 (a) states: “Minimizes the need for further maintenance.” This change is consistent with 40 CFR 264.111 (a).

6. *the panel closure system shall address the expected ground conditions in the waste disposal area*

The requirement was changed to require the PCS to address the expected ground conditions instead of the most severe ground conditions expected since the WPC does not interact with the DRZ as the Option D design does and the numerical modeling predicts that the DRZ would consolidate along with the run-of-mine salt.

7. *the panel closure system shall be built of substantial construction and non-combustible material except for flexible flashing used to accommodate salt movement*

   This requirement was changed because the design requirement “IIIb” currently identified in the Permit is obsolete.

8. *the design and construction shall follow conventional mining practices*

   No change made to this requirement.

9. *structural analysis shall use data acquired from the WIPP underground*

   No change made to this requirement.

10. *materials shall be compatible with their emplacement environment and function*

    No change made to this requirement.

11. *treatment of surfaces in the closure areas shall be considered in the design*

    No change made to this requirement.

12. *a QA/QC program shall verify material properties and construction*

    Some material properties and construction specifications may need to be verified prior to construction. The requirement was revised to remove the restriction that a QA/QC program need only verify material properties and construction specifications during construction.

13. *construction of the panel closure system shall consider shaft and underground access and services for materials handling*

    No change made to this requirement.

The following requirements were deleted:

1. the PCS shall perform its intended function under the conditions of a postulated methane explosion

   This requirement was deleted because the hydrogen and methane monitoring data collected for Panels 3 and 4 indicate that the postulated methane explosion is not credible during the performance life of the WPC.

   From April of 2008 through December 2012, the methane analysis results for all of the samples collected in both Panels 3 and 4 were reported as below the dilution corrected method detection limit (**MDL**) of approximately 45 parts per million by volume (ppmv). As such, generation of methane is not detectable and therefore negligible.

The report “Statistical Analysis to Evaluate Methane and Hydrogen Concentrations in Filled Panels at the Waste Isolation Pilot Plant,” Revision 1, February 2013, included in Appendix D of this PMR, provides analysis and conclusions from the collected data.

Furthermore, hydrogen can be generated by radiolysis and by corrosion of iron-based materials under inundated (anoxic) conditions. Methane can be produced from microbial degradation of organic materials such as cellulosics, plastics, and rubber (**CPR**) under humid or inundated conditions. However, during WIPP operations and closure, dry conditions will exist initially and may progress toward humid once ventilation is blocked. The data collected confirm the expectations with respect to hydrogen and methane gas generation in that the lack of significant flammable gas accumulation indicates that conditions do not favor gas generation in the filled panels.

2. thermal cracking of concrete shall be addressed

   This requirement was deleted because concrete is not part of the WPC design.

Deletion of the Hydrogen and Methane Monitoring

Hydrogen and methane monitoring was initiated to establish whether generation of these gases actually occurs and if so, determine more realistic accumulation rates for filled panels. It was anticipated that more realistic accumulation rates may lead to panel closure designs that are less complex than the current design. The data obtained were used in development of the WPC. The hydrogen and methane monitoring program is no longer required for the following reasons:

There are three factors that indicate the amount of hydrogen/methane monitoring in Panels 3 and 4 is sufficient. First, the accumulation rates are well below those predicted by Slezak and Lappin (1990). Slezak and Lappin modeled a disposal panel that is filled with drums of waste over a 30-month period. Ventilation barriers are placed at the entries of each room after they are filled. They estimated that the first room filled would have a hydrogen concentration of 0.7 percent and a methane concentration of 3.4 percent using very conservative gas generation rates and the last room filled will have concentrations of 0.1 percent hydrogen and 0.6 percent methane. Data presented in Appendix D “Statistical Analysis to Evaluate Methane and Hydrogen Concentration in Filled Panels at the Waste Isolation Pilot Plant,” agree with the prediction that the first room (Room 7) will have the highest concentration, however the measured levels are about a full order of magnitude smaller (see Table 2 in Appendix D). These slow accumulation rates indicate that the time period for sufficient gas to reach a flammable mixture is sufficiently long that continued monitoring is neither necessary nor practical. Second, Zerwekh (1979) observed that gas generation decreases with time as source material is depleted. The general trend in the data taken at the WIPP facility similarly indicates that accumulation decreases with time (see Figures 16 and 20 in Appendix D) supporting the conclusion that further monitoring is not necessary.

Third, researchers reporting on hydrogen generation rates in waste containers or in disposal rooms all agree that in order to have an accumulation that is potentially explosive, the system needs to be sealed. For example, Zerwekh (1979), who undertook laboratory and field experiments at Los Alamos Scientific Laboratory to determine gas generation rates under conditions to simulate twenty years of storage in a waste container, concluded that without an air-tight seal, hydrogen would diffuse out and air would diffuse into drums. Eleven years later, Slezak and Lappin (1990) reviewed gas generation on various scales as it might apply to the WIPP underground repository. They concluded that there was no credible mechanism for the accumulation of flammable and possibly detonable mixtures of gas in a disposal room prior to the emplacement of the “composite panel seal.” Their seal, which included a grout component in lieu of crushed salt, was necessary and was assumed to be effective immediately in order to create conditions favorable to the accumulation of detonable quantities of flammable gases. Furthermore, they postulated that the 18-inch gap above the emplaced waste was nominally large enough to propagate an explosion. The proposed WPC does not begin to seal the entry until after the air gap has closed which takes nominally 23 years. During this period, diffusion of hydrogen from the panel will prevent the buildup of flammable concentrations. Furthermore, based on the conclusions of Slezak and Lappin the closure of the air gap with time eliminates a suitably sized duct to allow the propagation of an explosion should flammable mixtures accumulate.

Another factor to consider in terminating the hydrogen/methane monitoring program is whether or not the waste disposed in Panels 3 and 4 is representative of waste that will be disposed elsewhere in the facility with regard to the potential for hydrogen/methane gas generation. With regard to future waste streams, the Permittees examined the 2012 Annual Transuranic Waste Inventory Report (**ATWIR**) which was issued in October, 2012. In this version of the ATWIR there is approximately 68,000 cubic meters of WIPP-bound waste streams only (ATWIR Table 3-1) that do not include data for emplaced or potential waste streams. The characterization information for most of these waste streams is well known. Based on information in Table 4-1 and Appendices A, B, and C of the ATWIR, it is possible to identify about 60 waste streams. This inventory represents about 9,800 cubic meters of transuranic (**TRU**) waste where the characterization information is not well known. However, because the descriptions of these waste streams indicate they are generated by processes that generated waste already shipped to the WIPP facility, the Permittees have no reason to anticipate that gas generation rates will be significantly different in the future. The conclusions drawn from the hydrogen/methane monitoring in Panels 3 and 4 are expected to hold for future waste streams.

Therefore, the hydrogen and methane monitoring program is no longer required for the following reasons:

- Sufficient data have been obtained to develop the design of the WPC.
- Sufficient data have been obtained to demonstrate that explosive levels of hydrogen and methane will not accumulate in either Panel 3 or 4 in the time for the postulated methane explosion – see Appendix D to this PMR
- Continued monitoring is not feasible in panels after installation of the WPC.

Revision to Clarify Applicability of Ongoing Disposal Room VOC Monitoring

Changes being proposed are editorial and are included to clarify that ongoing disposal room VOC monitoring will be required for all panels, not just Panels 3 through 8, until final panel closure, unless explosion-isolation walls are installed in a panel.

Revise the Panel Closure Schedule in Table G-1

Table G-1 was updated to reflect current actual and anticipated dates. Note 2 was revised to be consistent with Permit Attachment A2 which defines closure start as the point when ventilation is blocked using chain link and brattice cloth or bulkheads. Consolidation of Notes 5 and 6 is an editorial change.

<u>**Editorial Corrections to Permit Text Regarding Panel Closure**</u>

Editorial changes are explained in the attached Table of Changes (Appendix A) for each respective change.

4. 20.4.1.900 NMAC (incorporating 40 CFR §270.42(c)(1)(iv)), requires the applicant to provide the applicable information required by 40 CFR §§270.13 through 270.22, 270.62, 270.63, and 270.66.

The regulatory crosswalk describes those portions of the WIPP Permit that are affected by this PMR. Where applicable, regulatory citations in this modification reference Title 20, Chapter 4, Part 1, NMAC, revised March, 2009, incorporating the CFR, Title 40 (40 CFR Parts 264 and 270). 40 CFR §§270.16 through 270.22, 270.62, 270.63 and 270.66 are not applicable at WIPP. Consequently, they are not listed in the regulatory crosswalk table. 40 CFR §270.23 is applicable to the WIPP Hazardous Waste Disposal Units (HWDUs).

5. 20.4.1.900 NMAC (incorporating 40 CFR §270.11(d)(1) and 40 CFR §270.30(k)),requires any person signing under paragraph a and b must certify the document in accordance with 20.4.1.900 NMAC.

The transmittal letter for this PMR contains the signed certification statement in accordance with Permit Condition 1.9 of the WIPP Permit.

References

ATWIR *Annual Transuranic Waste Inventory Report* - 2012 DOE/TRU-12-3425, Effective date 10/12. http://www.wipp.energy.gov/library/TRUwaste/ATWIR-2012.pdf.

Zerwekh, A, 1979, *Gas Generation from Radiolytic Attack of TRU-Contaminated Hydrogenous Waste*, LA-7674-MS, Los Alamos Scientific Laboratory, Los Alamos, NM.

Slezak, S. and A. Lappin, 1990, Memo to Darrell Mercer, Craig Fredrickson, DOE/SEIS Office, *Potential for and Possible Impacts of Generation of Flammable and/or Detonable Gas Mixtures During the WIPP Transportation, Test, and Operational Phases*, Sandia National Laboratories, Albuquerque, NM.

Regulatory Crosswalk

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
§270.13		Contents of Part A permit application	Attachment B Part A		✓
§270.14(b)(1)		General facility description	Attachment A		✓
§270.14(b)(2)	§264.13(a)	Chemical and physical analyses	Part 2.3.1 Attachment C		✓
§270.14(b)(3)	§264.13(b)	Development and implementation of waste analysis plan	Part 2.3.1.1 Attachment C		✓
	§264.13(c)	Off-site waste analysis requirements	Part 2.2.1 Attachment C		✓
§270.14(b)(5)	§264.15(a-d)	General inspection requirements	Part 2.7 Attachment E-1a		✓
	§264.174	Container inspections	Attachment E-1b(1)		✓
§270.23(a)(2)	§264.602	Miscellaneous units inspections	Attachment E-1b Attachment E-1b(1)		✓
§270.14(b)(6)		Request for waiver from preparedness and prevention requirements of Part 264 Subpart C	NA		✓
§270.14(b)(7)	264 Subpart D	Contingency plan requirements	Part 2.12 Attachment D		✓
	§264.51	Contingency plan design and implementation	Part 2.12.1 Attachment D		✓
	§264.52 (a) & (c-f)	Contingency plan content	Attachment D		✓
	§264.53	Contingency plan copies	Part 2.12.2 Attachment D		✓
	§264.54	Contingency plan amendment	Part 2.12.3 Attachment D		✓
	§264.55	Emergency coordinator	Part 2.12.4 Attachment D-4a(1)		✓
	§264.56	Emergency procedures	Attachment D-4		✓
§270.14(b)(8)		Description of procedures, structures or equipment for:	Attachment A Part 2.11		✓
§270.14(b)(8)(i)		Prevention of hazards in unloading operations (e.g., ramps and special forklifts)	Part 2.11		✓
§270.14(b)(8)(ii)		Runoff or flood prevention (e.g., berms, trenches, and dikes)	Attachment A1-1c(1) Part 2.11		✓
§270.14(b)(8)(iii)		Prevention of contamination of water supplies	Part 2.11		✓
§270.14(b)(8)(iv)		Mitigation of effects of equipment failure and power outages	Part 2.11		✓
§270.14(b)(8)(v)		Prevention of undue exposure of personnel (e.g., personal protective equipment)	Part 2.11		✓
§270.14(b)(8)(vi) §270.23(a)(2)	§264.601	Prevention of releases to the atmosphere	Part 2.11 Part 4.4 Attachment D-4e Attachment G-1a		✓
	264 Subpart C	Preparedness and Prevention	Part 2.10		✓
	§264.31	Design and operation of facility	Part 2.1		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
	§264.32	Required equipment	Part 2.10.1 Attachment D		✓
	§264.33	Testing and maintenance of equipment	Part 2.10.2 Attachment E-1a		✓
	§264.34	Access to communication/alarm system	Attachment E-1a Part 2.10.3		✓
	§264.35	Required aisle space	Part 2.10.4		✓
	§264.37	Arrangements with local authorities	Attachment D-4a(3)		✓
§270.14(b)(9)	§264.17(a-c)	Prevention of accidental ignition or reaction of ignitable, reactive, or incompatible wastes	Part 2.9		✓
§270.14(b)(10)		Traffic pattern, volume, and controls, for example: Identification of turn lanes Identification of traffic/stacking lanes, if appropriate Description of access road surface Description of access road load-bearing capacity Identification of traffic controls	Attachment A4		✓
§270.14(b) (11)(i) and (ii)	§264.18(a)	Seismic standard applicability and requirements	Attachment G2-2.2 Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(11)(iii-v)	§264.18(b)	100-year floodplain standard	Attachment A1-1c(1) Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(12)	§264.16(a-e)	Personnel training program	Part 2.8 Attachment F		✓
§270.14(b)(13)	264 Subpart G	Closure and post-closure plans	Part 6 & 7 Attachment G & H	✓	
§270.14(b)(13)	§264.111	Closure performance standard	Attachment G-1a	✓	
§270.14(b)(13)	§264.112(a), (b)	Written content of closure plan	Attachment G-1	✓	
§270.14(b)(13)	§264.112(c)	Amendment of closure plan	Part 6.3 Attachment G-1d(4)		✓
§270.14(b)(13)	§264.112(d)	Notification of partial and final closure	Attachment G-2a		✓
§270.14(b)(13)	§264.112(e)	Removal of wastes and decontamination/dismantling of equipment	Attachment G-1e(2)	✓	
§270.14(b)(13)	§264.113	Time allowed for closure	Part 6.5 Attachment G-1d		✓
§270.14(b)(13)	§264.114	Disposal/decontamination	Part 6.6 Attachment G-1e(2)	✓	
§270.14(b)(13)	§264.115	Certification of closure	Part 6.7 Attachment G-2a		✓
§270.14(b)(13)	§264.116	Survey plat	Part 6.8 Attachment G-2b		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
§270.14(b)(13)	§264.117	Post-closure care and use of property	Part 7.3 Attachment H-1a		✓
§270.14(b)(13)	§264.118	Post-closure plan; amendment of plan	Part 7.5 Attachment H-1a (1)		✓
§270.14(b)(13)	§264.178	Closure/containers	Part 6.9 Attachment A1-1h Attachment G-1		✓
§270.14(b)(13)	§264.601	Environmental performance standards-miscellaneous units	Attachment A-4 Attachment D-1 Attachment G-1a	✓	
§270.14(b)(13)	§264.603	Post-closure care	Part 7.3 Attachment G-1a(3)		✓
§270.14(b)(14)	§264.119	Post-closure notices	Part 7.4 Attachment H-2		✓
§270.14(b)(15)	§264.142	Closure cost estimate	NA		✓
	§264.143	Financial assurance	NA		✓
§270.14(b)(16)	§264.144	Post-closure cost estimate	NA		✓
	§264.145	Post-closure care financial assurance	NA		✓
§270.14(b)(17)	§264.147	Liability insurance	NA		✓
§270.14(b)(18)	§264.149-150	Proof of financial coverage	NA		✓
§270.14(b)(19)(i), (vi), (vii), and (x)		Topographic map requirements Map scale and date Map orientation Legal boundaries Buildings Treatment, storage, and disposal operations Run-on/run-off control systems Fire control facilities	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(ii)	§264.18(b)	100-year floodplain	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(iii)		Surface waters	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(iv)		Surrounding land use	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
§270.14(b)(19)(v)		Wind rose	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(viii)	§264.14(b)	Access controls	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(ix)		Injection and withdrawal wells	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(xi)		Drainage on flood control barriers	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(xii)		Location of operational units	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(20)		Other federal laws Wild and Scenic Rivers Act National Historic Preservation Act Endangered Species Act Coastal Zone Management Act Fish and Wildlife Coordination Act Executive Orders	Attachment B Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.15	§264 Subpart I	Containers	Part 3 Part 4.3 Attachment A1		✓
	§264.171	Condition of containers	Part 3.3 Attachment A1		✓
	§264.172	Compatibility of waste with containers	Part 3.4 Attachment A1		✓
	§264.173	Management of containers	Part 3.5 Attachment A1		✓
	§264.174	Inspections	Part 3.7 Attachment E-1 Attachment A1-1e		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
§270.15(a)	§264.175	Containment systems	Part 3.6 Attachment A1		✓
§270.15(c)	§264.176	Special requirements for ignitable or reactive waste	Attachment A1-1g Permit Part 2.1		✓
§270.15(d)	§264.177	Special requirements for incompatible wastes	Attachment A1-1g Permit Part 2.3.3.4		✓
	§264.178	Closure	Part 6 Attachment G	✓	
§270.15(e)	§264.179	Air emission standards	Part 4.4.2 Attachment N		✓
§270.23	264 Subpart X	Miscellaneous units	Part 1.3.1 Attachment A2-1 Attachment G1.3.1		✓
§270.23(a)	§264.601	Detailed unit description	Part 4 Part 5 Attachment A2 Attachment L		✓
§270.23(b)	§264.601	Hydrologic, geologic, and meteorologic assessments	Part 4 Part 5 Attachment A2 Attachment L		✓
§270.23(c)	§264.601	Potential exposure pathways	Part 4 Part 5 Attachment A2 Attachment N Attachment L		✓
§270.23(d)		Demonstration of treatment effectiveness	Part 4 Attachment A2 Attachment N		✓
	§264.602	Monitoring, analysis, inspection, response, reporting, and corrective action	Part 4 Part 5 Attachment A2 Attachment E-1 Attachment N Attachment L	✓	
	§264.603	Post-closure care	Attachment H Attachment H1	✓	
	264 Subpart E	Manifest system, record keeping, and reporting	Permit Part 1 Permit Part 2.13 & 2.14 Permit Part 4 Attachment C		✓
§270.30(j)(2)	§264.73(b)	Ground-water records	Part 1		✓
	264 Subpart F	Releases from solid waste management units	Part 5 & 7 Attachment G2 & L		✓
	§264.90	Applicability	Part 5 Attachment L		✓
	§264.91	Required programs	Attachment L		✓
	§264.92	Ground-water protection standard	Attachment L		✓
	§264.93	Hazardous constituents	Attachment L		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
	§264.94	Concentration limits	Part 5 Attachment L		✓
	§264.95	Point of compliance	Part 5 Attachment L		✓
	§264.96	Compliance period	Attachment L		✓
	§264.97	General ground-water monitoring requirements	Part 5 Attachment L		✓
	§264.98	Detection monitoring program	Part 5 Attachment L		✓
	§264.99	Compliance monitoring program	Part 5 Attachment L		✓
	§264.100	Corrective action program	Part 5 Attachment L		✓
	§264.101	Corrective action for solid waste management units	Part 8 Attachment L		✓
	264 Appendix IX	Ground-water Monitoring List	Part 5 Attachment L		✓

Appendix A
Table of Changes

Table of Changes

Affected Permit Section	Explanation of Change
Part 1, Section 1.5	Revise the definition of Explosion-isolation Wall (Section 1.5.15) to clarify that it is not part of the approved PCS, but incorporated in the panel closure design as specified in Permit Attachment G1.
Part 1, Permit Attachments	Editorial change in reference to Permit Attachment G1 to delete the associated parenthetical information that no longer applies.
Part 4, Section 4.4.3	Editorial changes to clarify that ongoing disposal room VOC monitoring will be required for all panels, not just Panels 3 through 8, until final panel closure, unless explosion-isolation walls are installed in a panel.
Part 4, Section 4.6.1.2	Change to delete text associated with certification of the stability of any explosion-isolation walls because explosion-isolation walls will no longer be accessible for inspection.
Part 4, Section 4.6.5	Deleted section in its entirety as it pertains solely to hydrogen and methane monitoring which is being deleted as part of this PMR.
Part 4, Permit Attachments	Editorial change in reference to Permit Attachment G1 to delete the associated parenthetical information that no longer applies. Deleted reference to Permit Attachment N1 that is being deleted in its entirety as part of this PMR.
Part 6, Permit Attachments	Editorial changes in references to Permit Attachment G and Permit Attachment G1 to delete the associated parenthetical information that no longer applies.
Attachment G, Introduction	Deleted text to mitigate the impacts of methane buildup and deflagration that may be postulated for some closed panels since a postulated methane explosion is being deleted as part of this PMR.
Attachment G, Section G-1a(2)	Deleted text to withstand any flammable gas deflagration that may occur prior to final facility closure since a flammable gas deflagration is being deleted as part of this PMR.
Attachment G, Section G-1d(1)	Change to delete redundant text with respect to initially blocking ventilation and panel specific closure schedule that is specified previously in Section G-1d(1) and in Table G-1. Change to add text to clarify that the Permittees initially block ventilation through the panel in compliance with Section A2-2a(3) of Permit Attachment A2. Change to delete text associated with installation of explosion-isolation walls since explosion-isolation walls are not required to be constructed as a component of the panel closure design.
Attachment G, Section G-1e	Editorial change to add the word “respectively” to clarify that Permit Attachment G1 pertains to the PCS and Permit Attachment G2 pertains to the shaft seal designs.

Affected Permit Section	Explanation of Change
Attachment G, Section G-1e(1)	Modified some PCS design requirements for clarity and applicability. Editorial change to delete the reference to Permit Attachment A2 because Permit Attachment A2 does not pertain to the performance standard for air emissions from the WIPP facility. Deleted text pertaining to explosion-isolation wall and design Option (D) since design Option D is no longer part of the panel closure design and explosion-isolation walls are not required to be constructed as a component of the panel closure design. Change to identify date of source term that was used as the design basis for the WPC. Change to delete text pertaining to release of VOCs by diffusion through container vents since VOCs were assumed to have already diffused from container vents and be in equilibrium with the air in the panel. Change to delete text pertaining to discussion on proposed panel closure design options and reference to design Option (D) since this discussion is no longer applicable for the final panel closure design.
Attachment G, Section G-1e(2)	Change to reword text for Item 6 to clarify that the item refers to emplacement in the last HWDU to be filled and not the final panel closure design itself.
Attachment G, Table G-1	Table G-1 was updated to reflect current actual and anticipated dates. Clarified text for NOTE 2. Deleted NOTE 6 and consolidated it into NOTE 5 and modified NOTE 5 to pertain to Panels 1 through 6. Applied NOTE 5 to Panel 6.
Attachment G, Figure G-4	Replaced the figure in its entirety with a new figure for the WPC design.
Attachment G1	Replaced the contents of this attachment with the text (without appendices) of the new WPC design report.
Attachment G1, Appendix D	Create a new Attachment G1, Appendix D, with the technical specifications for the WPC as presented in Appendix D of the new WPC design report.
Attachment G1, Appendix E	Create a new Attachment G1, Appendix E, with the design drawings for the WPC as presented in Appendix D of the new WPC design report.
Attachment G1, Appendix G	Deleted the appendix in its entirety. New panel closure technical specifications were incorporated into the new Attachment G1, Appendix D, that is being proposed for addition as part of this PMR.
Attachment G1, Appendix H	Deleted the appendix in its entirety. New panel closure design drawings were incorporated into the new Attachment G1, Appendix E, that is being proposed for addition as part of this PMR.
Attachment H, Section H-1	Change to add text to clarify that panel closures are designed to require no post-closure maintenance of the disposal unit rather than the closure system. Editorial change to add the word “Repository” to the reference to the VOC Monitoring Program to clearly identify that it is the Repository VOC Monitoring Program, and not the Disposal Room VOC Monitoring Program, that is an aspect of the post-closure care program for closed panels.
Attachment N, Table of Contents	Change made to the Table of Contents to reflect title change to Section N-3a(3).
Attachment N, Section N-3a(3)	Editorial changes to make section title consistent with titles for Section N-3a(1) and N-3a(2) and to clarify that ongoing disposal room VOC monitoring will be required for all panels, not just Panels 3 through 8, until final panel closure, unless explosion-isolation walls are installed in a panel.
Attachment N1	Deleted this attachment in its entirety as it pertains solely to hydrogen and methane monitoring which is being deleted as part of this PMR.

Appendix B
Proposed Revised Permit Text

Proposed Revised Permit Text:

PART 1 - GENERAL PERMIT CONDITIONS

1.5.13 Substantial Barrier

"Substantial barrier" means salt or other non-combustible material installed between the waste face and the bulkhead to protect the waste from events such as ground movement or vehicle impacts. The substantial barrier incorporates the chain link and brattice cloth room closure specified in Permit Attachment A2.

1.5.14 Bulkhead

"Bulkhead" means a steel structure, with flexible flashing, that is used to block ventilation as specified in Permit Attachment A2 (Geologic Repository).

1.5.15 Explosion-Isolation Wall

"Explosion-isolation wall" means the 12-foot wall intended as an explosion isolation device that has been constructed in Panels 1, 2, and 5 and is incorporated into the panel closure design as ~~is part of the approved panel-closure system~~ specified in Permit Attachment G1 (Detailed Design Report for an Operation Phase Panel Closure System).

1.5.16 Filled Panel

"Filled panel" means an Underground Hazardous Waste Disposal Unit specified in Permit Part 4 that will no longer receive waste for emplacement.

1.5.17 Internal Container

"Internal container" means a container inside the outermost container examined during radiography or visual examination (**VE**). Drum liners, liner bags, plastic bags used for contamination control, capillary-type labware, and debris not designed to hold liquid at the time of original waste packaging are not internal containers.

1.5.18 Observable Liquid

"Observable liquid" means liquid that is observable using radiography or VE as specified in Permit Attachment C (Waste Analysis Plan).

PERMIT ATTACHMENTS

Permit Attachment G1, "Detailed Design Report for an Operation Phase Panel Closure System." ~~(as modified from WIPP Hazardous Waste Facility Permit Amended Renewal Application, "Detailed Design Report for an Operation Phase Panel Closure System" – Appendix I1)~~

PART 4 - GEOLOGIC REPOSITORY DISPOSAL

4.4.3 Ongoing Disposal Room VOC Monitoring ~~in Panels 3 Through 8~~

The Permittees shall continue disposal room VOC monitoring in Room 1 of ~~Panels 3 through 8 after completion of waste emplacement~~a filled panel until final panel closure unless ~~the~~an explosion-isolation wall ~~specified in Permit Attachment G1 (Detailed Design Report for an Operation Phase Panel Closure System)~~ is installed in the panel.

4,6,1,2 Reporting Requirements

The Permittees shall submit to the Secretary an annual report in October evaluating the geomechanical monitoring program and shall include geomechanical data collected from each Underground HWDU during the previous year, as specified in Permit Attachment A2, Section A2-5b(2), "Geomechanical Monitoring", and shall also include a map showing the current status of HWDU mining. ~~The Permittees shall also submit at that time an annual certification by a registered professional engineer certifying the stability of any explosion-isolation walls.~~ The Permittees shall post a link to the geomechanical monitoring report transmittal letter on the WIPP Home Page and inform those on the e-mail notification list as specified in Permit Section 1.11.

~~4.6.5 Hydrogen and Methane Monitoring~~

~~4.6.5.1 Implementation of Hydrogen and Methane Monitoring~~

~~The Permittees shall implement the Hydrogen and Methane Monitoring Plan specified in Permit Attachment N1 (Hydrogen and Methane Monitoring Plan).~~

~~4.6.5.2 Reporting Requirements~~

~~The Permittees shall report to the Secretary semi-annually in April and October the data and analysis of the Hydrogen and Methane Monitoring Plan.~~

~~4.6.5.3 Notification Requirements~~

~~The Permittees shall notify the Secretary in writing, within seven calendar days of obtaining validated analytical results, whenever the concentration of hydrogen or methane in a filled panel exceeds the action levels specified in Table 4.6.5.3 below.~~

The Permittees shall post a link to the notification letter on the WIPP Home Page and inform those on the e-mail notification list as specified in Permit Section 1.11.

Table 4.6.5.3 - Action Levels for Hydrogen and Methane Monitoring		
Compound	Action Level 1	Action Level 2
Hydrogen	4,000 ppm	8,000 ppm
Methane	5,000 ppm	10,000 ppm

4.6.5.4 Remedial Action

Upon receiving validated analytical results that indicate at least one compound exceeded "Action Level 1" in Table 4.6.5.3, the sampling frequency in that filled panel will increase to once per week. Upon receiving validated analytical results that indicate at least one compound exceeded "Action Level 2" in Table 4.6.5.3 in two consecutive weekly samples, the Permittees shall install in that panel the explosion-isolation wall specified in Permit Attachment G1.

4.6.5.5 Sampling Line Loss

The Permittees shall notify the Secretary in writing within seven calendar days of the discovery of loss of sampling line(s). The Permittees shall evaluate any loss of sampling lines as described in Permit Attachment N1, Section N1-5b, "Sample Tubing", and shall notify the Secretary in writing within seven calendar days the results of such evaluation. The Permittees shall also post a link to such notification letters on the WIPP Home Page and inform those on the e-mail notification list as specified in Permit Section 1.11

PERMIT ATTACHMENTS

Permit Attachment G1, "Detailed Design Report for an Operation Phase Panel Closure System." (as modified from WIPP Hazardous Waste Facility Permit Amended Renewal Application, "Detailed Design Report for an Operation Phase Panel Closure System" – Appendix I1).

Permit Attachment N1 (as modified from WIPP Hazardous Waste Facility Permit Amended Renewal Application, "Hydrogen and Methane Monitoring Plan" - Appendix N1)

PART 6 – CLOSURE REQUIREMENTS

Permit Attachment G, “Closure Plan.” (as modified from WIPP RCRA Part B Permit Application, “Closure Plans, Post-Closure Plans, and Financial Requirements” - Chapter I).

Permit Attachment G1, “Detailed Design Report for an Operation Phase Panel Closure System.” (as modified from WIPP RCRA Part B Permit Application, “Detailed Design Report for an Operation Phase Panel Closure System” - Appendix I1).

ATTACHMENT G

CLOSURE PLAN

Introduction

This plan was submitted to the New Mexico Environment Department (**NMED**) and the U.S. Environmental Protection Agency (**EPA**) in accordance with 20.4.1.900 NMAC (incorporating 40 CFR §270.14(b)(13)). Closure at the panel level will include the construction of barriers to limit the emission of hazardous waste constituents from the panel into the mine ventilation air stream below levels that meet environmental performance standards[1] ~~and to mitigate the impacts of methane buildup and deflagration that may be postulated for some closed panels~~. The Post-Closure Plan (Permit Attachment H) includes the implementation of institutional controls to limit access and groundwater monitoring to assess disposal system performance. Until final closure is complete and has been certified in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.115), a copy of the approved Closure Plan and all approved revisions will be on file at the WIPP facility and will be available to the Secretary of the NMED or the EPA Region VI Administrator upon request.

G-1a(2) Miscellaneous Unit

Post-closure migration of hazardous waste or hazardous waste constituents to ground or surface waters or to the atmosphere, above levels that will harm human health or the environment, will not occur due to facility engineering and the geological isolation of the unit. The engineering aspects of closure are centered on the use of panel closures on each of the underground HWDUs and final facility seals placed in the shafts. The design of the panel closure system is based on the criteria that the closure system for closed underground HWDUs will prevent migration of hazardous waste constituents in the air pathway in concentrations above health-based levels beyond the WIPP land withdrawal boundary during the 35 year operational and facility closure period ~~and to withstand any flammable gas deflagration that may occur prior to final facility closure~~.

G-1d(1) Schedule for Panel Closure

The anticipated schedule for the closure of the underground HWDUs ~~known as Panels 3 through 8~~ is shown in Figure G-2. This schedule assumes there will be little contamination within the exhaust drift of the panel. Underground HWDUs should be ready for closure according to the schedule in Table G-1. These dates are estimates for planning and permitting purposes. Actual dates may vary depending on the availability of waste from the generator sites.

[1] The mechanism for air emissions prior to closure is different than the mechanism after closure. Prior to closure, volatile organic compounds (VOC) will diffuse through drum filters based on the concentration gradient between the disposal room and the drum headspace. These VOCs are swept away by the ventilation system, thereby maintaining a concentration gradient that is assumed to be constant. Hence, the VOCs in the ventilation stream are a function of the number of containers only. After closure, the panel air will reach an equilibrium concentration with the drum headspace and no more diffusion will occur. The only mechanism for release into the mine ventilation system is due to pressure that builds up in the closed panel. This pressure arises from the creep closure mechanism that is reducing the volume of the rooms and from the postulated generation of gas as the result of microbial degradation of organic matter in the waste. Consequently, the emissions after panel closure are a direct function of pressurization processes and rates within the panel.

In the schedule in Figure G-2, notification of intent to close occurs 30 days before placing the final waste in a panel. Once a panel is full, the Permittees will initially block ventilation through the panel as described in Permit Attachment A2, Section A2-2a(3) "Subsurface Structures," and then will assess the closure area for ground conditions and contamination so that a definitive schedule and closure design can be determined. If as the result of this assessment the Permittees determine that a panel closure cannot be emplaced in accordance with the schedule in this Closure Plan, a modification will be submitted requesting an extension to the time for closure.

~~The Permittees will initially block ventilation through Panel 5 as described in Permit Attachment A2, Section A2-2a(3), "Subsurface Structures," once Panel 5 is full. The Permittees will then install the explosion-isolation wall portion of the panel closure system that is described in Permit Attachment G1, Section 3.3.2, "Explosion- and Construction-Isolation Walls." Construction of the explosion-isolation wall shall be completed within 180 days after the last receipt of waste in Panel 5. Final closure of Panels 1, 2, and 5 will be completed as specified in this Permit no later than January 31, 2016.~~

~~To ensure continued protection of human health and the environment, the Permittees will initially block ventilation through Panels 3 through 7 as described in Permit Attachment A2, Section A2-2a(3), after waste disposal in each panel has been completed. The Permittees shall continue VOC monitoring in such panels until final panel closure. If the measured concentration, as confirmed by a second sample, of any VOC in a panel exceeds the "95% Action Level" in Permit Part 4, Table 4.6.3.2, the Permittees will initiate closure of that panel by installing the 12-foot explosion-isolation wall as described in Section G-1e(1) and submit a Class 1* permit modification request to extend closure of that panel, if necessary. Regardless of the outcome of disposal room VOC monitoring, final closure of Panels 3 through 7 will be completed as specified in this Permit no later than January 31, 2016.~~

G-1e Closure Activities

Closure activities include those instituted for panel closure (i.e., closure of filled underground HWDUs), contingency closure (i.e., closure of surface HWMUs and decontamination of other waste handling areas), and final facility closure (i.e., closure of surface HWMUs, D&D of surface facilities and the areas surrounding the WHB, and placement of repository shaft seals). Panel closure systems will be emplaced to separate areas of the facility and to isolate panels. Permit Attachments G1 and G2 provide panel closure system and shaft seal designs, respectively. All closure activities will meet the applicable quality assurance (**QA**)/quality control (**QC**) program standards in place at the WIPP facility. Facility monitoring procedures in place during operations will remain in place through final closure, as applicable.

G-1e(1) Panel Closure

Following completion of waste emplacement in each underground HWDU, disposal-side ventilation will be established in the next panel to be used, and the panel containing the waste will be closed. A panel closure system will be emplaced in the panel access drifts, in accordance with the design in Permit Attachment G1 and the schedule in Figure G-2 and Table G-1. The panel closure system is designed to meet the following requirements that were established by the DOE for the design to comply with 20.4.1.500 NMAC (incorporating 40 CFR §264.601(a)):

- the panel closure system shall contribute to meeting the environmental performance standards in Permit Part 4, Section 4.6.2 by mitigating the migration of VOCs from closed panels~~limit the migration of VOCs to the compliance point so that compliance is achieved by at least one order of magnitude~~
- the panel closure system shall consider potential flow of VOCs through the disturbed rock zone (**DRZ**) in addition to flow through closure components
- the panel closure system shall perform its intended functions under loads generated by creep closure of the tunnels
- ~~the panel closure system shall perform its intended function under the conditions of a postulated methane explosion~~
- the nominal operational life of the closure system is 35 years
- the panel closure system may require minimal maintenance per 20.4.1.500 NMAC (incorporating 40 CFR 264.111)~~for each individual panel shall not require routing maintenance during its operational life~~
- the panel closure system shall address the expected~~most severe~~ ground conditions ~~expected~~ in the waste disposal area
- ~~the design class of~~ the panel closure system shall be built of substantial construction and non-combustible material except for flexible flashing used to accommodate salt movement ~~IIIb (which means that it is to be built to generally accepted national design and construction standards)~~
- the design and construction shall follow conventional mining practices
- structural analysis shall use data acquired from the WIPP underground
- materials shall be compatible with their emplacement environment and function
- treatment of surfaces in the closure areas shall be considered in the design
- ~~thermal cracking of concrete shall be addressed~~
- ~~during construction,~~ a QA/QC program shall ~~be established to~~ verify material properties and construction ~~practices~~
- construction of the panel closure system shall consider shaft and underground access and services for materials handling

The performance standard for air emissions from the WIPP facility is established in Permit Part 4 ~~and Permit Attachment A2~~. Releases shall be below these limits for the facility to remain in compliance with standards to protect human health and the environment. The ~~following~~ panel closure design has been shown, through analysis, to meet these standards, if emplaced in accordance with the specifications in Permit Attachment G1.

~~The approved design for the panel closure system calls for a composite panel barrier system consisting of a rigid concrete plug with removal of the DRZ, and an explosion-isolation wall.~~ The design basis for this closure is such that the migration of hazardous waste constituents from closed panels during the operational and closure period would result in concentrations well below health-based standards. The source term used as the design basis included the average concentrations of VOCs from CH waste containers as measured in headspace gases through November 2010~~January 1995~~. The VOCs are assumed ~~to have been released by diffusion through the container vents and are assumed~~ to be in equilibrium with the air in the panel. Emissions from the closed panel occur at a rate determined by gas generation within the waste and creep closure of the panel.

Figures G-4 and G-5 show a diagram of the panel closure design and installation envelopes. Permit Attachment G1 provides the detailed design and the design analysis for the panel closure system. ~~Although the permit application proposed several panel closure design options, depending on the gas generated by wastes and the age of the mined openings, the NMED and EPA determined that only the most robust design option (D) would be approved. This decision does not prevent the Permittees from continuing to collect data on the behavior of the wastes and mined openings, or proposing a modification to the Closure Plan in the future, using the available data to support a request for reconsideration of one or more of the original design options. If a design different from Option D as defined in Permit Attachment G1 is proposed, the appropriate permit modification will be sought.~~

G-1e(2) Decontamination and Decommissioning

The objective of D&D activities at the WIPP facility is to return the surface to as close to the preconstruction condition as reasonably possible, while protecting the health and safety of the public and the environment. Major activities required to accomplish this objective include, but are not limited to the following:

1. Review of operational records for historical information on releases
2. Visual examination of surface structures for evidence of spills or releases
3. Performance of site contamination surveys
4. Decontamination, if necessary, of usable equipment, materials, and structures including surface facilities and areas surrounding the WHB.
5. Disposal of equipment/materials that cannot be decontaminated but that meet the treatment, storage, and disposal facility waste acceptance criteria (**TSDF-WAC**) in an underground HWDU
6. Emplacement of ~~final~~ panel closure system in the last HWDU
7. Emplacement of shaft seals[2]
8. Regrading the surface to approximately original contours

[2] For the purposes of planning, the conclusion of shaft sealing is used by the DOE as the end of closure activities and the beginning of the Post-Closure Care Period.

9. Initiation of active controls

Table G-1
Anticipated Earliest Closure Dates for the Underground HWDUs

HWDU	OPERATIONS START	OPERATIONS END	CLOSURE START	CLOSURE END
PANEL 1	3/99*	3/03*	3/03*	7/03* SEE NOTE 5
PANEL 2	3/03*	10/05*	10/05*	3/06* SEE NOTE 5
PANEL 3	4/05*	2/07*	2/07*	2/07* SEE NOTE 56
PANEL 4	1/07*	5/09*	5/09*	8/09* SEE NOTE 56
PANEL 5	3/09*	7/11*	7/11*	1/12 SEE NOTE 5
PANEL 6	3/11*	1/132/14	3/142/13	9/148/13 SEE NOTE 5
PANEL 7	81/13	9/171/15	10/172/15	4/188/15
PANEL 8	1/171/15	5/211/17	6/212/17	12/218/17
PANEL 9	1/179/20	1/281/25	2/282/25	SEE NOTE 4
PANEL 10	1/285/24	9/30	10/30	SEE NOTE 4

* Actual date

NOTE 1: Only Panels 1 to 4 will be closed under the initial term of this permit. Closure schedules for Panels 5 through 10 are projected assuming new permits will be issued in 2009 and 2019.

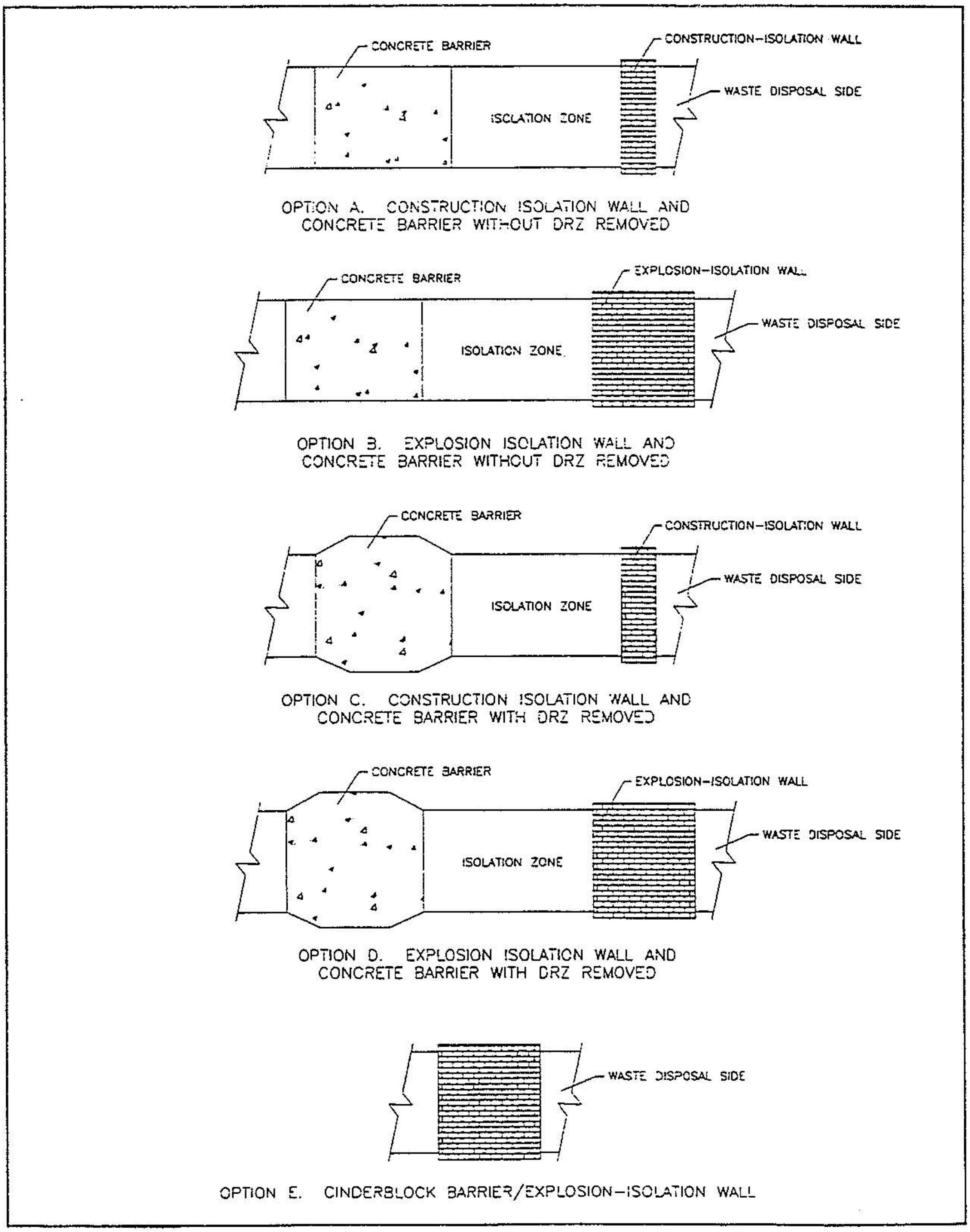
NOTE 2: The point of closure start is defined as the date when ventilation to the panel is blocked per Permit Attachment A260 days following notification to the NMED of closure.

NOTE 3: The point of closure end is defined as 180 days following placement of final waste in the panel.

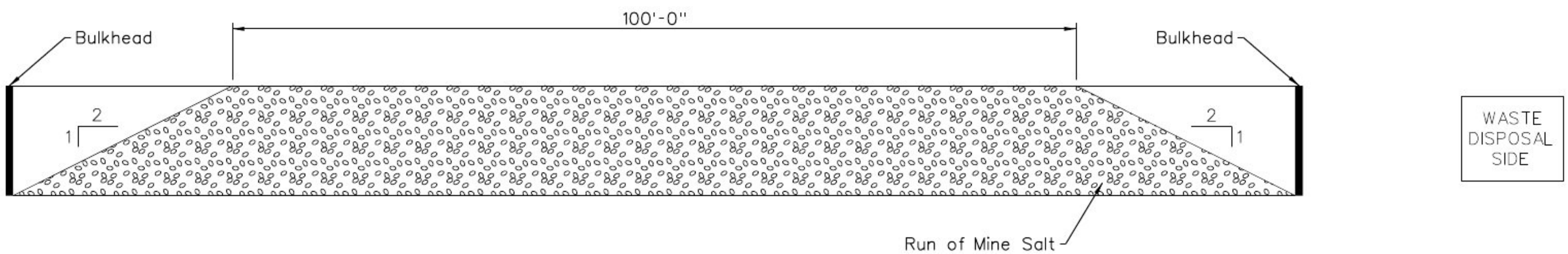
NOTE 4: The time to close these areas may be extended depending on the nature and extent of the disturbed rock zone. The excavations that constitute these panels will have been opened for as many as 40 years so that the preparation for closure may take longer than the time allotted in Figure G-2. If this extension is needed, it will be requested as an amendment to the Closure Plan.

NOTE 5: Installation of the 12-foot explosion-isolation wall for Panels 1, 2, and 5 must be completed by the closure end date. Final closure of Panels 1 through 6, 2, and 5 will be completed as specified in this Permit no later than January 31, 2016.

NOTE 6: Final closure of Panels 3 and 4 will be completed as specified in this Permit no later than January 31, 2016.



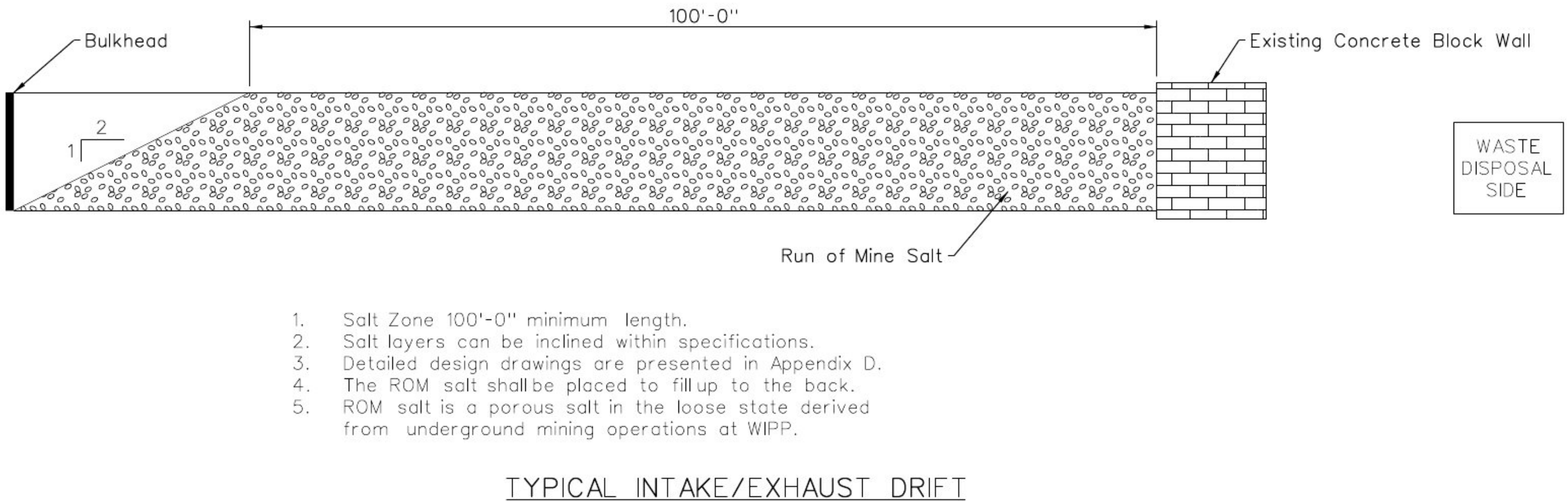
~~Figure G-4~~
~~Design of a Panel Closure System~~



1. Salt Zone 100'-0" minimum length.
2. Salt layers can be inclined within specifications.
3. Detailed design drawings are presented in Appendix D.
4. The ROM salt shall be placed to fill up to the back.
5. ROM salt is a porous salt in the loose state derived from underground mining operations at WIPP.

Panel access drifts without existing block walls.

Figure G-4
Design of a Panel Closure System



Panel access drifts with existing block walls.

Panel 1 intake and Panel 5 exhaust drifts represent extremes with respect to drifts with existing block walls. Panel closures for other drifts with existing block walls will be constructed at or within these two extremes.

Figure G-4
Design of a Panel Closure System (continued)

ATTACHMENT G1

DESIGN REPORT FOR A PANEL CLOSURE SYSTEM AT THE WASTE ISOLATION PILOT PLANT

Adapted from the October 2012 Design Report for a Panel Closure System at the Waste Isolation Pilot Plant

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*Appendices A and B are not included in the Permit.

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LIST OF ABBREVIATIONS/ACRONYMS/UNITS

cfm	cubic feet per minute
CFR	Code of Federal Regulations
CCl_4	Carbon tetrachloride
cm	centimeter
DOE	Department of Energy
DRZ	disturbed rock zone
ft	foot (feet)
FLAC	Fast Lagrangian Analysis of Continua
FLAC3D	Fast Lagrangian Analysis of Continua in Three Dimensions
HBL	Health Based Levels
kcfm	thousands of cubic feet per minute
kg	kilogram
LHD	load haul dump
m	meter
min	minute
mm	milimeter
MPa	megapascal
MSHA	Mine Safety and Health Administration
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
PCS	panel closure system
Permit	WIPP Hazardous Waste Facility Permit
ppbv	parts per billion by volume
psi	pounds per square inch
QA/QC	quality assurance/quality control
RAA	running annual average
RCRA	Resource Conservation and Recovery Act
ROM	run-of-mine
s	second
SNL	Sandia National Laboratories
TRU	transuranic
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant
WPC	WIPP Panel Closure

ATTACHMENT G1

DETAILED DESIGN REPORT FOR AN OPERATION PHASE PANEL CLOSURE SYSTEM

Executive Summary

Scope. This report describes the design and evaluation of a Waste Isolation Pilot Plant (**WIPP**) Panel Closure (**WPC**) system consisting of run-of-mine (**ROM**) salt and steel bulkheads.

The report was modified to make it a part of the Resource Conservation and Recovery Act (**RCRA**) Permit issued by the New Mexico Environment Department (**NMED**) and represents a proposal to modify the closure plan from the previously described Option D design. Other changes included in this version of the report revised for the Permit are minor formatting changes to be consistent with the Permit format that include revision of table and figure numbers and the movement of all figures to the end of the document. Appendices A and B in the original document are not included in this Permit Attachment. Although these Appendices were important in demonstrating that the panel closures will meet the Panel Closure requirements identified in Permit Attachment G, they do not provide design details or plans to be implemented as Permit requirements. References to these original Appendices were modified to indicate that they were part of the design report, but are not included in the Permit. In contrast, Appendix C (Technical Specifications) and Appendix D (Design Drawings) are necessary components of future activities and are retained as parts of this Permit Attachment.

Purpose. The purpose of the WPC is to comply with the closure performance standard in Permit Attachment G, Section G-1a pursuant to 20.4.1.500 NMAC (incorporating 40 CFR 264 Subpart X).

The WPC will be located in the panel air-intake and panel air-exhaust drifts of each waste-filled panel as shown in Figure G1-1. Two steel bulkheads will be placed at the ends of the ROM salt. This report also presents an alternate design for filled Panels 1, 2 and 5 where explosion isolation walls have been installed. The alternate design consists of one steel bulkhead and a block wall placed at the ends of the ROM salt.

Volatile Organic Compounds (**VOCs**) flow analyses through the WPC and then from the repository show that VOC concentrations will not exceed VOC Health Based Levels (**HBLs**) at the WIPP site boundary. In addition, the WPC will comply with the applicable requirements of the Mine Safety and Health Administration (**MSHA**). Finally, the WPC will use common construction practices according to existing standards to the extent practicable.

Background. In 1996, a report entitled "Detailed Design Report for an Operational Phase Panel-Closure System" was prepared. This design was submitted as part of the original Hazardous Waste Facility Permit (Permit) application to the **NMED**. The NMED subsequently selected portions of the report and included them in the issued permit.

Section 4.6.2 of the current Permit establishes limits and actions for VOCs of concern. The VOCs of concern in the Permit include carbon tetrachloride (**CCl_4**), chlorobenzene, chloroform, 1,1-dichloroethene, 1,2-dichloroethane, methylene chloride, 1,1,2,2-tetrachloroethane, toluene and 1,1,1-trichloroethane. Additional VOCs that contribute lesser risks are considered in this report. New VOCs and HBLs for the VOCs have been identified for the WIPP site boundary and are used in the report (Kehrman, 2012, Table 11).

Revised performance requirements are presented in this report. The WPC is evaluated against these revised performance requirements.

Design. The WPC consists of two steel bulkheads and ROM salt. An alternate WPC for Panels 1, 2, and 5 consists of one steel bulkhead, ROM salt and one block wall. The construction methods and materials used in the design represent available technologies from previous mining projects (Fernandez et al., 1994, pp. 5-11 to 5-20) and as demonstrated by recent insitu testing of ROM salt (Zimmerly and Zavicar, 2012). No special requirements are identified for these components during the operational period of the repository. The fabrication, installation and maintenance of ventilation bulkheads are standard practice. Salt can be pushed reasonably tight to the underground surfaces of the drifts. A variety of techniques are available for placing the salt. These construction methods are simple and allow flexibility in construction scheduling and construction materials transportation.

Evaluation of WPC Performance. The evaluation of the WPC presented in this report included a review of current information on repository ventilation, VOC source terms and expected concentrations of VOCs in the mine exhaust air stream. Based upon a review of this information, a design performance specification was developed to emplace salt over a minimum length of 100 ft.

The ROM salt may be emplaced in a series of layers. The emplacement density is expressed in terms of fractional density, which is represented as a percentage of the intact density (135 lbf/ft^3 [2,160 kg/m^3]). The ROM salt is emplaced at an assumed fractional density of 65% (88 lbf/ft^3 [1,400 kg/m^3]).

Steel bulkheads with flexible flashing to accommodate salt creep are used in the WPC design. Farnsworth (2011) indicated that smaller drifts with bulkheads near the Exhaust Shaft in the WIPP underground have resistances as high as 2,200 Practical Units [2,200 (milli-in wg)/$kcfm^2$]. The smaller drifts with bulkheads near the Exhaust Shaft are the closest in size to the Panel intake and exhaust drifts.

Structural analyses of the ROM salt in a single zone were performed using a Fast Lagrangian Analysis of Continua in Three Dimensions (**FLAC3D**) computer code. FLAC3D is used by the WIPP site for geotechnical analyses and was used for the previous WPC design analyses. The FLAC3D analyses showed that an air gap between panel entry ceilings and the top of the run-of mine salt forms and increases over a period of several years. The air gap forms because initially the rate of settlement of the ROM salt exceeds the rate of panel-entry creep closure. Two years after WPC installation, the air gap starts to close. The air gap reaches a maximum value of 19 inches (47 centimeter [**cm**]). After approximately 23 years, the air gap is eliminated. Also, the fractional density of ROM salt increases with time. These calculations are input into the VOCs Flow Model.

VOCs Flow Model. The VOC flow analyses evaluate the flow of VOCs of concern through the WPC. The VOCs Flow Model considers VOCs emissions from open rooms (Kehrman, 2012, Table 12) up until the time that air gaps close within individual WPCs. When air gaps are present, air flow resistance is predominately due to steel bulkhead resistances for individual panels. After approximately 23 years, the air gap closes and the air flow resistance is predominately due to the consolidated ROM salt. VOCs flow equals the product of the air flow rate and the average headspace concentration for individual panels at this time. The VOCs flow model is based upon inventory average headspace concentrations (Kehrman, 2012, Table 1). The analysis compares the predicted results to measured results. The model is then used to evaluate future VOCs emissions considering ventilation air flow effects, other source terms for air flow (panel creep closure and gas generation) and average headspace concentrations of individual VOCs. Air flow due to ventilation through the air gap and ROM salt zone of the WPC is evaluated considering the air conductivity of ROM salt and the surrounding disturbed rock zone (**DRZ**), and the air flow resistance of steel bulkheads. The air conductivity values for all components are discussed in Section 3.

The results show a reduction in the air gap and air conductivity with time from panel intake drift and exhaust drift creep closure that isolates the waste from the underground ventilation air stream starting approximately 2 years after WPC installation with complete air gap closure after 23 years. The results indicate that for a period of about 23 years after WPC installation (28 years after panel excavation), the air flow induced from ventilation effects is dominant and that after this period of time, gas generation and panel creep closure would become dominant.

The analysis accounts for the reduction of VOC concentrations at the Exhaust Shaft of the WIPP due to underground repository ventilation, and then due to atmospheric dispersion to the WIPP site boundary (Kehrman, 2012, Table 6). The analyses consider only this receptor boundary, and do not provide calculations at other intermediate surface and underground receptor points.

The analysis uses HBLs that have been identified by the WIPP Project (Kehrman, 2012, Table 11). The projected concentrations from the VOC flow model are compared to the HBLs at the site boundary through calculation of risk fractions. These evaluations include the case for peak emissions from the WIPP repository.

The predicted mass flow rates for VOCs through the WPC (including flow through the air gap; the ROM salt; DRZ and the steel bulkheads) from ventilation, panel creep closure and gas generation are estimated to result in concentrations that are below the HBLs (Kehrman, 2012, Table 11) for the receptor point at the WIPP site boundary. Concentrations at other surface and underground receptor locations were not analyzed as part of this scope of work.

While no specific requirements exist for closing disposal areas under MSHA regulations, the intent of the regulations is to safely isolate abandoned areas from active workings using barricades of substantial construction.

This report presents the WPC system description with supporting calculations (Appendices A to B), Specifications (Appendix C), and Engineering Drawings (Appendix D) that comply with the design requirements for the WPC. Structural and air flow analyses are used to select the design features and are based upon data acquired from the WIPP underground. The Drawings illustrate the construction and details for the WPC. The Specifications cover the general requirements of the system, quality assurance and quality control, site work, and ROM salt emplaced in the panel entries. The WPC can be built to generally accepted national design and construction standards.

The design complies with the revised design requirements established for the WPC. The design can be constructed in the underground environment with no special requirements at the WIPP facility.

1.0 Introduction

The Waste Isolation Pilot Plant (**WIPP**) facility is a U.S. Department of Energy (**DOE**) facility located near Carlsbad, New Mexico, established for the safe disposal of defense-generated transuranic (**TRU**) waste. The WIPP repository is 2,150 feet (**ft**) (655 meters [**m**]) below the surface, in the Salado Formation.

One important aspect of repository operations at the WIPP facility is the activity associated with closure of waste disposal panels. Each panel consists of a panel air-intake drift, a panel air-exhaust drift, and seven rooms (Figure G1-1). After completion of waste disposal activities in a panel, it must be closed. The closure of individual panels during the operational period is conducted in compliance with the WIPP Hazardous Waste Facility Permit (**Permit**).

In 1996, a report entitled "Detailed Design Report for an Operational Phase Panel-Closure System" (DOE, 1996) was prepared. That design was submitted as part of the original Permit application to the New Mexico Environment Department (**NMED**). The NMED subsequently selected portions of the 1996 report and included them in the Permit.

This report builds on data collection and presents a design consisting of a run-of-mine (**ROM**) salt and steel bulkheads as are currently used in the WIPP repository. ROM salt is defined as a porous salt in the loose state derived from underground mining operations.

1.1 Scope

This report describes the design of the WIPP Panel Closure (**WPC**), presents WPC analyses relating to structural response and volatile organic compounds (**VOCs**) flow, and provides an evaluation of the WPC against revised design requirements presented in Chapter 2. The WPC consists of ROM salt and steel bulkheads for 10 panels. The WPC relies on air flow resistance of ventilation bulkheads to control VOCs emissions at the WIPP site receptor boundary for 23 years following each individual panel closure installation. The work scope does not include other intermediate receptor points.

The design complies with the revised design requirements established for the WPC. The proposed design is of substantial construction and complies with applicable requirements promulgated by the U. S. Department of Labor Mine Safety and Health Administration (**MSHA**).

1.2 Regulatory Requirements

The following subsections discuss the regulatory requirements specified in the Resource Conservation and Recovery Act (**RCRA**) and MSHA that apply to closure.

1.2.1 Resource Conservation and Recovery Act (40 CFR 264 and 270)

The Closure Plan in the WIPP Permit (NMED, 2012) was prepared in accordance with the requirements of 20.4.1.500 New Mexico Administrative Code (incorporating Title 40, Code of Federal Regulations [**CFR**], Part 264, Subparts G, I and X). The WPC design incorporates measures to mitigate VOC migration for compliance with environmental performance standards.

1.2.2 Mine Safety and Health Administration

Under 30 CFR 57 (MSHA, 2012), “seals and stoppings” must be constructed of noncombustible materials appropriate for the specific mine category and must be of “substantial construction.” “Substantial construction” implies construction of such strength, material and workmanship that the barrier could withstand conditions expected in the mining environment. As discussed subsequently in this report, the WPC complies with relevant requirements.

1.3 Report Organization

This report presents the engineering analysis of the WPC in each panel entry consisting of two steel bulkheads and ROM salt emplaced to a minimum length of 100 feet. Chapter 2 presents the Permit Design Requirements and a description of the final design in terms of WPC design components. Chapter 3 presents the design evaluations addressing the structural adequacy and the VOC flow of the WPC. Chapter 4 presents a list of the technical specifications for the design. Chapter 5 presents a list of the design drawings. Chapter 6 presents conclusions. Chapter 7 presents supporting references.

2.0 Design Descriptions

This chapter presents the WPC evaluated in this report, including its design requirements and design components.

2.1 Permit Design Requirements

Original design requirements were presented in Table 7-1 of DOE, 1996, and were accepted in the Permit. Since then, the Permittees have collected gas emission and mined opening performance data that has greatly increased the understanding of current and future conditions in the repository. This increased understanding has led to a reassessment of the design requirements for a panel closure system. The WPC was evaluated against the following revised design requirements:

- The panel closure system shall contribute to meeting the environmental performance standards in Permit Part 4 Section 4.6.2 by mitigating the migration of VOCs from closed panels.
- The panel closure system shall consider potential flow of VOCs through the disturbed rock zone (**DRZ**) in addition to flow through closure components.
- The panel closure system shall perform its intended functions under loads generated by creep closure of the tunnels.
- The nominal operational life of the closure system is 35 years.
- The panel closure system may require minimal maintenance per 20.4.1.500 NMAC (incorporating 40 CFR 264.111).
- The panel closure system shall address the expected ground conditions in the waste disposal areas.
- The panel closure system shall be built of substantial construction and non-combustible material except for flexible flashing used to accommodate salt movement.
- The design and construction shall follow conventional mining practices.
- Structural analysis shall use data acquired from the WIPP underground.
- Materials shall be compatible with their emplacement environment and function.
- Treatment of surfaces in the closure areas shall be considered in the design.
- A Quality Assurance/Quality Control (**QA/QC**) program shall verify material properties and construction.
- Construction of the panel closure system shall consider shaft and underground access and services for materials handling.

Chapter 6 presents the expected compliance of the WPC with these requirements and identifies the sections of this report where each requirement is addressed.

Figure G1-2 and Figure G1-3 illustrate the design that is evaluated in this report. Figure G1-2 applies to drifts without existing block walls. Figure G1-3 shows the configuration for drifts with existing block walls.

Conventional mining practices will be used in construction of the WPC. After completion of waste emplacement operations in future active panels, in-by steel bulkheads will be installed in the intake and exhaust panel entries as illustrated in Figure G1-2. Work packages prepared for the fabrication and installation of bulkheads will list the materials used, the equipment used, special precautions and limitations. Each work package will address prerequisites for installing the WPC and the required performance and documentation of such performance.

The ROM salt can be emplaced using conventional mining equipment in such a manner as to maintain a slope of 2 horizontal to 1 vertical at the ends. The ROM salt can be emplaced as is from the mining operations at an assumed fractional density of 65% (Zimmerly and Zavicar, 2012). After salt emplacement, the outer steel bulkhead is installed.

Three panels have block walls[3] installed and an alternate design is presented for these panels. The installation of the WPC in these panels shall follow preapproved work packages as outlined previously. In these cases (Figure G1-3), the ROM salt is emplaced up to the block wall. After salt emplacement, the outer steel bulkhead is installed.

2.2 Design Components

The following subsection presents system and component design features. Appendices C and D present specifications and drawings for the WPC, respectively. Individual specifications address shaft and underground access and materials handling, construction quality control, treatment of surfaces in the closure areas, and applicable design and construction standards.

2.2.1 Steel Bulkhead

The steel bulkhead (Figure G1-4) serves to block ventilation at the intake and exhaust of the panel and prevents personnel access. This use of a bulkhead is a standard practice and will be constructed as a typical WIPP bulkhead with no access (NMED, 2012, Figure N1-2). The bulkhead will consist of a noncombustible steel member frame covered with sheet metal. Telescoping tubular steel is used to bolt the bulkhead to the floor and roof. Flexible flashing material such as a rubber conveyor belt (or other appropriate material) will be attached to the steel frame and the salt as a gasket, thereby providing an effective yet flexible blockage to ventilation air. The steel bulkheads need maintenance for air flow resistance and the accommodation of panel entry salt creep during a 23-year period following each individual panel closure installation. The out-by bulkhead will be repaired, renovated or replaced as required. The WPC relies upon bulkheads for approximately 23 years to control VOCs flow. During this period steel bulkheads may need to be maintained or replaced and the surrounding DRZ may need to be treated or removed to provide air flow resistance as intended.

[3] The block wall was originally designed to resist underground methane deflagration due to a hypothetical buildup of methane gas after panel closure.

2.2.2 ROM Salt

ROM salt material from mining operations is as delivered by haul truck or load haul dump (**LHD**) units to the panel closure area in a loose state. As such, it is a noncombustible natural material that is completely compatible with the repository environment. The ROM salt is emplaced over a minimum length of 100 feet. The ROM salt at the ends would be emplaced at a slope of approximately 2 horizontal 1 vertical.

The air flow and structural modeling analyses (Chapter 3) use the basic design for the WPC. Air flow resistance through a panel closure is proportional to flow path length and inversely proportional to the product of the air conductivity and the flow path cross sectional area.

Figures G1-2 and G1-3 illustrate the design for typical cases with and without block walls. Variations in entry height are expected for individual WPCs. For WPCs emplaced in panel entries with block walls, the end slope for the ROM salt can be steepened to 1.4 horizontal to 1.0 vertical to accommodate the full length of ROM salt. The emplacement of ROM salt will avoid putting significant lateral pressure on bulkheads.

The bulk density of the ROM salt is not prescribed in this report. A fractional density of 64% to 65% for ROM salt is nearly universal for WIPP and other salt mining operations throughout the world (Hansen, et. al, 1998 and Rothfuchs and Wieczorek, 2010). It is assumed that any additional salt compaction that occurs during construction will improve the performance by reducing the air gap that forms above and lowering permeability within the ROM salt.

2.3 Constructability, Environmental and Worker Safety, Operational Considerations, and Longevity

This section presents information on the constructability, environmental and worker safety, operational considerations, and longevity. More detailed information is presented in the supporting Appendices C and D that present specifications and engineering drawings.

2.3.1 Constructability

The WPC can be constructed using available technologies for the construction of steel bulkheads and placement of salt. The construction methods and materials used in the design represent available technologies from previous mining projects (Fernandez et al., 1994, pp. 5-11 to 5-20) and as demonstrated by recent insitu testing of ROM salt at WIPP (Zimmerly and Zavicar, 2012). Field tests and construction experience at the WIPP facility will guide the emplacement and construction methods used to construct these barriers. Construction quality control and quality assurance requirements will be based on the construction method employed. The steel bulkheads are commonly used and ROM salt is available in sufficient quantities at minimum cost.

2.3.2 Environmental and Worker Safety

The proposed WPC is not expected to adversely impact environmental safety. The construction materials are primarily natural material removed from the mine, with the exception of the bulkheads, which are already used throughout the underground. The construction methods use equipment identical or similar to day-to-day mining operations or in construction.

Note that the analysis presented in this report does not address specific compliance with Health Based Levels (**HBLs**) for worker exposure at WIPP during installation and operation of the WPC. Such analyses are beyond the scope of this report.

The following qualitative discussion addresses the complexity and risks in the current design as compared to those in the previous design. Two factors are involved in qualitatively estimating the increase in worker safety and risk reduction associated with installation of the proposed WPC. One factor involves the complexity of the construction project. The other related factor is the number of workers and the time that they spend transporting, handling, and installing the WPC. The exposure of workers to VOCs relates to exposure times during the construction and emplacement of individual WPCs.

The Permittees reviewed the complexity of the construction project associated with Option D versus the construction of the current WPC. The previous design (DOE, 1996) used complex steel formwork and concrete, with removal of portions of the DRZ and closure of the interface zones. The current design is easier to construct as there is no need for complex formwork or the production and placement of Salado Mass Concrete.

As part of a previous redesign process, the Permittees prepared installation schedules for the Option D panel closure system (**PCS**) and WPC (NMED, 2002). The underground construction activities for Option D were estimated to require approximately 14 months. The comparable period for construction of the WPC is estimated at six months or less (40 CFR 264.113 (b)). The WPC construction project uses more common materials for the steel bulkheads and salt than Salado Mass Concrete, thus reducing the number of workers required and the time required for workers to be in the construction area. Less complex construction translates into less time for transportation, handling, and emplacement of materials. Shorter construction time translates to an increase in worker safety and lower risk to workers.

2.3.3 Operational Considerations

The construction of the current WPC can be stopped and re-started as necessary to accommodate operational concerns and reduce or eliminate impact on waste handling. Temporarily stopping construction will not affect the performance of the WPC. The equipment used to construct the WPC can be quickly mobilized and demobilized to accommodate waste handling and other operational needs. Shaft schedules would not be impacted as the majority of the construction materials are already underground.

2.3.4 Longevity

As discussed in Chapter 3, the WPC closures derive their air flow resistances primarily from steel bulkheads for a period of 23 years and from ROM salt thereafter. During the 23-year period of time that steel bulkheads are relied on for air flow resistance, the steel bulkheads will be maintained in the underground environment. The panel entry creep closure with time reduces the air gap at the interface of the ROM salt and entry roof as well as the porosity of the ROM salt, which in turn reduces the air conductivity due to the plastic deformation of the ROM salt. ROM salt is completely compatible with the underground environment. This results in improved performance with time or longevity. Eventually, the ROM salt will become structurally indistinguishable from the surrounding intact salt.

3.0 Analysis

This chapter presents evaluations of the engineered WPC: (1) structural analyses; (2) projected VOC emissions from air flow analysis and advection analysis; and (3) a material compatibility evaluation.

3.1 Analyses Addressing Operational Requirements

To evaluate the effectiveness of the panel closure system, structural analyses were performed to examine the geomechanical performance of the WPC over the operational period of the repository. Air flow analyses were then performed to evaluate the change in WPC air flow resistance, and then evaluate VOCs flow through the WPC. Structural analyses predict a gap forms between the roof and top of the ROM and reduction of the fractional density due to creep of intact rock salt of the surrounding panel entry surfaces. Air flow analyses are then conducted to predict the release of VOCs through the panel closure system due to gas generation, panel creep closure and the effects of underground ventilation. These analyses support the WPC design for the protection of human health and the environment at the WIPP site boundary. Explosion effects on the WPC were not analyzed because monitoring of methane and hydrogen concentrations indicates that they will not reach minimum explosive concentrations during the operational period (Myers, 2012 and Nelson, 2011).

3.2 Structural Analyses of ROM Salt Emplacements

Three dimensional geomechanical models of a 100-foot long section of ROM salt were analyzed using Fast Lagrangian Analysis of Continua in Three Dimensions (**FLAC3D**). The following discussion presents the properties of the ROM salt, the structural modeling method, a crushed salt benchmark calculation, model geometry, modeling sequence, and modeling results.

3.2.1 ROM Salt Properties

The FLAC3D requires the initial densities and material properties of the ROM salt. As discussed previously, the ROM salt initial density is assumed to be 65% of the intact density of salt. The intact density used in this study is 2,160 kilograms (**kg**)/m^3 (Callahan, 1999).

3.2.2 Structural Modeling Method

The settlement and change in density with time (and implicitly intrinsic permeability) of the ROM salt was calculated using the three-dimensional geomechanical modeling program FLAC3D (Itasca Consulting Group, 2006). The predecessor program Fast Lagrangian Analysis of Continua (**FLAC**) and FLAC3D have been used for 20 years for the WIPP project, including structural analyses for the previous panel closure design. FLAC3D implements the Callahan and DeVries (1991) crushed salt creep constitutive model. This model is based on Sjaardema and Krieg (1987) and was verified by Callahan (1999) through comparisons of numerical analysis predictions with laboratory test results. Material properties for the other materials in the surrounding salt are from Krieg (1984).

3.2.3 Crushed Salt Benchmark Calculation

A benchmark calculation (Wagner et al., 1990) was performed to provide comparisons of the predicted consolidation of salt from several models. These included the SANCHO model developed by Sandia National Laboratories (**SNL**). A FLAC3D model was developed for comparison to Wagner's results. The FLAC3D three-dimensional model consisted of a backfilled disposal room at the repository horizon that is subjected to a lithostatic stress of 2070 pounds per square inch (**psi**) (14.3 megapascal [**MPa**]). In order to simulate the two-dimensional model in FLAC3D, the lateral displacements were set to zero for the plane strain condition. The FLAC3D model used the material properties and crushed salt constitutive model in the room-scale model developed by RE/SPEC for SNL.

Figure G1-5 compares the FLAC3D results to the SNL SANCHO results from a previous calculation. The FLAC3D results were reasonably close to the SANCHO results because both use the same constitutive model and backfill type as implemented in FLAC3D.

3.2.4 Model Geometry

The horizontal extents of the intake and exhaust models are shown in Figure G1-6 and Figure G1-7 respectively. Separate models were developed for the panel intake and exhaust drifts. These figures show the model extents for each case below the roof of the room. The model includes half of Room 1 of a generic panel and the access drift from a line halfway between the rib of Room 1 and the ventilation drift (E-300 or W-170, depending on the panel). The north-south extents go from halfway between panels to an east-west line bisecting the panel. The salt fill is modeled in half-symmetry so only the half nearest Room 1 is modeled. The vertical extents run from about 250 ft (75 m) above and below the floor of the openings.

The crushed salt is modeled in half-symmetry along its length to reduce the run-time of the model, which in turn allows a more refined discretization, producing more accurate results. The behavior of the out-by end of the emplaced salt is not expected to be significantly different than the in-by end. This is because the closure rates that would affect the void or pore space of the WPC do not vary significantly along the length of the WPC. Additionally, the end effects are assumed to be essentially identical at each end.

The stratigraphy consists of rock salt with the inclusion of the anhydrite Marker Bed 139 located below the floor of the repository horizon and thin clay seams E, G and H. The roof of the entry corresponds to Clay G. The model grid is made up of over 313,000 three-dimensional zones. The model uses interface elements at the boundary between the emplaced salt and the surrounding drift. These interface elements provide a sliding boundary condition along this surface.

The ROM salt is emplaced at an assumed initial density of 65 % of intact density (88 lbf/ft^3 [1,404 kg/m^3]). This is the natural fractional density of ROM salt.

3.2.5 Modeling Sequence

The openings in the model are excavated instantaneously to reduce model run time. The model is then run without the ROM salt to five years after excavation to simulate the waste emplacement period in the active panel. This time was chosen based on estimates for the time between excavation and closure of Panel 5. In the models, the creep rates that control salt compaction reach steady state within the first two years, so the timing of ROM salt emplacement only affects the volume of the ROM salt, not the consolidation or permeability. Figure G1-8 shows the model-calculated vertical (roof-to-floor) and horizontal (wall-to-wall) closure rate histories at the center of the panel intake drift where the ROM salt will be located. Elapsed time in the FLAC3D analysis is from the time of excavation with the completion of waste emplacement activities in five years.

Figure G1-9 shows the same calculations for the panel exhaust drift. The horizontal measurements were only recorded after the ROM salt was emplaced. Oscillations in the curves occur at Year 28 when the top of the salt fill re-contacts the excavation roof (see Figures G1-11 and G1-12).

3.2.6 Structural Modeling Results

The variation with time of the fractional density of the emplaced salt in each drift is shown in Figure G1-10. These calculations are input into the air flow calculations. The values in Figure G1-10 were calculated by taking a volumetric average of the fractional density of all zones (model elements) in the compacted salt. The fractional density values for the panel intake and exhaust drifts are nearly identical. The intake drift is about 30% wider than the exhaust drift. The larger span results in larger intact rock displacement rates, but it also leads to a larger volume of fill under consolidation. In this case, the effect of the higher displacement rates in the intake drift is nearly balanced by the larger volume of material undergoing compaction. In other words, the larger volume in the intake drift requires larger displacements to reach the same level of compaction (volumetric strain) as seen in the exhaust drift.

As a result of the self-settlement of the ROM salt, the post-installation consolidation rate is faster in this case than the roof-to-floor convergence rate. This results in an air gap forming between the roof of the excavation and the top of the emplaced salt. Figure G1-11 shows the gap magnitude versus time for points at the center and ends of the fill in the intake drift. Figure G1-12 shows the gap magnitude versus time in the exhaust drift. The gap reaches a maximum of 18.5 inches (47 cm) in the intake drift and 16.5 inches (42 cm) in the exhaust drift. The maximum gap occurs 2.5 years after installation in the intake drift and 1.8 years after installation in the exhaust drift. The gap magnitude reduces when the consolidation rate slows to less than the excavation closure rate. The gap closes in approximately 23 years after installation in both drifts. Gap magnitude and duration is slightly lower at the ends of the fill.

3.3 VOCs Flow Analyses

The VOCs flow analyses evaluate the flow of VOCs of concern through the WPC to the time of completion of waste emplacement operations at the WIPP facility. These analyses address the VOCs of concern; the VOC concentration data; the current emission rate of VOCs of concern; the schedule for closure of panels; and the future projected VOC emission rates. Also, the effective air conductivity of the panel closure system is evaluated and used as input to the air flow model (DOE, 1996) to assess VOCs flow performance.

Three sources for air flow are considered in projecting future emission rates. These include: (1) an average gas generation rate due to microbial degradation (Kehrman, 2012, Table 2); (2) a volumetric closure rate due to salt creep; and (3) an underground ventilation rate.

3.3.1 WPC VOCs Evaluation Procedure

The WPC VOCs evaluation procedure includes the analysis of air flow rates from a single panel. A detailed evaluation is then made of VOC concentrations for CCl_4 based upon open room emissions prior to closure of the air gap, and average headspace CCl_4 concentrations after closure of the air gap. A schedule is considered for individual WPC closure assuming approval of a Class 3 Permit Modification to include the WPC in the Permit in December 2013. The contributions from individual panels are superimposed to obtain the repository CCl_4 emissions.

The risk fractions at the WIPP site boundary receptor point are then evaluated for CCl_4. The risk fractions for other VOCs are then calculated at the time of peak VOC emissions.

The WPC VOC analysis for a single panel closure includes: (1) evaluation of air flow rates after placement of a single layer of salt (65% fractional density) and the construction of steel bulkheads; (2) the period of time when a gap exists and air flow resistance is provided by steel bulkheads; (3) a period of time when the air gap is closed and air flow resistance is increased; and (4) a final period of time when air flows through consolidating ROM salt. The VOC concentrations are evaluated as the CCl_4 emission rate for open rooms (Kehrman, 2012, Table 12) during time periods when the air gap exists. After the gap is closed in 23 years, the dominant air flow resistance is through the pore space of the ROM salt. VOC emission then equals the product of the air flow rate and the average headspace concentration. These analyses compare predicted VOC concentrations from the model with existing VOC emissions measurements for Panels 1 through 5 and part of 6 to July 2012. Other assumptions used in the analysis are:

- Air flow occurs under quasi-steady state conditions. Air flows from gas generation and panel creep closure are source terms from each panel while air flow from underground ventilation occurs under Darcy's Law between the panel entries.

- The gas generation rate is 4,020 moles per panel per year (0.1 moles per drum per year) (Kehrman, 2012).

- Volumetric reduction of a panel due to creep closure reduces the void space at a rate of 28,680 ft^3 per year (812 m^3 per year) (DOE 1996, Appendix B).

- Underground ventilation in the adjacent main exhaust drift[4] results in a pressure drop between the panel air-intake and panel air-exhaust drifts for each panel (See Appendix A). The ventilation air flow entering each panel air-intake drift equals the air flow leaving the panel air-exhaust drift for each waste panel under a pressure drop of 170 milli-inches (4.3 millimeters [**mm**]) of water gage. The ventilation network analysis results in an average flow rate of several hundred cubic feet per minute (**cfm**) prior to closure of the air gap. The air flow rate is then reduced to less than 0.1 cfm.

- Steel bulkheads (Section 2.2.1) with flexible flashing to accommodate salt creep are used in the WPC design. Farnsworth (2011) indicated that smaller drifts with bulkheads near the Exhaust Shaft in the WIPP underground have air flow resistances as high as 2,200 Practical Units. The smaller drifts with bulkheads near the Exhaust Shaft are the closest in size to the Panel intake and exhaust drifts. Steel bulkheads will be maintained to accommodate panel entry salt creep to achieve a minimum air flow resistance of 2,200 Practical Units for as long as the bulkheads are needed to provide flow resistance.

- VOC transport occurs by advection. Hydrodynamic dispersion through the WPC is neglected. The VOC releases are determined for individual panels and then are superimposed in time.

[4] The E-300 drift is the adjacent main exhaust drift for Panels 1 through 4, while W-170 is the adjacent main exhaust drift for Panels 5 through 8.

The WPC VOC flow analyses are considered bounding because: (1) the pressure drop of 170 milli-inches (4 mm) of water gage is considered a maximum value; (2) a permeability vs. porosity relationship provides a maximum envelope for measured data (see Figure G1-13); and (3) the analysis models panel creep closure and gas generation as point-source at the panel air exhaust drift. These bounds are discussed in the following subsections.

3.3.2 Existing VOCs Emissions Measurements for Panels 1 through 5

The WIPP collected measurements on VOC concentration data and ventilation rates at the E-300 point of compliance were collected during the period from January 2008 to July 2012 for the VOCs of concern. The E-300 point is located at the intersection of the E-300 main exhaust drift, and S-1300 cross drift. The existing measurements reflect VOC emissions from Panels 1 through 6, with Panel 6 being the active panel during the measurement time period.

3.3.3 Estimation of Air Flow Rates

Three sources for air flow are considered in projecting future emission rates. These include: (1) a gas generation rate due to microbial degradation; (2) a volumetric closure rate due to salt creep; and (3) an air flow rate due to underground ventilation in the adjacent exhaust drift. The air flow rate due to ventilation in the adjacent exhaust drift includes estimates of the potential air flow boundary condition for the WPC, the air flow resistances for components of the WPC and how these resistances change with time due to closure of the air gap, and consolidation of the salt.

Underground ventilation measurements and the analysis of these measurements are provided by the operating staff (Appendix B). This information is used to assess VOC emissions rates for the underground repository.

Figure A-1 shows the configuration for evaluating ventilation effects. A comparison of the analyses presented in Appendix A and DOE (1996, Appendix B) indicates that ventilation effects in the adjacent main exhaust drift are more significant than gas generation and panel creep closure. Since the flow in the adjacent exhaust drift is the path of least resistance for air flow, the pressure drop or potential is set by the head loss down the adjacent main exhaust drift. The potential difference then provides the pressure or head differential for flow through the WPC. It is much smaller than flow through the adjacent exhaust drift. However, it is much larger than flow generated by gas generation and panel creep closure used in previous studies (DOE, 1996).

Appendix B presents information on ventilation rates in thousands of cubic feet per minute (**kcfm**) and pressure drops in milli-inches of water gage for the WIPP underground ventilation network. The measurements include pressure drop measurements in the main exhaust drift adjacent to each WPC as shown in Figure A-1.

The normal and full operating modes provide measurements during testing and balancing that are representative of underground ventilation conditions. Appendix B describes the normal and full operating modes. For the normal operating mode, the average value for the pressure drop was 163 milli-inches of water gage. The range of pressure drops was from 12 to 350 milli-inches (0.3 to 9 mm) of water gage. For the full operating mode, the average value was 165 milli-inches of water gage with a range of values from 0 to 394 milli-inches (0 to 10 mm) of water gage.

The FLAC3D analysis provides the settlement time histories of ROM salt that results in the reduction of the air gap and increase in fractional density or reduction in porosity of the ROM salt.

The FLAC3D analysis indicates closure of the air gap at different locations within the ROM salt over time. The analyses of both the WPC Intake and Exhaust drift show an increase in air gap occurs for two years followed by a reduction in the air gap after this time. The air gap closes first near the ends, and then followed by the middle of the ROM salt. These times are approximately 23 years after panel closure. Prior to the time of closure of the air gap, air flow resistance through the WPC is predominately due to the steel bulkhead resistance. After approximately 20 years, the air gap closes to a point at which the air flow resistance offered by the consolidating salt equals the air flow resistance through steel bulkheads. Flow rates through the WPC are calculated using methods presented in Appendix A Section A5.0. The estimated flow rates are of the order of several hundred cfm.

After closure of the air gap, the dominant air flow resistance is through the consolidating salt. Air flow is reduced to a small percentage of the air flow through the gap. The air conductivities were then calculated based upon the intrinsic permeability relationship that accounts for both the relative density and the average particle size of the ROM salt backfill (Kelsall et al., 1983, Equation A-4). This relationship is illustrated in Figure G1-13 and is based upon the investigations made by Shor, et al. (1981) and bounds the intrinsic permeability relationship derived from laboratory investigations of crushed salt (Case et al., 1987, Figure 1, and from Mellegard, 1999, Figure 4-15). The analysis is bounding in that measured intrinsic permeabilities of ROM salt from measured relationships (Case et al., 1987, Figure 1 and Mellegard, 1999, Figure 4-15) are lower than those predicted on the basis of the Shor relationship for a particle size of 0.13 inches (0.34 cm). Figure G1-14 and Figure G1-15 present the air conductivities based upon the relative density vs. intrinsic permeability relationship for a single panel. The reduction in fractional density is anticipated to result in a reduction in air conductivity through the ROM salt over a 30-year period.

Small amounts of moisture exist in the ROM salt. Also small amounts of brine will flow from the surrounding entries into the ROM salt (Deal and Case, 1987). Moisture within the salt is conservatively neglected in the analysis. The technical basis for this assumption is that moisture existing or being introduced in the pore space will reduce the intrinsic air permeability to the gas phase, and thus reduce the flow of VOCs.

Bear (1972, p. 712) provides an air flow network resistance method. Appendix A presents derivations for the air flow model. Air flow is governed by Darcy's Law under quasi steady state conditions.

The air flow analysis considers flow through other components as presented in Table G1-1. Flow through the disturbed rock zone (referred to as fractured and dilated salt in Table G1-1), clay seams and Marker Bed 139 occur in parallel to air flow through the WPC.

Case and Kelsall (1987) evaluated permeability measurements performed by Peterson et al. (1985). These data showed a zone of increased permeability (10^{-18} to 10^{-20} ft^2 [10^{-19} to 10^{-21} m^2]) from 3 to 42 ft (1 to 14 m) from the opening. Based on this observation, the calculations assumed that the cross-sectional area for flow through the DRZ and the panel closure system will equal nine times the panel intake or panel exhaust drift area or that the DRZ extends out three radii from the center (DOE 1996, Section 2.1.1.1).

A distinction is made between "dilated rock salt" and "fractured rock salt." Dilated rock salt exhibits a higher permeability than intact rock salt due to stress relief from the lithostatic state of stress and this corresponds to the increased permeability zone observed by Case and Kelsall (1987). The value used here for the intrinsic permeability of dilated rock salt (10^{-18} ft^2 (10^{-19} m^2)) is more conservative than measurements using the guarded packer straddle system (Case and Kelsall, 1987, Figure 5). The fractured rock salt refers to the highly fractured zone in the immediate vicinity of the openings.

A comparison is made of the air conductance of the ROM salt emplaced in the drift to the air conductance in the surrounding DRZ. The flow resistance through the DRZ and the adjacent 100 ft (30.5 m) of ROM salt can be compared by considering the sum of the product of the air conductivities times the cross sectional areas of each DRZ component to the product of the air conductivity times the cross sectional area of the ROM salt. The estimated flow is several orders of magnitude lower through the DRZ. The analysis predicts the dominant flow path is through the ROM salt and flows through components of the DRZ are small.

Comparisons were made between the flow resistance of the ROM salt with a minimum length of 100 ft (30.5 m) with steel bulkheads. Using the fundamental relationship relating head loss to air flow and considering 170 milli-inches (4 mm) of water gage with bulkhead resistance of 2,200 Practical Units[5] (0.070 mm/(m^3/min)^2), the estimated air flow resistance through a gap above the ROM salt was about two orders of magnitude smaller than the resistance of bulkheads. After 23 years following WPC emplacement, the air gaps are closed and the resistance of the salt is much higher than that of steel bulkheads. Flow resistance through 100 ft (30.5 m) of ROM salt is dominant after 23 years. See Appendix A for details. Steel bulkheads will be maintained to provide a minimum air flow resistance of 2,200 Practical Units during the 23-year period following WPC construction.

Figure G1-16 presents the results of the single panel air flow analysis and compares air flow from air-ventilation effects of the adjacent main exhaust drift with the other point source terms for gas generation and panel creep closure. The analysis assumes that gas generation and panel creep closure are point source terms for air flow out of the WPC and that the total air flow is the sum of the air flow from ventilation effects of the adjacent main exhaust drift and the other source terms.

After ROM salt emplacement and installation of steel bulkheads, the analysis predicts that air flow through the WPC is initially of the order of 10 cfm. Soon after emplacement, the air gap aperture quickly grows and air flow increases until flow is limited by the bulkheads to about 200 cfm. After about 20 years, the air flow resistance through closing air gap and the steel bulkheads are nearly equal. After about 23 years, closure of the air gaps above the consolidating salt is complete, and air flow resistance is dominantly through the pore space of the consolidating salt. The estimated flow through the WPC is of the order of 1 cfm (0.028 m^3/min) and air flows from ventilation effects are twice the flow from gas generation and panel creep closure.

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[5] A Practical Unit equals 1 milli-inch of water gage divided by (1 kcfm [1000 cubic feet per minute)^2 (Mine Ventilation Services (2003, p. 10). 1 kcfm = 1000 ft^3/min (28.3 m^3/min). The Practical Unit is equivalent to 3.17×10^{-5} mm/(m^3/min)^2 in the metric system. The Practical Unit is derived from the Square Law used in underground ventilation analysis.

Table G1-1
Air Conductivity of Other Flow Components

Component	Air Conductivity		References
	ft/s	m/s	
Dilated salt	2.03×10^{-13}	6.2×10^{-14}	DOE, 1996
Fractured salt	2.03×10^{-9}	6.2×10^{-10}	DOE, 1996
Clay seams	2.03×10^{-11}	6.2×10^{-12}	DOE, 1996
Marker Bed 139	2.03×10^{-10}	6.2×10^{-11}	DOE, 1996

3.3.4 Transport of VOCs by Advection

Transport of VOCs occurs either from the open room emissions (Kehrman, 2012, Table 12) prior to closure of the air gap in each WPC, and then by advection with the projected emission rate determined as the product of the air flow rate times the average head space concentration for each VOC. When the air gap is closed, it is assumed for the air flow model that the average headspace concentrations serve as a constant source of VOCs. This assumption is conservative because some containers may only have trace quantities of VOCs, either trapped in the headspace or on the surfaces of the various waste components. The analysis uses the weighted average headspace concentration for VOCs (Kehrman, 2012, Table 1) and no VOC source depletion is assumed.

Previous analysis (DOE, 1996) evaluated the effects of hydrodynamic dispersion on VOC transport through the WPC, using a one-dimensional dispersion model (Freeze and Cherry, 1979). Analysis was performed to evaluate the breakthrough or travel time of a concentration front considering the average linear velocity of the air flow. The analysis shows that breakthrough times increase with time as the salt compacts to higher fractional densities. The analysis shows that breakthrough times range from 7 to 70 days over 10 years. Hydrodynamic effects can be neglected for this rapid breakthrough time.

Comparisons of the model predictions with existing VOCs running average measurements at E-300 provide model validation. Figure G1-17 presents the analysis of CCl_4 and compares predictions with existing CCl_4 measurements from January 2008 to July 2012. The measurements include the emission rates during the time period when Panels 1 through 3 were closed and Panels 4 through 6 were active. The analysis initially predicts a higher rate of VOC emissions than what has been measured. This is because Panels 1 and 2 received smaller inventories of Type IV solidified organic wastes. At the time that Panel 6 is in operation, the VOCs model is in agreement with measurements of the running annual average (**RAA**) for CCl_4 at the E-300 location. The analysis predicts that the estimated CCl_4 emissions reach a value of about 300 parts per billion by volume (**ppbv**) at year 20, and then reduce with time as individual WPCs are constructed followed by closure of the air gap 23 years after each closure. The field measurements include a variety of factors that are not considered in the emissions model. These include changes in ventilation, temperature, barometric pressure, etc. This results in the oscillations in the field measurements that are not seen in the model predictions.

3.3.5 VOCS Analysis Results

The evaluation includes the case when all but one panel is closed using the WPC at the time of repository closure, and the single open active panel consists of six filled and closed rooms and one open room at current existing emissions rates. The case being evaluated is equivalent to the evaluations performed for other panel closures with the updated source term information.

The current Permit Application considers compliance with HBLs (Kehrman, 2012, Table 11) at the WIPP site boundary. Kehrman (2012, Table 6) provides the air dispersion factor for evaluating concentrations at this point. Kehrman (2012, Table 11) provides HBLs for these WIPP boundary receptor points for CCl_4 for carcinogenic risk and noncarcinogenic risk scenarios.

Figure G1-18 presents the risk fractions for the carcinogenic scenario for CCl_4 at the WIPP site boundary. Noncarcinogenic scenarios result in lower risk fractions than for carcinogenic scenarios (see Table G1-2). The figure also shows the average risk fractions for CCl_4 at the WIPP boundary receptor location are about 0.16 or less.

The predicted mass flow rates for CCl_4 through the WPC due to open room emissions prior to closure of the interface gap and then through the WPC after interface gap closure (including flow through the DRZ, the steel bulkheads and ROM salt) from gas generation, panel creep closure and ventilation effects of the adjacent main exhaust drift are predicted to result in concentrations that are below the limits established at the WIPP receptor boundary. The risk fractions are in compliance at the time of completion of waste emplacement operations in which nine WPCs have been installed, and there are six closed rooms with one open room in a single panel. The evaluation of risk fractions at intermediate locations has not been performed, and is not part of the scope of work.

3.3.6 Other VOCs

Table G1-2 presents an evaluation of risk fractions for all VOCs in the waste inventory at the time of maximum release. Risk fractions are the ratio of the predicted emissions to the HBLs. The analysis shows that the release fractions are less than one and that releases from the WIPP repository results in VOCs concentrations that are less than HBLs for VOCs of interest (Kehrman, 2012, Table 11) at the WIPP site boundary. Concentrations at other surface and underground locations were not analyzed as part of this scope of work.

Table G1-2
Maximum Risk Fractions for VOCS at WIPP Site Boundary

VOC	Carcinogen Site Boundary Ratio	Non-carcinogen Site Boundary Ratio
Carbon Tetrachloride	1.59E-01	5.26E-04
Chloroform	1.13E-02	1.04E-05
Trichloroethylene	6.13E-03	1.50E-03
1,1,2,2-Tetrachloroethane	5.24E-03	N/A
1,2-Dichloroethane	2.95E-03	3.37E-05
Benzene	1.02E-03	8.85E-06
1,1-Dichloroethane	5.11E-04	N/A
Ethyl Benzene	2.35E-04	1.88E-07
Bromoform	4.81E-05	N/A
Tetrachloroethylene	4.59E-05	8.82E-06
Methylene Chloride	1.25E-05	4.18E-06
1,2,4-Trimethlybenzene	N/A	1.81E-05
Butanol	N/A	1.41E-05
Methyl Chloride	N/A	1.31E-05
1,1,1-Trichloroethane	N/A	8.46E-06
trans-1,2-Dichloroethylene	N/A	4.52E-06
1,1-Dichloroethylene	N/A	4.26E-06
m,p-Xylene	N/A	3.34E-06
Chlorobenzene	N/A	2.93E-06
o-Xylene	N/A	1.95E-06
Methanol	N/A	1.61E-06
Carbon Disulfide	N/A	1.11E-06
1,1,2-Trichloro-1,2,2-Trifluoroethane	N/A	4.43E-07
Methyl Isobutyl Ketone	N/A	2.15E-07
Methyl Ethyl Ketone	N/A	1.71E-07
Toluene	N/A	1.37E-07
Acetone	N/A	1.17E-07
Cyclohexane	N/A	1.05E-07
Total	**1.87E-01**	**2.17E-03**

Note: N/A indicates there is no regulatory limit for the VOC.

3.4 ROM Salt Material Compatibility Evaluation

The WPC consists of bulkheads and ROM salt. Additional steel from bulkheads used in the WPC for individual panels is not expected to affect repository modeling and analysis. Since only the outer steel bulkheads are subject to repository ventilation, only trace amounts of brine would contact the steel bulkheads over the operational period. This is due to the low moisture content of the halite. The outer steel bulkheads can be replaced or repaired if needed. ROM salt is entirely compatible with the underground environment.

4.0 Technical Specifications

The specifications are in the engineering file room at the WIPP facility. These specifications are included as an attachment in Appendix C and are summarized in Table G1-3.

Table G1-3
Technical Specifications for the WIPP Panel Closure System

Division 1 – General Requirements	
Section 01010	Summary of Work
Section 01090	Reference Standards
Section 01400	Contractor Quality Control
Section 01600	Material and Equipment
Division 2 – Site Work	
Section 02010	Mobilization and Demobilization
Section 02222	Excavation
Division 4 – Salt	
Section 04100	Run-of-Mine-Salt

5.0 Drawings

The Drawings (Appendix D) are in the engineering file room at the WIPP facility and are summarized in Table G1-4.

Table G1-4
WIPP Panel Closure System Drawings

Drawing Number	Title
262-001	WIPP Panel Closure System Title Sheet
262-002	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (3, 4, 6, 7, 8)
262-003	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (1, 2, 5)
262-004	WIPP Panel Closure System, Construction Details

6.0 Conclusions

This chapter presents the conclusions for the design activities for the WPC. Table G1-5 shows the Permit design requirements for the WPC and the compliance of the design with these requirements. The design configuration and essential features for the WPC include ROM salt, and two barriers. The barriers consist of two steel bulkheads placed at the ends of the ROM salt or alternatively, one steel bulkhead and a block wall. The design includes a minimum length of 100 ft of ROM salt.

This report presents the design as a series of calculations and engineering drawings and specifications that comply with the design requirements for the WPC. Structural and air flow analyses are used to select the design features and are based upon data acquired from the WIPP underground. The drawings illustrate and describe the construction and details for the WPC. The specifications cover the general requirements of the system, quality assurance and quality control, site work, and ROM salt emplaced in the panel entries. The WPC can be built to generally accepted national design and construction standards. Bulkheads are not included in the specifications (Section 2.1) since they are routinely constructed and used at the WIPP facility. There is no construction or materials specification for bulkheads, only a performance requirement (2,200 P.U. air flow resistance).

The design complies with all aspects of the design basis established for the WPC. The design can be constructed in the underground environment with no special requirements at the WIPP facility. To investigate several key aspects of the design and to implement the design, design evaluations were performed. The conclusions reached from the evaluations are as follows:

- An air gap forms between the excavation roof and the top of the fill due to the settlement of the ROM salt. Structural modeling results using the three dimensional finite difference code FLAC3D predict the change in gap height and density of the salt with time. The salt compacts from its initial placement density to approximately 90% of the intact salt density under its own weight 23 years after panel closure.

- A VOC Flow Model accounts for gas generation, panel-creep closure, and the effects of underground ventilation of the adjacent main exhaust drift. The VOC Flow Model evaluates the reduction in air conductivity that occurs with the increase in salt density, reduction in gap size and reduction in porosity. The low air flow through the WPC is initially caused by the effects of ventilation of the adjacent main exhaust drift. About 23 years after closure, the air gap above the ROM salt is eliminated. The ROM salt consolidates due to panel-entry closure and air conductivity is significantly reduced. This results in low air flow rates.

- The passive design components of the WPC require minimal routine maintenance during the nominal operational life. Out-by bulkheads must be maintained to provide 2,200 P.U. resistance for 23 years after installation.

- The WPC provides for flexibility over the remaining operational life in construction scheduling and construction material transportation and therefore minimizes the effect on waste receipt.

In addition to the design requirements presented above, the design includes a construction QA/QC program to verify material properties and construction practices.

The predicted mass flow rates for CCl_4 and other VOCs through the WPC (including flow through the DRZ, the steel bulkheads and the ROM salt) will result in concentrations that are below the HBLs established at the WIPP site boundary. Concentrations at other surface and underground locations were not analyzed. Modeling results of the WPC did not produce VOC concentrations from combined effects that would exceed limits for the repository. If the HBLs, air dispersion factors, or the average headspace values change, the calculations should be re-evaluated to ensure that compliance is maintained.

It is also concluded that:

- The WPC provides for flexibility over the remaining operational life in construction scheduling and construction material transportation effects on facility operations.

- The existing shafts and underground access can accommodate the construction of the WPC.

While no specific requirements exist for closing disposal areas under MSHA regulations, the intent of the regulations is to safely isolate abandoned areas from active workings using barricades of substantial construction. The ROM salt is considered substantial construction.

Table G1-5
Expected Compliance with Performance Specifications

No.	Current Design Requirement	Expected Compliance with Requirement	Section in Report	Notes on Compliance
1	The panel closure system shall contribute to meeting the environmental performance standards in Permit Part 4 Section 4.6.2 by mitigating the migration of VOCs from closed panels.	Complies	3.3.5, Appendix A	Complies with the use of ventilation bulkheads with flexible flashing to accommodate salt creep and ROM salt a minimum of 100 ft in length.
2	The panel closure system shall consider potential flow of VOCs through the DRZ in addition to flow through closure components.	Complies	3.3.3	VOCs flow model considers flow through the DRZ.
3	The panel closure system shall perform its intended functions under loads generated by creep closure of the tunnels.	Complies	3.2.7	The flexible flashing and maintenance of the steel bulkhead accommodates panel entry creep closure. The plastic deformation of the ROM salt will result in a reduction in porosity and permeability with time.
4	The nominal operational life of the closure system is thirty-five (35) years.	Complies	3.2.7, 3.3.5	The combination of maintaining the outer bulkheads with ROM salt can accommodate a design life of 35 years.
5	The panel closure system may require minimal maintenance per 20.4.1.500 NMAC (incorporating 40 CFR 264.111)	Complies	2.2.1	The ROM salt requires no future maintenance. The outbye bulkhead can be maintained or replaced with minimal maintenance.
6	The panel closure system addresses the expected ground conditions in the waste disposal areas.	Complies	2.2, 3.2.6	Design is based upon structural analyses and flow for the most severe ground conditions.
7	The panel closure system shall be built of substantial construction and non-combustible material except for flexible flashing used to accommodate salt movement.	Complies	Appendix G1-C Section 01400	The panel closure system uses ROM salt which is of substantial construction. The materials are noncombustible except for the flexible flashing.

No.	Current Design Requirement	Expected Compliance with Requirement	Section in Report	Notes on Compliance
8	The design and construction shall follow conventional mining practices.	Complies	2.3	The future construction sequence for the design will follow conventional civil and mining practices.
9	Structural analysis shall use data acquired from the WIPP underground.	Complies	3.2, 3.3	Available geomechanical, air flow and gas generation measurements were used in the analysis.
10	Materials shall be compatible with their emplacement environment and function.	Complies	3.4	ROM salt is compatible with the surrounding environment. The outbye steel bulkheads can be replaced when the design life is exceeded.
11	Treatment of surfaces in the closure areas shall be considered in the design.	Complies	2.1, Appendix G1-C Section 02222	Surface scaling of loose material surrounding the WPC is included in the design specifications.
12	A QA/QC program shall verify material properties and construction.	Complies	2.1, Appendix G1-C Section 01400	Future submittals according to the design specifications will utilize materials testing to verify material properties and future construction practices as necessary.
13	The construction of the panel closure system shall consider shaft and underground access and services for materials handling.	Complies	2.1, Appendix G1-C Section 01010	The specification allows future construction within the capacities of the underground access.

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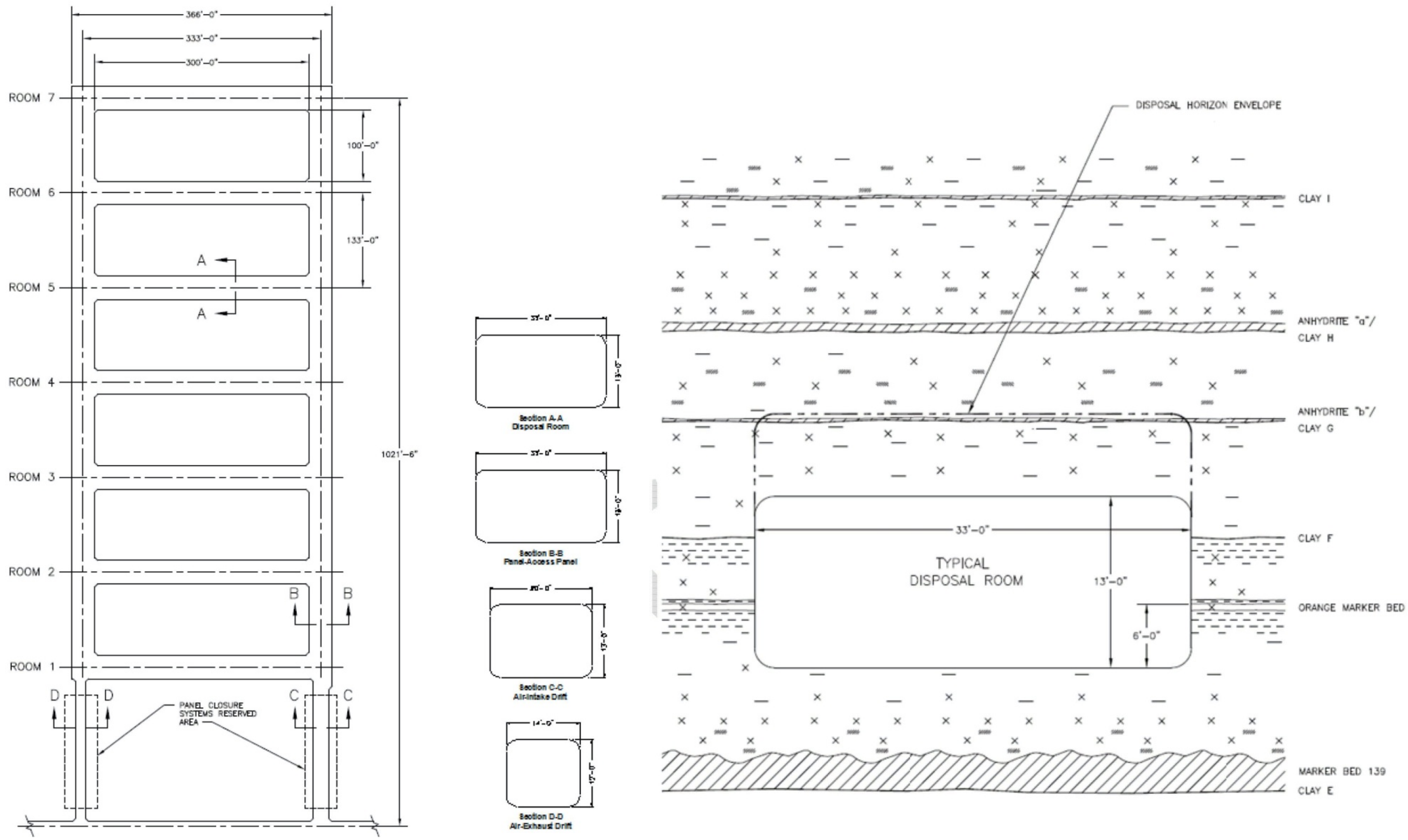


The figure shows the plan view of a waste panel (left), vertical cross sections (middle), and a stratigraphic cross section at the repository horizon (right). The disposal horizon may be selected within the envelope shown based on geomechanical, operational, and safety considerations (Westinghouse, 1995).

Figure G1-1
Typical Panel Layout with Drift Cross Sections

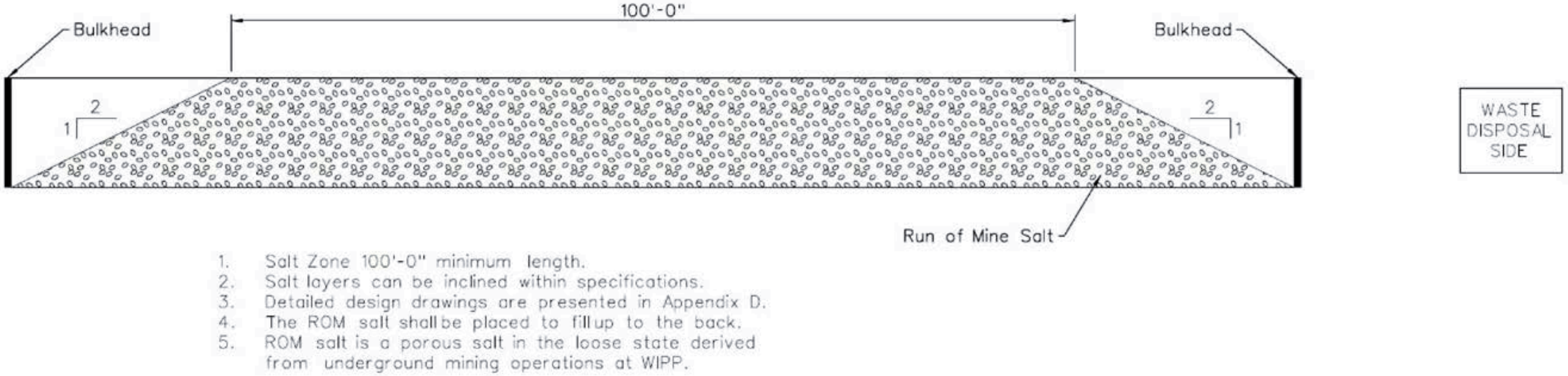


Figure G1-2
Typical WPC for Drifts without Block Walls

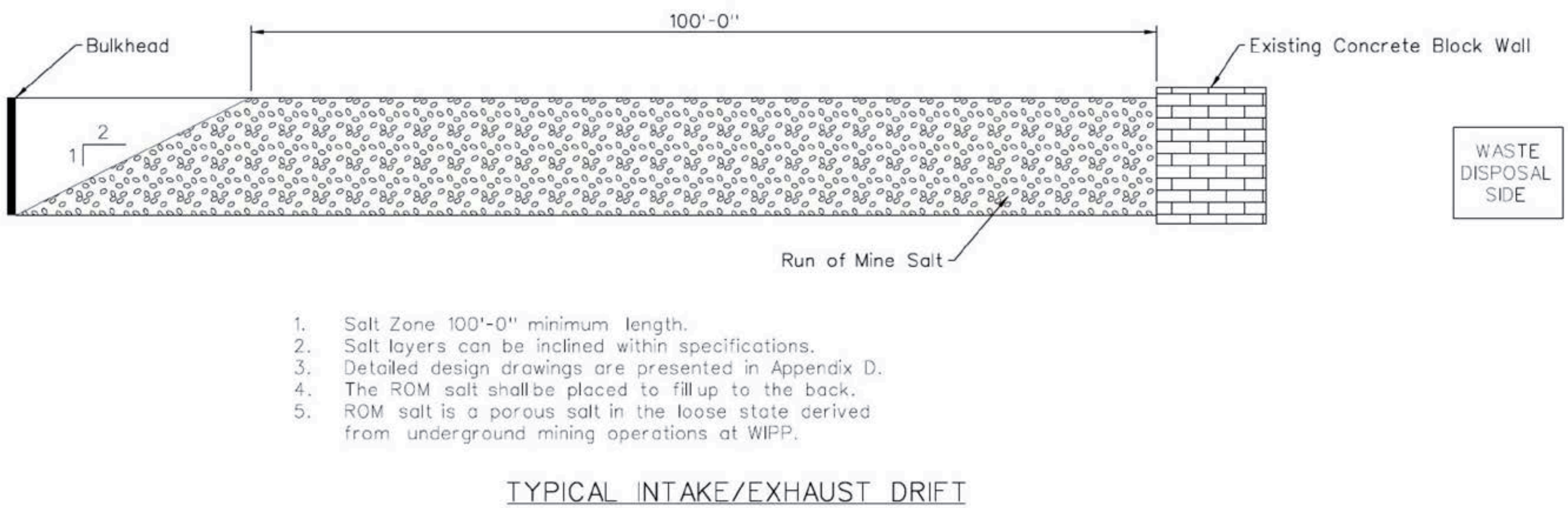


Figure G1-3
Typical WPC for Drifts with Existing Block Walls

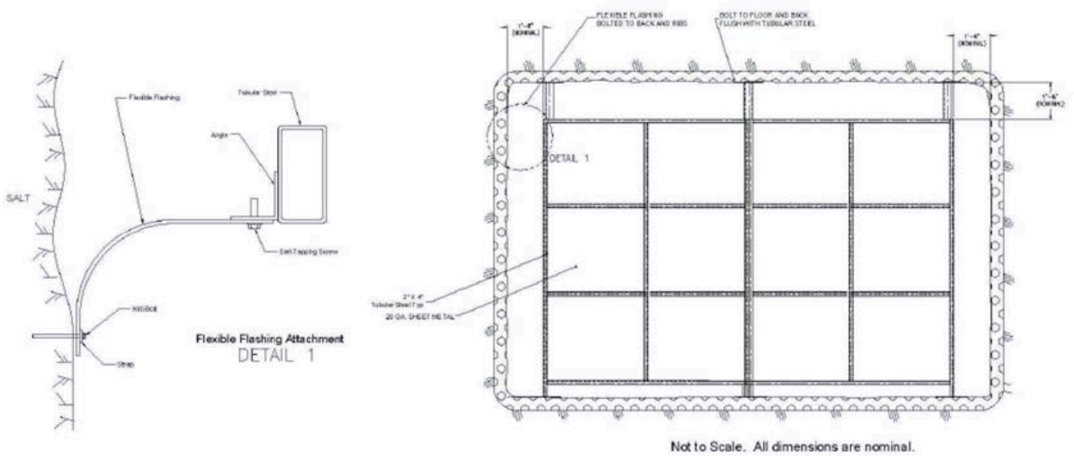
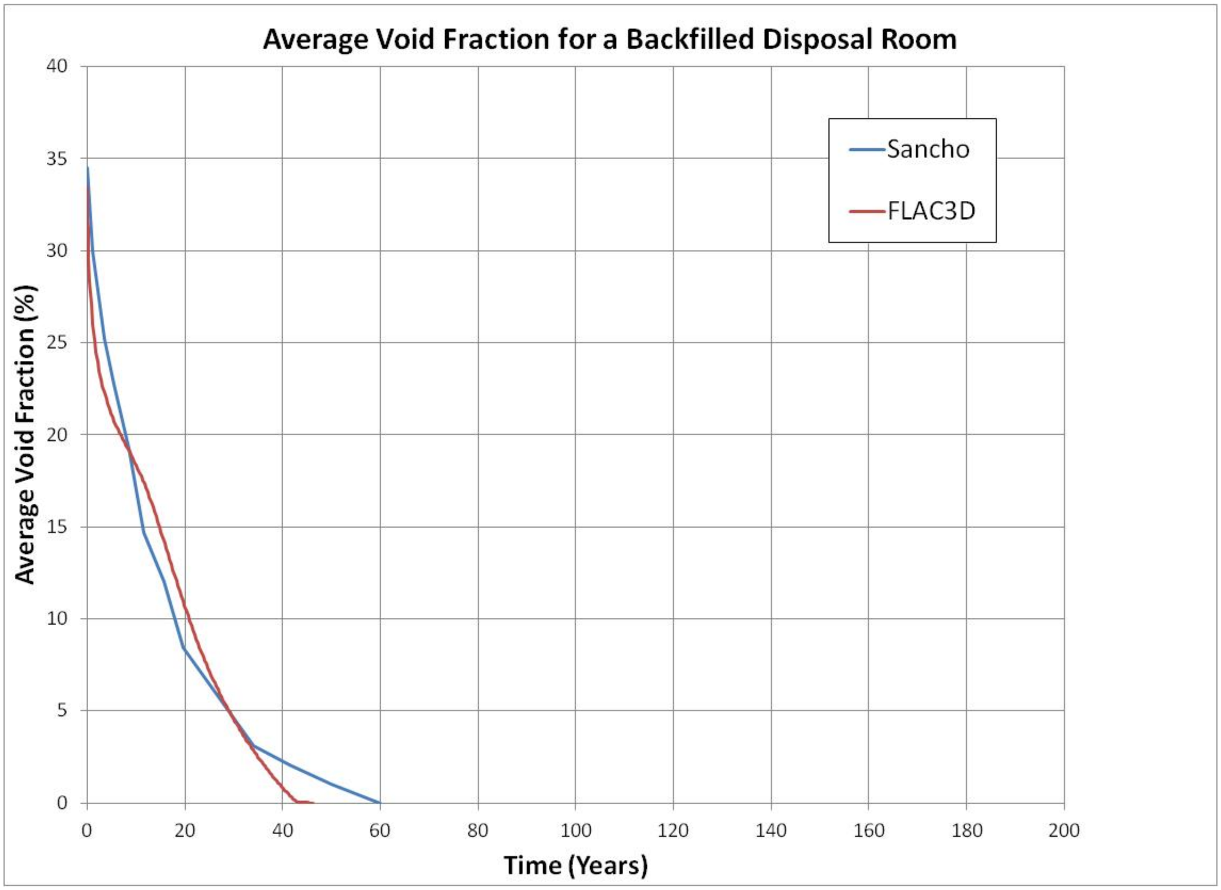
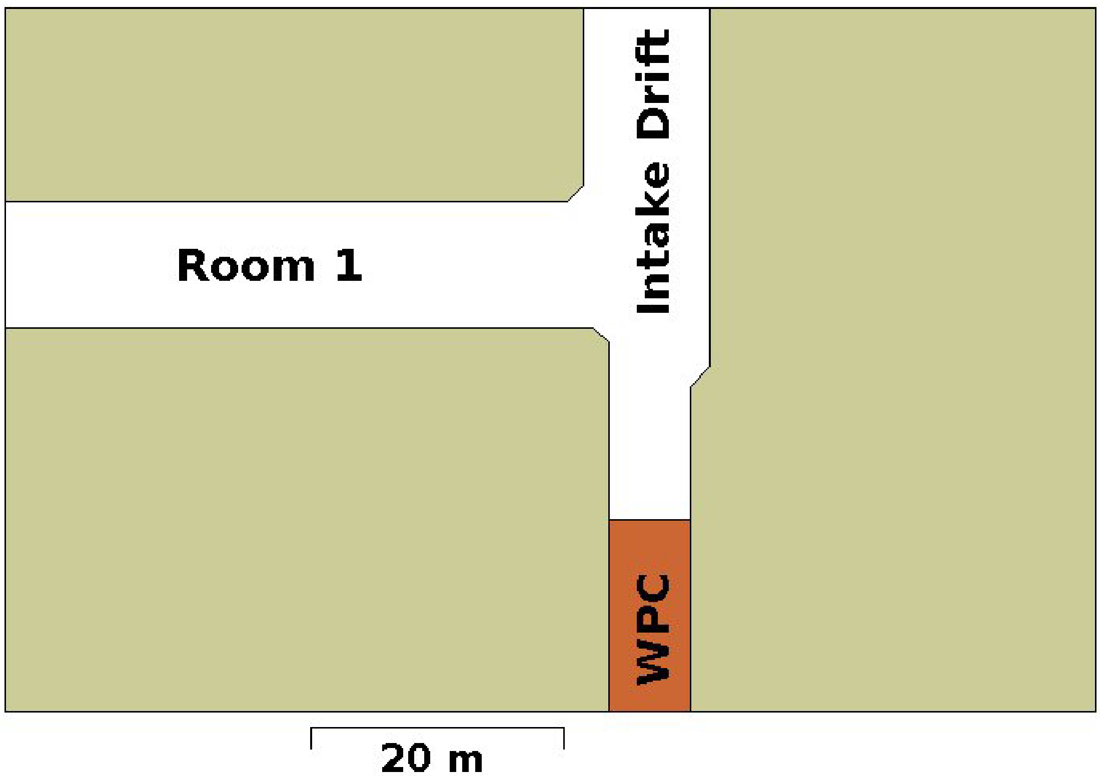


Figure G1-4
Typical Bulkhead for the WPC



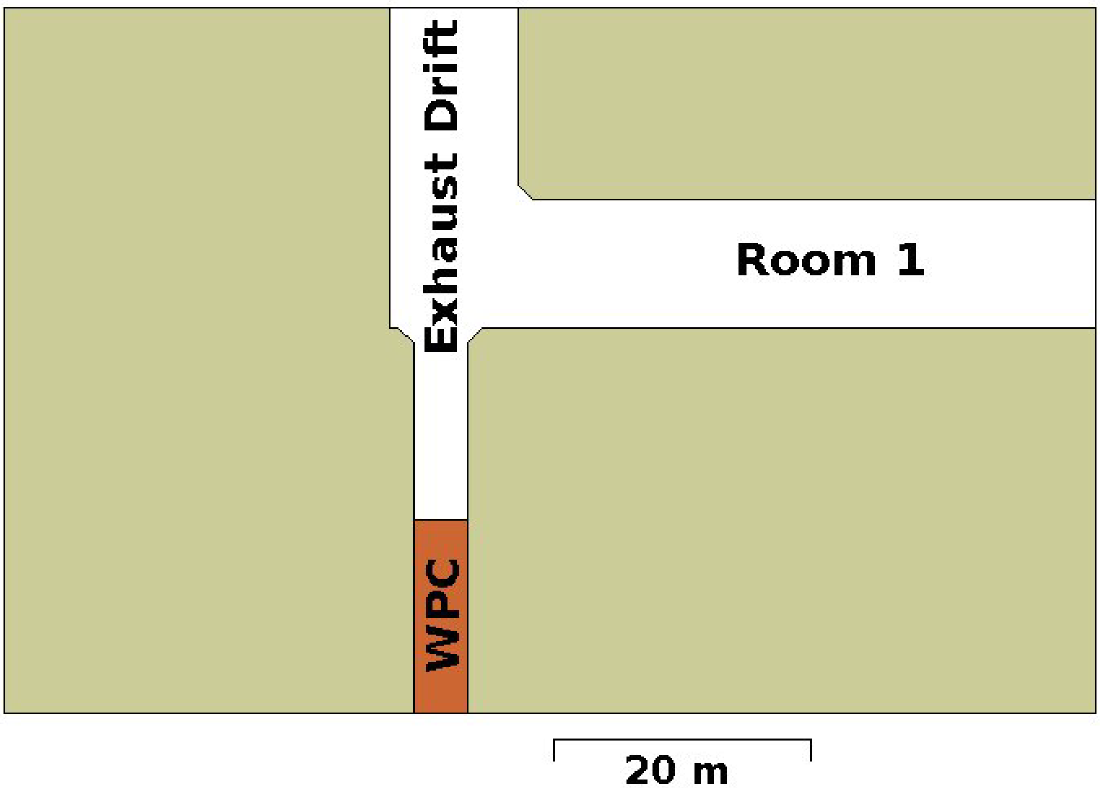
The average void fraction equals 1 minus the porosity.

Figure G1-5
Comparison of FLAC3D and Previous SANCHO Results for the Crushed Salt Benchmark Problem



The lower edge shown is the center of the emplaced fill. All edges are considered planes of symmetry in the analysis.

Figure G1-6
Horizontal Extents for Intake Drift Model



The lower edge shown is the center of the emplaced fill. All edges are considered planes of symmetry in the analysis.

Figure G1-7
Horizontal Extents for Panel Exhaust Drift Model

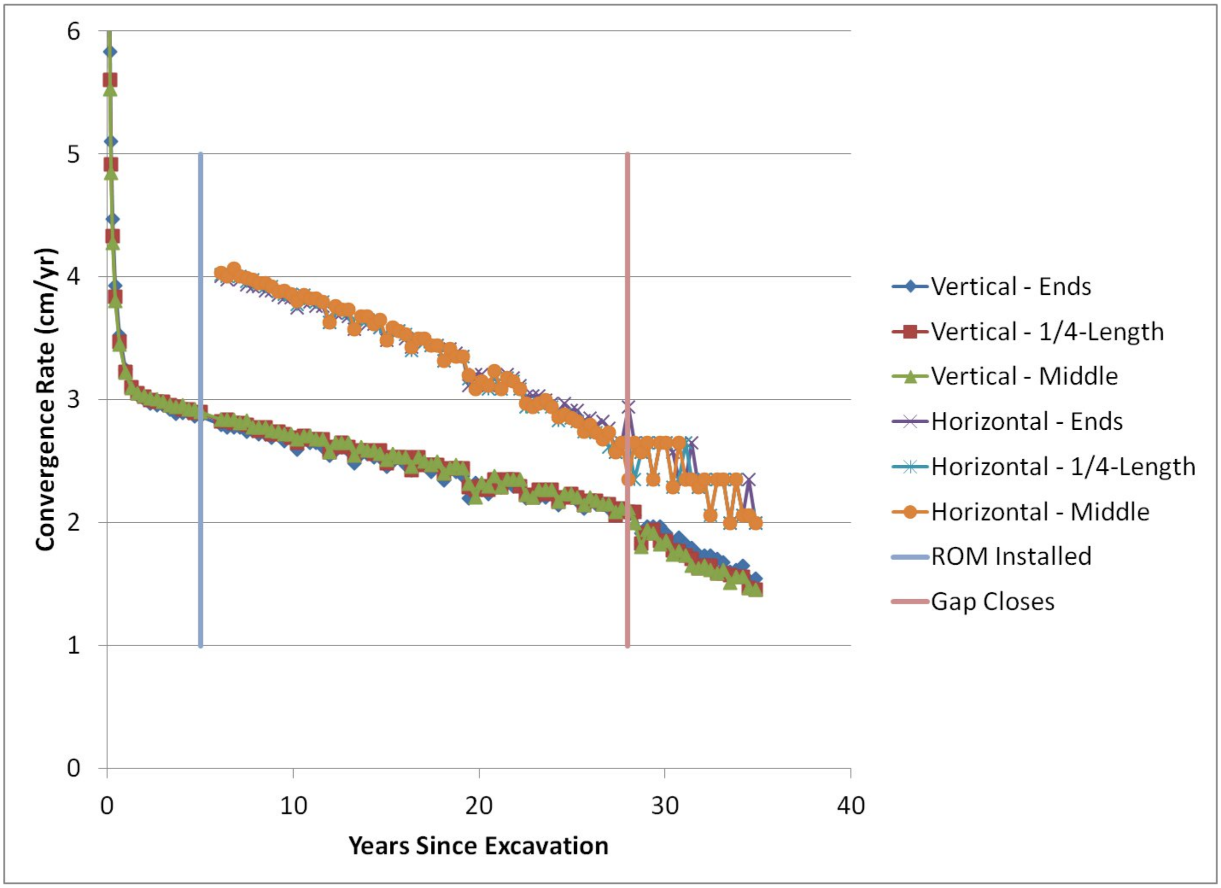


Figure G1-8
Calculated Vertical and Horizontal Panel Intake Entry Convergence Rates Before and After ROM Salt Emplacement

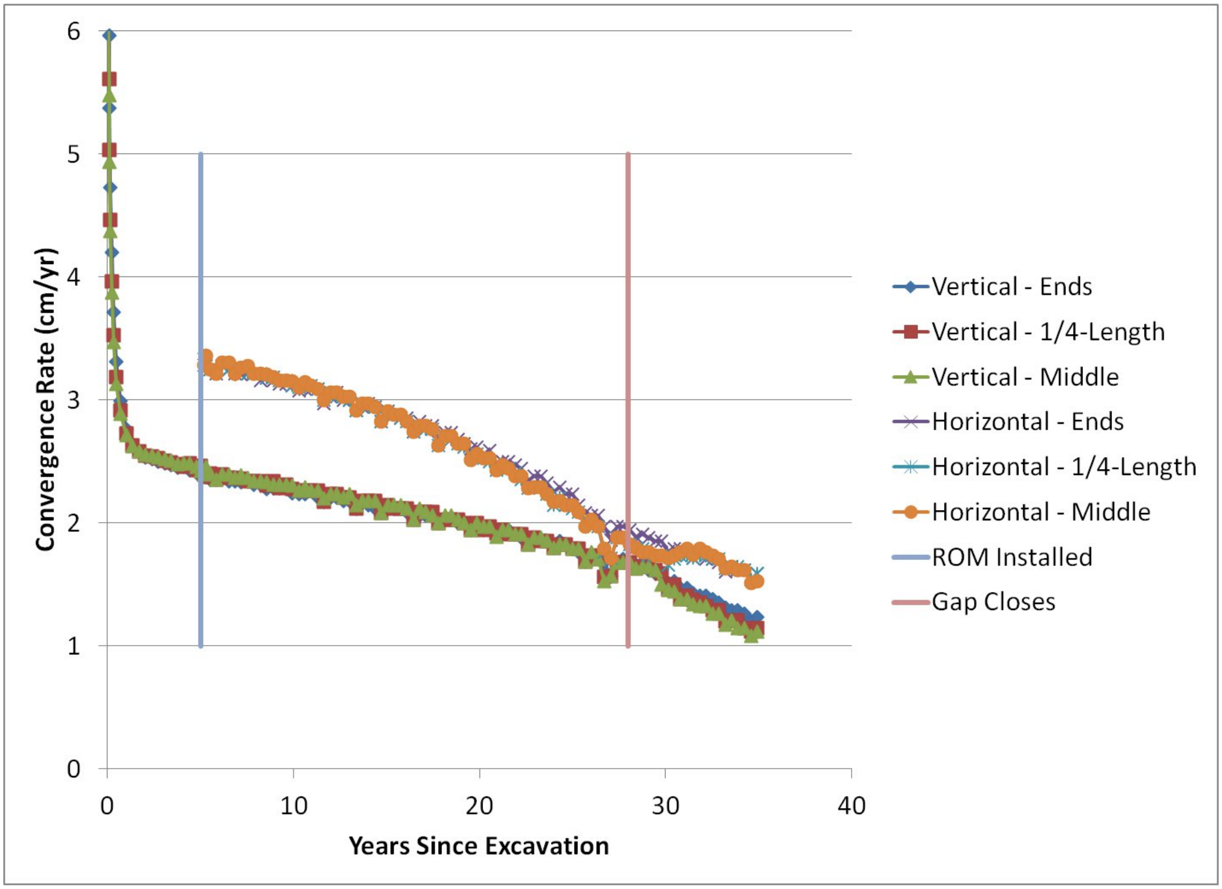


Figure G1-9
Calculated Vertical and Horizontal Panel Exhaust Entry Convergence Rates Before and After ROM Salt Emplacement

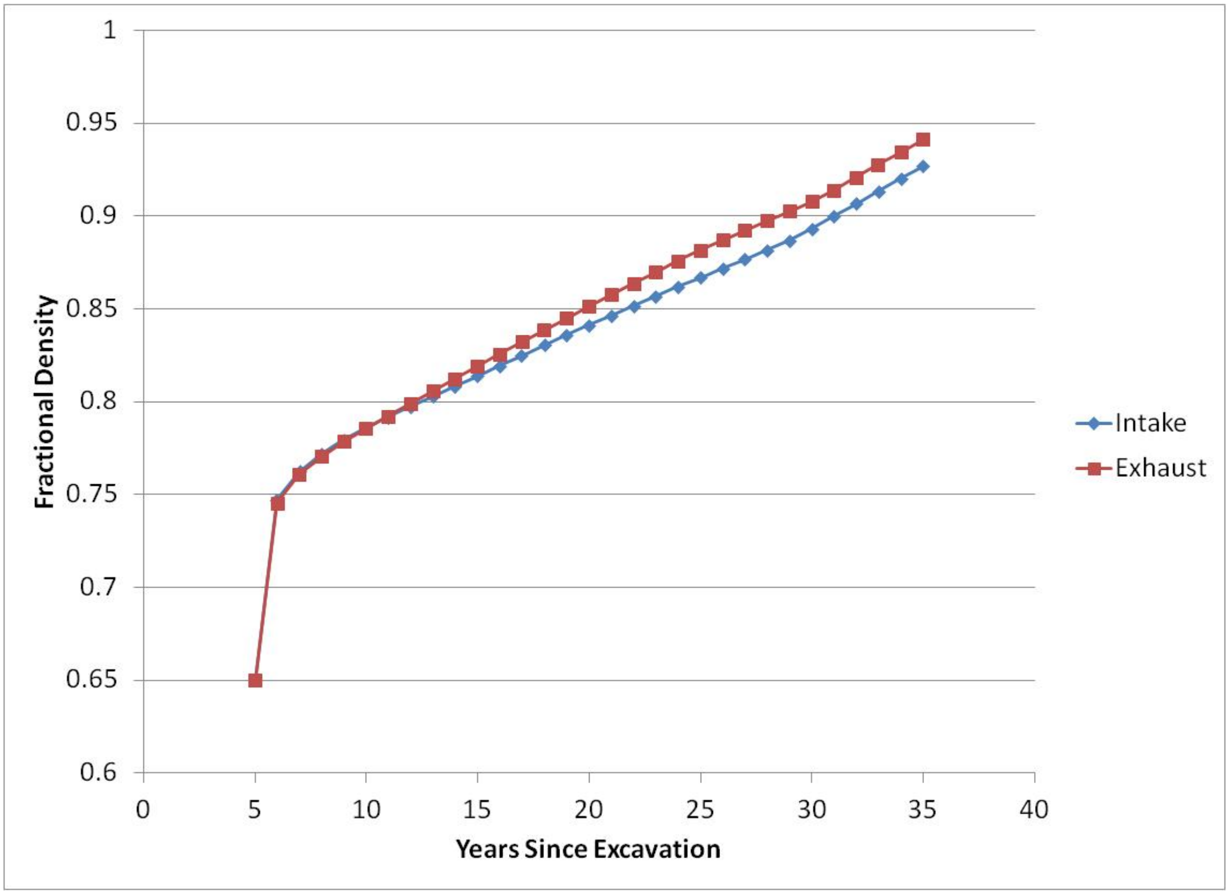


Figure G1-10
Fractional Density of ROM Salt vs. Time for Both Drifts

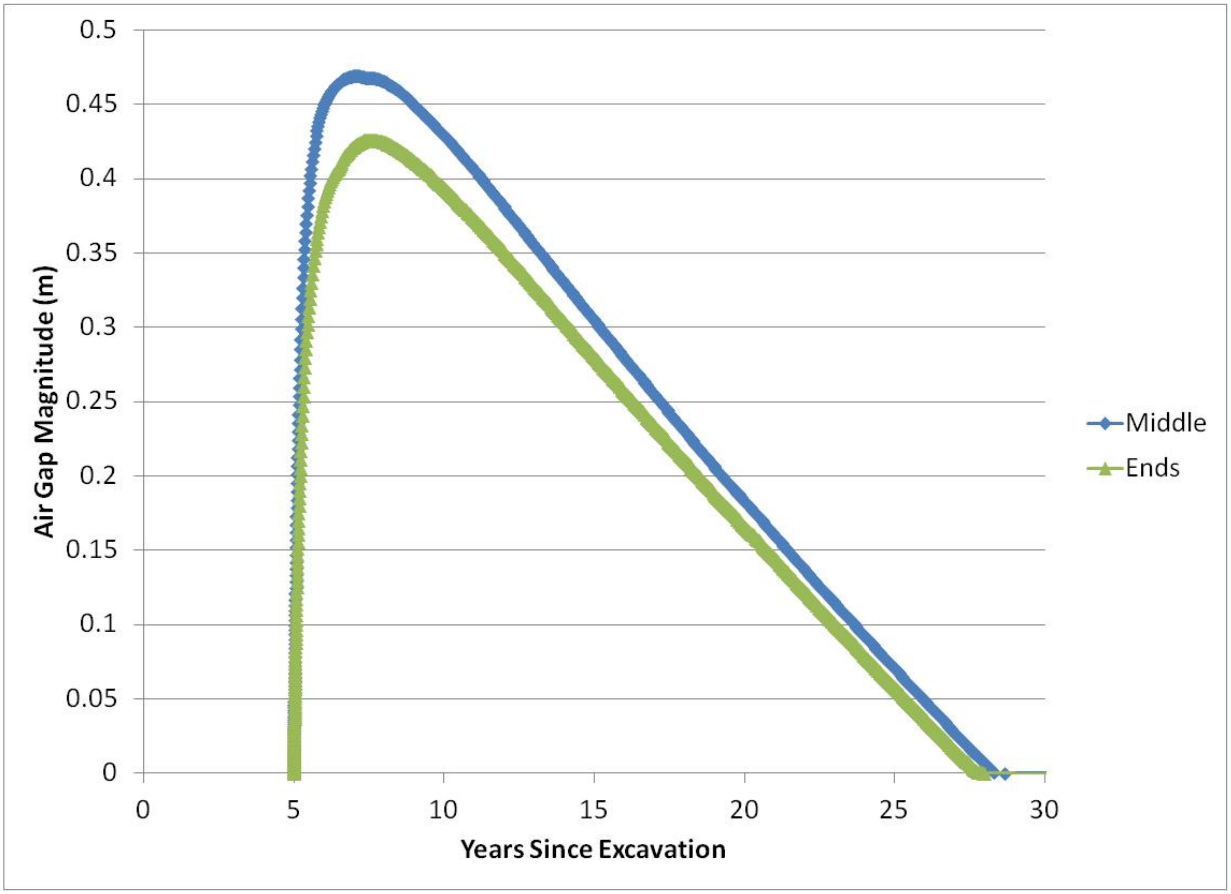


Figure G1-11
Air Gap Magnitude in Intake Drift

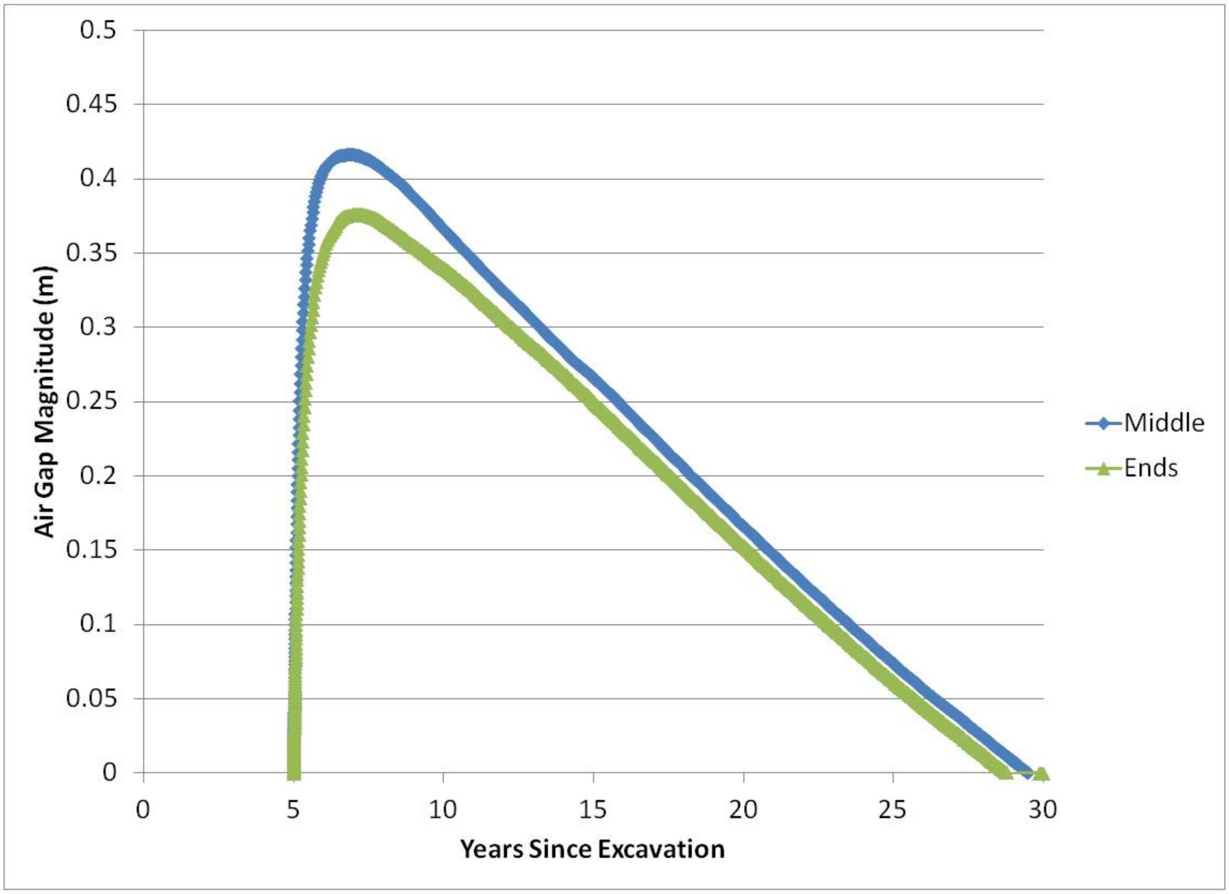


Figure G1-12
Air Gap Magnitude in Exhaust Drift

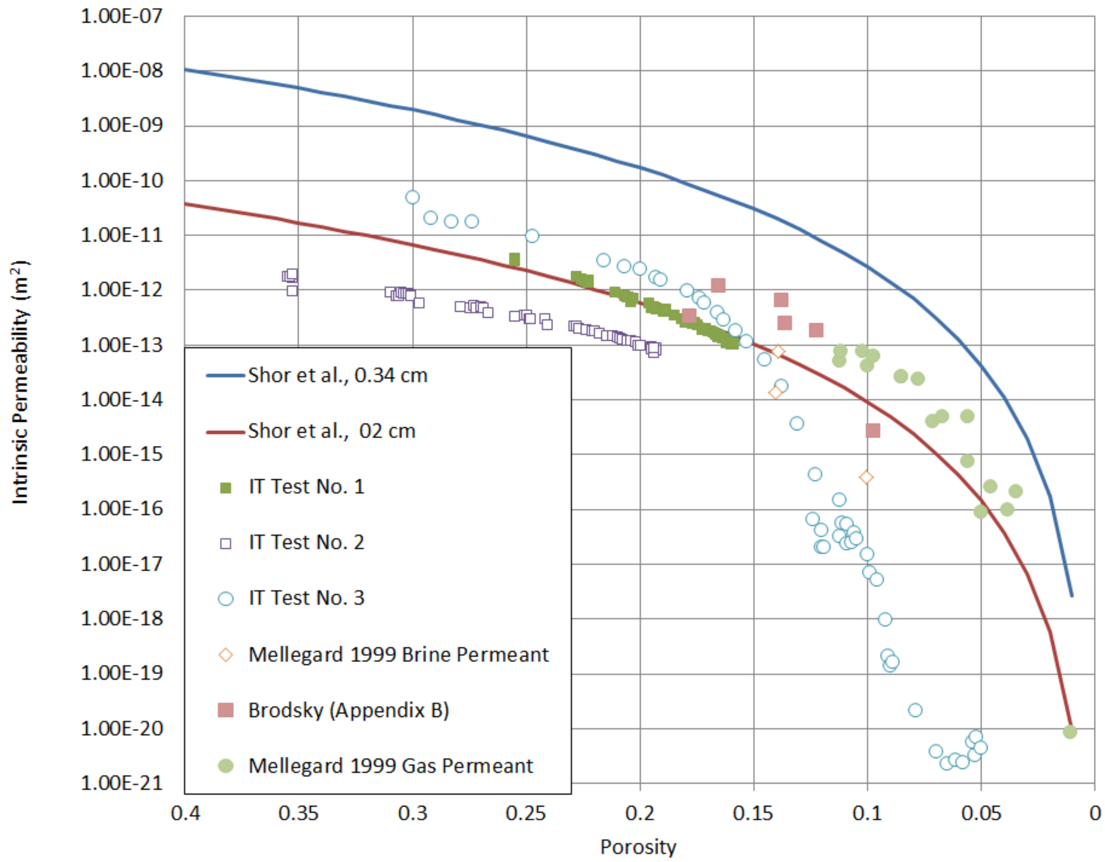


Figure G1-13
Relationship of Intrinsic Permeability to Porosity

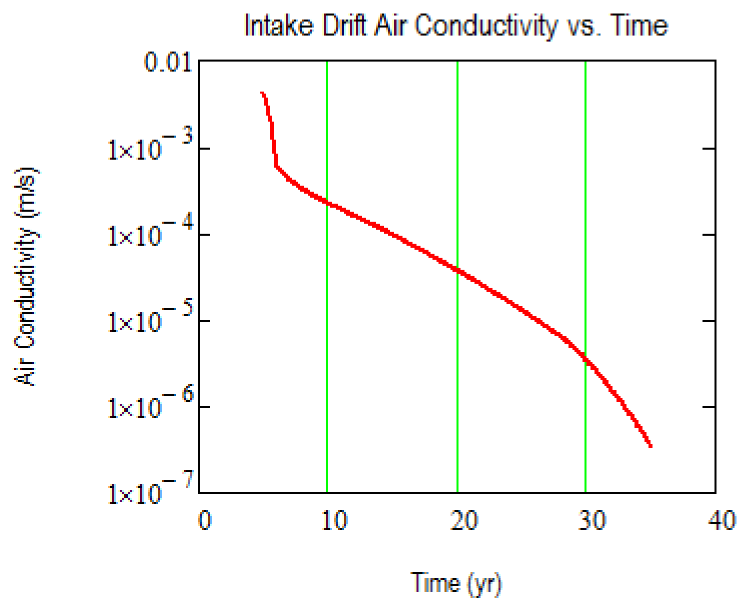


Figure G1-14
Panel Intake Drift Air Conductivity through ROM Salt vs. Time

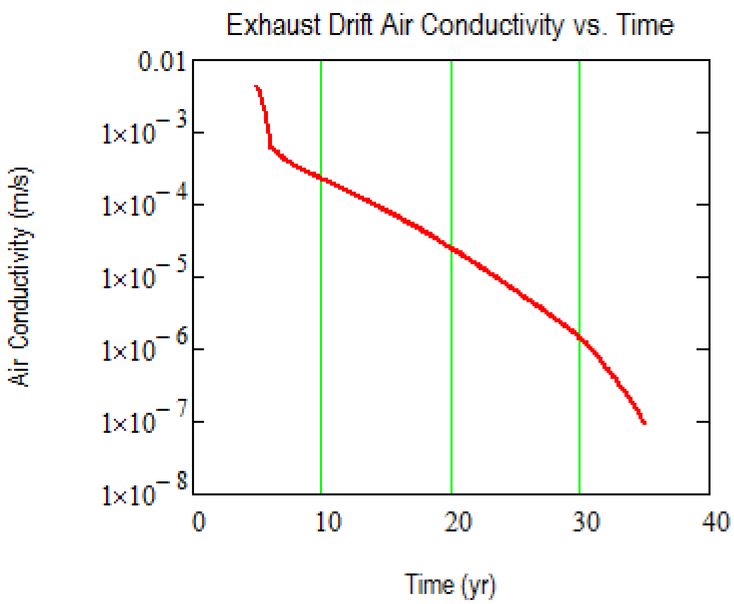
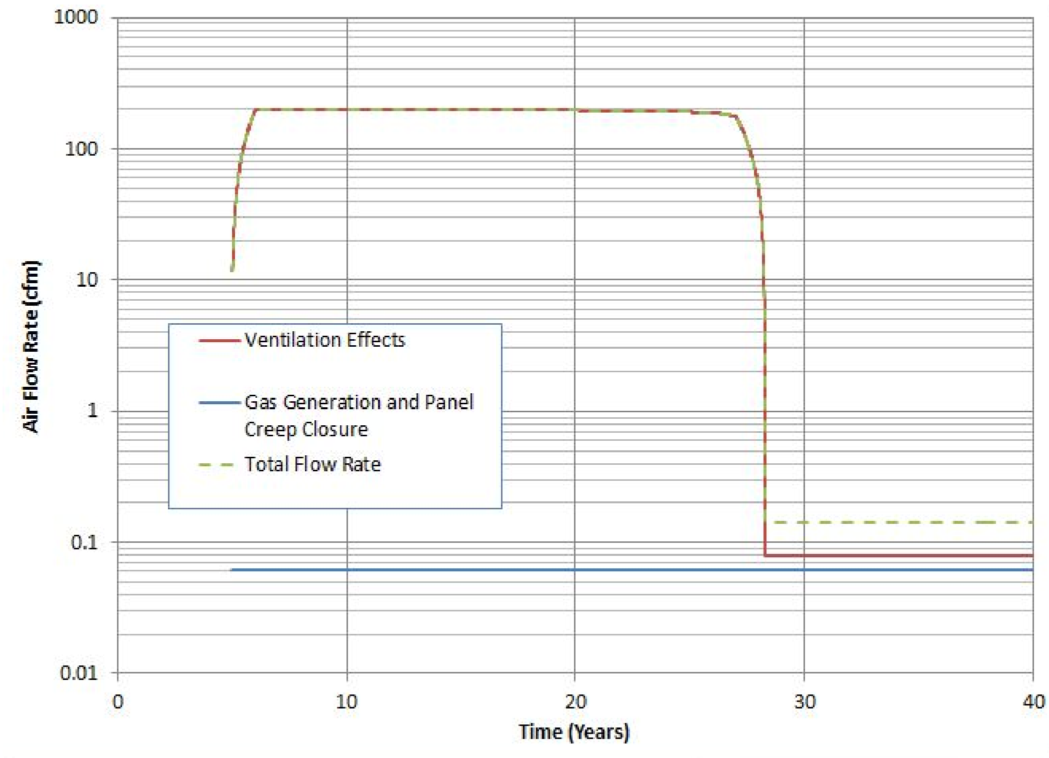


Figure G1-15
Panel Exhaust Drift Air Conductivity through ROM Salt vs. Time



Time shown is after panel excavation with panel closure occurring after 5 years.

Figure G1-16
Air Flow Rate for a Single Panel

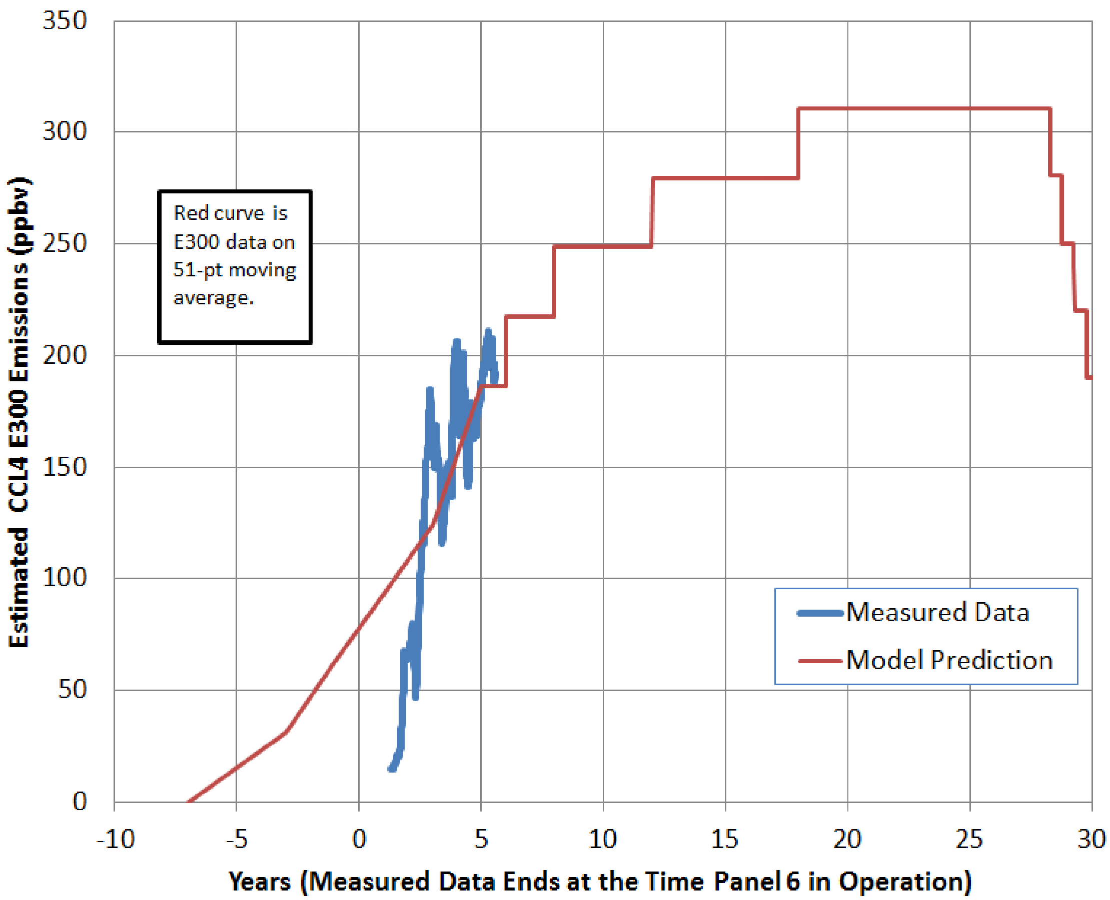


Figure G1-17
Comparison of Predicted and Measured Concentrations for CCl_4 at E-300-

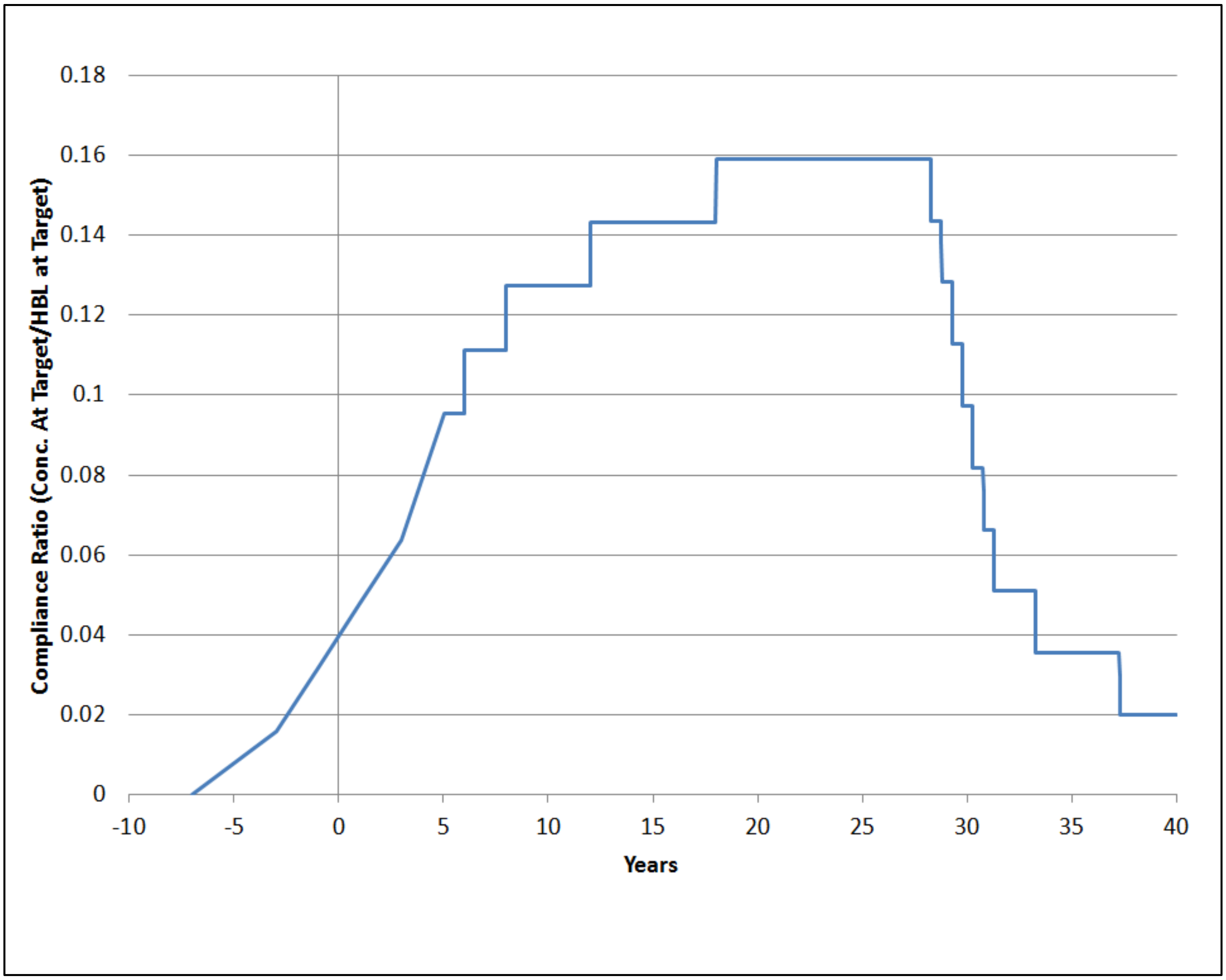


Figure G1-18
Risk Fractions For CCl_4 At WIPP Boundary Receptor Points

~~ATTACHMENT G1~~

~~DETAILED DESIGN REPORT FOR AN OPERATION PHASE PANEL CLOSURE SYSTEM~~

~~Adapted from DOE/WIPP 96-2150~~

~~ATTACHMENT G1~~

~~DETAILED DESIGN REPORT FOR AN OPERATION PHASE PANEL CLOSURE SYSTEM~~

~~TABLE OF CONTENTS~~

~~*Appendices A through F are not included in the Permit.~~

LIST OF TABLES

LIST OF FIGURES

List of Abbreviations/Acronyms

ACI	American Concrete Institute
AISC	American Institute for Steel Construction
*CFR	Code of Federal Regulations
cm	centimeter
°C	degrees celsius
°F	degrees Fahrenheit
DOE	U.S. Department of Energy
DRZ	disturbed rock zone
EEP	Excavation Effects Program
ESC	expansive salt-saturated concrete
FLAC	Fast Lagrangian Analysis of Continua
ft	foot (feet)
GPR	ground-penetrating radar
Kips	1,000 pounds
m	meter(s)
MB 139	Marker Bed 139
MOC	Management and Operating Contractor (Permit Section 1.5.3)
MPa	megapascal(s)
MSHA	Mine Safety and Health Administration
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NaCl	sodium chloride
NMVP	no-migration variance petition
psi	pound(s) per square inch
RCRA	Resource Conservation and Recovery Act
SMC	Salado Mass Concrete
TRU	transuranic
VOC	volatile organic compound(s)
WIPP	Waste Isolation Pilot Plant

ATTACHMENT G1

DETAILED DESIGN REPORT FOR AN OPERATION PHASE PANEL CLOSURE SYSTEM

Executive Summary

Scope. Under contract to the Management and Operating Contractor (**MOC**), IT Corporation has prepared a detailed design of a panel-closure system for the Waste Isolation Pilot Plant (**WIPP**). Preparation of this detailed design of an operational-phase closure system is required to support a Resource Conservation and Recovery Act (**RCRA**) Part B permit application. This report describes the detailed design for a panel-closure system specific to the WIPP site. The recommended panel-closure system will adequately isolate the waste-emplacement panels for at least 35 years.

The report was modified to make it a part of the RCRA Permit issued by the New Mexico Environment Department. The primary change required in the original report was to specify that Panel Closure Design Options A, B, C and E are not approved as part of the facility Permit. Option D is the most robust of the original group of options, and it was specified in the Permit as the design to be constructed for all panel closures. The concrete to be used for panel closures is salt-saturated Salado Mass Concrete as specified in Permit Attachment G1, Appendix G, instead of the proposed plain concrete. The Permittees may submit proposals to modify the Permit (Part 2), the Closure Plan (Permit Attachment G) and this Appendix (identified as Permit Attachment G1) in the future, as specified in 20.4.1.900 NMAC (incorporating 40 CFR §270.42).

Other changes included in this version of the report revised for the permit are minor edits to regulatory citations, deletion of references to the No Migration Variance Petition (no longer required under 40 CFR §268.6), and movement of all figures to the end of the document. Appendices A through F in the original document are not included in this Permit Attachment. Although those Appendices were important in demonstrating that the panel closures will meet the performance standards in the hazardous waste regulations, they do not provide design details or plans to be implemented as Permit requirements. References to these original Appendices were modified to indicate that they were part of the permit application, but are not included in the Permit. In contrast, Appendix G (Technical Specifications) and Appendix H (Design Drawings) are necessary components of future activities and are retained as parts of this Permit Attachment.

Purpose. This report provides detailed design and material engineering specifications for the construction, emplacement, and interface-grouting associated with a panel-closure system at the WIPP repository, which would ensure that an effective panel-closure system is in place for at least 35 years. The panel-closure system provides assurance that the limit for the migration of volatile organic compounds (**VOC**) will be met at the point of compliance, the WIPP site boundary. This assurance is obtained through the inherent flexibility of the panel-closure system. The panel-closure system will be located in the air-intake and air-exhaust drifts (Figure G1-1). The system components have been designed to maintain their intended functional requirements under loads generated from salt creep, internal pressure, and a postulated methane explosion. The design complies with regulatory requirements for a panel-closure system promulgated by RCRA and the Mine Health and Safety Administration (**MSHA**). The design uses common construction practices according to existing standards.

Background. The engineering design considers a range of expected subsurface conditions at the location of a panel-closure system. The geology is predominantly halite with interbedded anhydrite at the repository horizon. During the operational period, the panel-closure system would be subject to creep from the surrounding host rock that contains trace amounts of brine.

During the conceptual design stage, two air-flow models were evaluated: (1) unrestricted flow and (2) restricted flow through the panel-closure system. The "unrestricted" air flow model is defined as a model in which the gas pressure that develops is at or very near atmospheric pressure such that there exists no back pressure in the disposal areas. Flow is unrestricted in this model. The "restricted" air flow model is defined as a model in which the back pressure in the waste emplacement panels develops due to the restriction of flow through the barrier, and the surrounding disturbed rock zone. The analysis was based on an assumed gas generation rate of 8,200 moles per panel per year (0.1 moles per drum per year) due to microbial degradation, an expected volumetric closure rate of 28,000 cubic feet (800 cubic meters) per year due to salt creep, the expected headspace concentration for a series of nine VOCs, and the expected air dispersion from the exhaust shaft to the WIPP site boundary. The analysis indicated that the panel-closure system would limit the concentration of each VOC at the WIPP site boundary to a small fraction of the health-based exposure limits during the operational period.

Alternate Designs. Various options were evaluated considering active systems, passive systems, and composite systems. Consideration of the aforementioned factors led to the selection of a passive panel-closure system consisting of an enlarged tapered concrete barrier which will be grouted at the interface and an explosion-isolation wall. This system provides flexibility for a range of ground conditions likely to be encountered in the underground repository. No other special requirements for engineered components beyond the normal requirements for fire suppression and methane explosion or deflagration containment exist for the panel-closure system during the operational period.

The panel-closure system design incorporates mitigative measures to address the treatment of fractures and therefore minimizes the potential migration of contaminants. The design includes excavating the disturbed rock zone (**DRZ**) and emplacing an enlarged concrete barrier.

To be effective, the excavation and installation of the panel-closure system must be completed within a short time frame to minimize disturbance to the surrounding salt. A rigid concrete barrier will promote interface stress buildup, as fractures are expected to heal with time. For this purpose, the main concrete barrier would be tapered to reduce shear stress and to increase compressive stress along the interface zone.

Design Classification. Procedure WP 09-CN3023 (Westinghouse, 1995a) was used to establish a design classification for the panel-closure system. It uses a decision-flow-logic process to designate the panel-closure system as a Class IIIB structure. This is because during the methane explosion the concrete barrier would not fail.

Design Evaluations. To investigate several key design issues, design evaluations were performed. These design evaluations can be divided into those that satisfy (1) the operational requirements of the system and (2) the structural and material requirements of the system.

The conclusions reached from the evaluations addressing the operational requirements are as follows:

- Based on an air-flow model used to predict the mass flow rate of carbon tetrachloride through the panel-closure system for the alternatives, the air-flow analysis suggests that the fully enlarged barrier provides the highest protection for restricting VOCs during the operational period of 35 years.

- Results of the Fast Lagrangian Analysis of Continua (**FLAC**) analyses show that the recommended enlarged configuration is a circular rib-segment excavated to Clay G and under MB 139. Interface grouting would be performed at the upper boundary of the concrete barrier.

- The results of the transverse plane-strain models show that higher stresses would form in MB 139 following excavation, but that after installation of the panel-closure system, the barrier confinement will result in an increase in barrier-confining stress and a reduction in shear stress. The main concrete barrier would provide substantial uniform confining stresses as the barrier is subjected to secondary salt creep.

- The removal of the fractured salt prior to installation of the main concrete barrier would reduce the potential for flexure. The fracturing of MB 139 and the attendant fracturing of the floor could reduce structural load resistance (structural stiffness), which could initially result in barrier flexure and shear. With the removal of MB 139, the fractured salt stiffens the surrounding rock and results in the development of more uniform compression.

- The trade-off study also showed that a panel-closure system with an enlarged concrete barrier with the removal of the fractured salt roof and anhydrite in the floor was found to be the most protective.

The conclusions reached from the design evaluations addressing the structural and material requirements of the panel-closure system are as follows:

- Existing information on the heat of hydration of the concrete supports placing concrete with a low cement content to reduce the temperature rise associated with hydration. Plasticizers might be used to achieve the required slump at the required strength. A thermal analysis, coupled with a salt creep analysis, suggests installation of the enlarged barrier at or below ambient temperatures to adequately control hydration temperatures.

- In addition to installation at or below ambient temperatures, the concrete used in the main barrier would exhibit the following:

  – An 8 inch (0.2 meter) slump after 3 hours of intermittent mixing

  – A less-than-25-degree Fahrenheit heat rise prior to installation

  – An unconfined compressive strength of 4,000 pounds per square inch (psi) (28 megapascals [MPa]) after 28 days

  – Volume stability

  - ~~Minimal entrained air.~~

- ~~The trace amounts of brine from the salt at the repository horizon will not degrade the main concrete barrier for at least 35 years.~~

- ~~In 20 years, the open passage above the waste stack would be reduced in size. Further, rooms with bulkheads at each end would be isolated in the panel. It is unlikely that a long passage with an open geometry would exist; therefore, the dynamic analysis considered a deflagration with a peak explosive pressure of 240 psi (1.7 MPa).~~

- ~~The heat-transfer analysis shows that elevated temperatures would occur within the salt and the explosion-isolation wall; however, the elevated temperatures will be isolated by the panel-closure system. Temperature gradients will not significantly affect the stability of the wall.~~

- ~~The fractures in the roof and floor could be affected by expanding gas products reaching pressures on the order of 240 psi (1.7 MPa). Because the peak internal pressure from the deflagration is only one fifth of the pressure, fractures could not propagate beyond the barrier.~~

~~A composite system is selected for the design with various components to provide flexibility. These design options are described below.~~

~~**Design Options.** Figure G1-2 illustrates the options developed to satisfy the requirements for the panel-closure system. The basis for selecting an option depends on conditions at the panel-closure system locations as would be documented by future subsurface investigations. As noted earlier, Option D is the only option approved for construction as part of the facility permit issued by the NMED.~~

~~While no specific requirements exist for barricading inactive waste areas under the MSHA, their intent is to safely isolate these abandoned areas from active workings using barricades of "substantial construction." A previous analysis (DOE, 1995) examined the issue of methane gas generation from transuranic waste and the potential consequence in closed areas. The principal concern is whether an explosive mixture of methane with an ignition source would result in deflagration. A concrete block wall of sufficient thickness will be used to resist dynamic and salt creep loads.~~

~~It was shown (DOE, 1995) that an explosive atmosphere may exist after approximately 20 years.~~

~~**Design Components.** The enlarged concrete barrier location within the air-intake and air-exhaust drifts will be determined following observation of subsurface conditions. The enlarged concrete barrier will be composed of salt-saturated Salado Mass Concrete with sufficient unconfined compressive strength. The barrier will consist of a circular rib segment excavated into the surrounding salt where the central portion of the barrier will extend just beyond Clay G and MB 139. FLAC analyses showed that plain concrete will develop adequate confined compressive strength.~~

~~The enlarged concrete barrier will be placed in four cells, with construction joints formed perpendicular to the direction of potential air flow. The concrete will be placed through 6-inch~~

~~(15.2 centimeter) diameter steel pipes and will be vibrated from outside the formwork. The formwork is designed to withstand the hydrostatic loads that would occur during installation with minimal bracing onto exposed salt surfaces. This will be accomplished by a series of steel plates that are stiffened by angle iron, with load reactions carried by spacer rods. Some exterior bracing will be required when the concrete is poured into the first cell at the location for the enlarged concrete barrier. All structural steel will be American Society of Testing and Materials [grade] A36 in conformance with the latest standards specified by the American Institute for Steel Construction. After concrete placement, the formwork will be left in place and will stiffen the enlarged concrete barrier if nonuniform reactive loadings should occur after panel closure.~~

~~After completion of the enlarged concrete barrier installation, it will be grouted through a series of grout supply and air return lines that terminate in grout boxes. The boxes will be mounted near the top of the barrier. The grout will be injected through one set of lines and returned through a second set of air lines.~~

~~An explosion-isolation wall, constructed with concrete-blocks, will mitigate the effects of a methane explosion. The explosion-isolation wall would consist of 3,500 psi (24 MPa) concrete blocks mortared together with a bonding agent. The concrete-block wall design complies with MSHA requirements, because it consists of noncombustible materials of "substantial construction." The concrete-block walls will be keyed into the salt. For the WIPP, an explosion-isolation wall is designed to resist loading from salt creep.~~

~~The compliance of the detailed design was evaluated against the design requirements established for the panel-closure system. The design complies with all aspects of the design basis established for the panel-closure system.~~

~~1.0 Introduction~~

~~The Waste Isolation Pilot Plant (**WIPP**) repository, a U.S. Department of Energy (**DOE**) research facility located near Carlsbad, New Mexico, is approximately 2,150 feet (ft) (655 meters [m]) below the surface, in the Salado Formation. The WIPP facility consists of a northern experimental area, a shaft-pillar area, and a waste-emplacement area. The WIPP facility will be used to dispose transuranic (**TRU**) mixed waste.~~

~~One important aspect of future repository operations at the WIPP is the activities associated with closure of waste-emplacement panels. Each panel consists of air-intake and air-exhaust drifts, panel-access drifts, and seven rooms (Figure G1-1). After completion of waste-emplacement activities, each panel will be closed, while waste emplacement may be occurring in the other panel(s). The closure of individual panels during the operational period will be conducted in compliance with project-specific health, safety, and environmental performance criteria.~~

~~1.1 Scope~~

~~This report provides information on the detailed design and material engineering specifications for the construction, installation, and interface grouting associated with a panel-closure system for a minimum operational period of 35 years. The panel-closure system design provides assurance that the limit for the migration of volatile organic compounds (**VOC**) will be met at the point of compliance, the WIPP site boundary. This assurance is obtained through the inherent flexibility of the panel closure system. The panel-closure system will be located in the air-intake and air-exhaust drifts to each panel (Figure G1-1). The panel-closure system design maintains~~

~~its intended functional requirements under loads generated from salt creep, internal panel pressure, and a postulated methane explosion. The design complies with regulatory requirements for a panel-closure system promulgated by the Resource Conservation and Recovery Act (**RCRA**) and Mine Safety and Health Administration (**MSHA**) (see citations in Section 1.3 below).~~

~~Figure G1-3 illustrates the design process used for preparing the detailed design. The design process commenced with the evaluation of the performance requirements of the panel-closure system through review of the work performed in developing the conceptual design and the "Underground Hazardous Waste Management Unit Closure Criteria for the Waste Isolation Pilot Plant Operation Phase" (Westinghouse, 1995b). The various design evaluations were performed to address specific design-implementation issues identified by the project. The results of these design evaluations are presented in this report.~~

~~1.2 Design Classification~~

~~Procedure WP 09-CN3023 (Westinghouse, 1995a) was used to establish a design classification for the panel-closure system. The design classification for the panel-closure system evolved from addressing the short-term operational issues regarding the reduction of VOC migration. Figure G1-4 shows the decision flow logic process used to designate the panel-closure system as a Class IIIB structure.~~

~~1.3 Regulatory Requirements~~

~~The following subsections discuss the regulatory requirements specified in RCRA and MSHA for the panel-closure system.~~

~~1.3.1 Resource Conservation and Recovery Act (40 CFR §264 and §270)~~

~~In accordance with 20.4.1.500 NMAC, incorporating Title 40, Code of Federal Regulations (**CFR**), Part 264, Subpart X (40 CFR §264, Subpart X), "Miscellaneous Units," and 20.4.1.900 NMAC, incorporating 40 CFR §270.23, "Specific Part B Information Requirements for Miscellaneous Units," a RCRA Part B permit application has been submitted for the WIPP facility.~~

~~1.3.2 Protection of the Environment and Human Health~~

~~The WIPP RCRA Part B permit application indicates that VOCs must not exceed health-based standards beyond the WIPP site boundary. Worker exposure to VOCs, and VOC emissions to non-waste workers or to the nearest resident will not pose greater than a 10^{-6} excess cancer risk in order to meet health-based standards. The panel-closure system design incorporates measures to mitigate VOC migration for compliance with these standards.~~

~~1.3.3 Closure Requirements 20.4.1.500 NMAC~~

~~The Permittees will notify the Secretary of the New Mexico Environment Department in writing at least 60 days prior to the date on which partial and final closure activities are scheduled to begin.~~

1.3.4 Mining Safety and Health Administration

The significance of small natural-gas occurrences within the WIPP repository is within the classification of Category IV for natural gas under the MSHA (30 CFR 57, Subpart T) (MSHA, 1987). These regulations include the hazards of methane gas and volatile dust. Category IV "applies to mines in which non-combustible ore is extracted and which liberate a concentration of methane that is not explosive nor capable of forming explosive mixtures with air based on the history of the mine or the geological area in which the mine is located." For "barriers and stoppings," the regulations provide for noncombustible materials (where appropriate) for the specific mine category and require that "barriers and stoppings" be of "substantial construction." Substantial construction implies construction of such strength, material, and workmanship that the barrier could withstand air blasts, methane detonation or deflagration, blasting shock, and ground movement expected in the mining environment.

1.4 Report Organization

This report presents the engineering package for the detailed design of the panel-closure system. Chapter 2.0 presents the design evaluations. Chapter 3.0 describes the design and Chapter 4.0 presents the Constructability Design Calculations Index. Chapter 5.0 shows the technical specifications. Chapter 6.0 presents the design drawings. The conclusions are presented in Chapter 7.0 and the references presented in Chapter 8.0. Appendices to this report provide detailed information to support the information contained in Chapters 2.0 through 7.0 of this report.

2.0 Design Evaluations

This chapter in the Part B permit application presented the results of the various design evaluations that support the panel-closure system: (1) analyses addressing the operational requirements, and (2) analyses addressing the structural and material requirements. These evaluations were important in demonstrating that the panel closures will adequately restrict releases of VOCs and will be structurally stable during the operations phase of the WIPP. However, these evaluations are not necessary as part of the facility permit and have been deleted from this edited document.

3.0 Design Description

This chapter presents the final design selected from the evaluations performed in the previous chapter. It presents design modifications to cover a range of conditions that may be encountered in the underground and describes the design components for the panel-closure system. Finally, information is presented on the proposed construction for the panel-closure system.

3.1 Design Concept

The composite panel-closure system proposed in the permit application included (1) a standard concrete barrier, rectangular in shape, or (2) an enlarged tapered concrete barrier. Options (1) and (2) were both proposed to be grouted along the interface and may contain explosion- or construction-isolation walls. Figure G1-2 illustrates these design components. The construction methods and materials to be used to implement the design have been proven in previous mining and construction projects. The standard concrete barrier without DRZ removal was intended to apply to future panel air-intake and air-exhaust drifts where the time duration between excavation and barrier emplacement is short. The enlarged concrete barrier with DRZ removal and explosion-isolation wall is the only option approved in the RCRA facility Permit. The design concept for the enlarged concrete barrier incorporates:

- A concrete barrier that is tapered to promote the rapid stress buildup on the host rock. The stiffness was selected to provide rapid buildup of compressive stress and reduction in shear stress in the host rock.

- The enlarged barrier requires DRZ removal just beyond Clay G and MB 139, and to a corresponding distance in the ribs to keep the tapered shape approximately spherical. The design includes DRZ removal and thereby limits VOC flow through the panel-closure system.

- The design of the approved panel-closure system includes an explosion-isolation wall designed to provide strength and deformational serviceability during the operational period. The length was selected to assure that uniform compression develops over a substantial portion of the structure and that end-shear loading that might result in fracturing of salt into the back is reduced.

3.2 Design Options

The design options consist of the following:

- An enlarged concrete barrier with the DRZ removed and a construction-isolation wall

- An enlarged concrete barrier with the DRZ removed and an explosion-isolation wall (This is the only option approved in the RCRA facility Permit.)

- A rectangular concrete barrier without the DRZ removed and a construction-isolation wall

- A rectangular concrete barrier without the DRZ removed and an explosion-isolation wall.

In each case, interface grouting will be used for the upper barrier/salt interface to compensate for any void space between the top of the barrier and the salt. The process for selecting these options was proposed to depend on the subsurface conditions at the panel-closure system locations described in the following subsections.

Observation boreholes will be drilled into the roof or floor of the new air-intake and air-exhaust drifts and will be used for observation of fractures and bed separation. Observations can be made in the boreholes using a small video camera, or a scratch rod. A scratch rod survey will be performed in accordance with the current Excavation Effects Program (**EEP**) procedure.

The EEP was initiated in 1986 with the occurrence of fractures in Site and Preliminary Design Validation Room 3. The purpose of the EEP is to study fractures that develop as a result of underground excavation at the WIPP and to monitor those fractures. Borehole inspections have been successful for determining the fracturing and bed separation in the host rock. These inspections have been performed since 1983 (Francke and Terrill, 1993). This technique in addition to the above will be used to determine the optimum location for the panel-closure system.

Since the enlarged barrier is required to be constructed for all panel closures, the proposed DRZ investigations are not required as part of the RCRA facility Permit.

3.3 Design Components

The following subsections present system and components design features.

3.3.1 Concrete Barrier

The enlarged concrete barrier consists of Salado Mass Concrete, with sufficient unconfined compressive strength and with an approximately circular cross-section excavated into the salt over the central portion of the barrier (Figure G1-5). The enlarged concrete barrier will be located at the optimum locations in the air-intake and air-exhaust drifts with the central portion extending just beyond Clay G and MB 139.

The enlarged concrete barrier will be placed in four cells, with construction joints perpendicular to the direction of potential air flow. The concrete strength will be selected according to the standards specified by the latest edition of the ACI code for plain concrete. The concrete will be placed through 6-inch- (15-cm)-diameter steel pipes and vibrated from outside the formwork. The formwork is designed to withstand the hydrostatic loads during construction, with minimal bracing onto exposed salt surfaces. This will be accomplished by placing a series of steel plates that are stiffened by angle iron, with load reactions carried by spacer rods. The spacer rods will be staggered to reduce potential flow along the rod surfaces through the barrier. Some exterior bracing will be required when the first cell is poured. All structural steel will be ASTM A36, with detailing, fabrication, and erection of structural steel in conformance with the latest edition of the AISC steel manual (AISC, 1989). After concrete placement, the formwork will be left in place.

The above design is for the most severe conditions expected to be encountered at the WIPP.

~~3.3.2 Explosion- and Construction-Isolation Walls~~

~~An explosion-isolation wall, consisting of concrete-blocks, will mitigate the effects of a postulated methane explosion. The explosion-isolation wall consists of 3,500-psi (24-MPa) concrete blocks mortared together with cement (Figure G1-6).~~

~~The concrete block wall design complies with MSHA requirements (MSHA, 1987) because it uses incombustible materials of substantial construction. The explosion-isolation wall will be placed into the salt for support. The explosion-isolation walls are designed to resist creep loading from salt deformation. In the absence of the postulated methane explosion, the design was proposed to be simplified to a construction-isolation wall. The construction-isolation wall design provides temporary isolation during the time the main concrete barrier is being constructed. The construction-isolation wall was not approved as part of the RCRA facility Permit.~~

~~3.3.3 Interface Grouting~~

~~After construction of the main concrete barrier, the interface between the main concrete barrier and the salt will be grouted through a series of grout-supply and air-return lines that will terminate in grout distribution collection boxes. The openings in these boxes will be protected during concrete placement (Figure G1-7). The grout boxes will be mounted near the top of the barrier. The grout will be injected through one distribution system, with air and return grout flowing through a second distribution system.~~

~~3.4 Panel-Closure System Construction~~

~~The construction methods and materials to be used to implement the design have been proven in previous mining and construction projects. The design uses common construction practices according to existing standards. The proposed construction sequence follows completion of the waste-emplacement activities in each panel: (1) Perform subsurface exploration to determine the optimum location for the panel closure system, (2) select the appropriate design option for the location, (3) prepare surfaces for the construction- or explosion-isolation walls, (4) install these walls, (5) excavate for the enlarged concrete barrier (if required), (6) install concrete formwork, (7) emplace concrete for the first cell, (8) grout the completed cell, and (9) install subsequent formwork, concrete and grout until completion of the enlarged concrete barrier. (Step 2 above is not required as part of the RCRA facility Permit, because there are no design options to choose between.)~~

~~The explosion-isolation wall will be located approximately 30 feet from the main concrete barrier. The host rock will be excavated 6 inches (15 cms) around the entire perimeter prior to installing the explosion-isolation wall. The surface preparation will produce a level surface for placing the first layer of concrete blocks. Excavation may be performed by either mechanical or manual means.~~

~~Excavation for the enlarged concrete barrier will be performed using mechanical means, such as a cutting head on a suitable boom. The existing roadheader at the main barrier location in each drift is capable of excavating the back and the portions of the ribs above the floor level. Some manual excavation may be required in this situation as well. If mechanical means are not available, drilling boreholes and an expansive agent can be used to fragment the rock (Fernandez et al., 1989). Excavation will follow the lines and grades established for the design. The roof will be excavated to just above Clay G and then the floor to just below MB 139 to~~

~~remove the DRZ. The tolerances for the enlarged concrete-barrier excavation are +6 to 0 inches (+15 to 0 cm). In addition, loose or spalling rock from the excavation surface will be removed to provide an appropriate surface abutting the enlarged concrete barrier. The excavations will be performed according to approved ground control plans.~~

~~Following completion of the roof excavation for the enlarged barrier, the floor will be excavated. If mechanical means are not available, drilling boreholes and using an expansive agent to fragment the rock (Fernandez et al., 1989) is a method that can be used. Expansive agents would load the rock salt and anhydrite, producing localized tensile fracturing in a controlled manner, to produce a sound surface.~~

~~A batch plant at the surface or underground will be prepared for batching, mixing, and delivering the concrete to the underground in sufficient quantity to complete placement of the concrete within one form cell. The placement of concrete will be continuous until completion, with a time for completing one section not to exceed 10 hours, allowing an additional 2 hours for cleanup of equipment.~~

~~Pumping equipment suitable for placing the concrete into the forms will be provided at the main concrete barrier location. After transporting, and prior to pumping, the concrete will be remixed to compensate for segregation of aggregate during transport. Batch concrete will be checked at the surface at the time of mixing and again at the point of transfer to the pump for slump and temperature. Admixtures may be added at the remix stage in accordance with the batch design.~~

4.0 Design Calculations

Table G1-1 summarizes calculations to support the construction details for an explosion-isolation wall, construction-isolation wall, and structural steel formwork for concrete barriers up to 29-ft high. The codes for the explosion-isolation and construction-isolation wall are specified by the Uniform Building Code (International Conference of Building Officials, 1994), with related seismic design requirements. The external loads for the solid block wall are as developed in the methane-explosion and fracture propagation design evaluations.

Table G1-1
Constructability Design Calculations Index

Section	Design Area	Category
1.0	Explosion-isolation wall	W
2.0	Explosion-isolation wall seismic check	S
3.0	Formwork design	F

The structural formwork for all cells is designed in accordance with the AISC guidelines on allowable stress (AISC, 1989). Lateral pressures are developed using ACI 347R-88, using a standard concrete weighing 150 pounds per cubic foot (2,410 kg/m^3) with a slump of 8 inches (20 cm) or less. Design loadings reflect full hydrostatic head of concrete, with lifts spaced at 4 ft (1.2 m) intervals from bottom to top through portals, with no external vibration. All forms will remain in place.

5.0 Technical Specifications

The specifications are in the engineering file room at the WIPP and are the property of the MOC. These specifications are included as an attachment in Appendix G and summarized in Table G1-2.

Table G1-2
Technical Specifications for the WIPP Panel-Closure System

Division 1 - General Requirements	
Section 01010	Summary of Work
Section 01090	Reference Standards
Section 01400	Contractor Quality Control
Section 01600	Material and Equipment
Division 2 - Site Work	
Section 02010	Mobilization and Demobilization
Section 02222	Excavation
Section 02722	Grouting
Division 3 - Concrete	
Section 03100	Concrete Formwork
Section 03300	Cast-in-Place Concrete
Division 4 - Masonry	
Section 04100	Mortar
Section 04300	Unit Masonry System

6.0 Drawings

The drawings (Appendix H) are in the engineering file room at the WIPP and are the property of the MOC and summarized in Table G1-3.

Table G1-3
Panel-Closure System Drawings

Drawing Number	Title
762447-E1	Title Sheet
762447-E2	Underground Waste Disposal Plan
762447-E3	Air Intake Drift Construction Details
762447-E4	Air Exhaust Drift Construction Details
762447-E5	Construction and Explosion Barrier Construction Details
762447-E6	Grouting and Miscellaneous Details

7.0 Conclusions

This chapter presents the conclusions for the detailed design activities of the panel-closure system. A design basis, including the operational requirements, the structural and material requirements, and the construction requirements, was developed that addresses the governing regulations for the panel-closure system. Table G1-4 summarizes the design basis for the panel-closure system and the compliance with the design basis. The panel-closure system design incorporates mitigative measures to address the treatment of fractures and therefore counter the potential migration of VOCs. Several alternatives were evaluated for the treatment of fractures. These included excavation and emplacement of a fully enlarged barrier with removal of the DRZ, excavation of the roof and emplacement of a partially enlarged barrier, and emplacement of a standard barrier with formation grouting.

To investigate several key design issues and to implement the design, design evaluations were performed. These design evaluations can be divided into evaluations satisfying the operational requirements of the system and evaluations satisfying the structural and materials requirements of the system. The conclusions reached from the evaluations addressing the operational requirements are as follows:

- Based on an air-flow model used to predict the mass flow rate of carbon tetrachloride through the panel-closure system for the alternatives, the air-flow analysis suggests that the fully enlarged barrier is the most protective for restricting VOCs during the operational period of 35 years.

- Results of the FLAC analyses show that the recommended enlarged configuration is a circular rib-segment excavated to Clay G and under MB 139. Interface grouting would be performed at the upper boundary of the concrete barrier.

- The results of the transverse plane-strain models show that high stresses would form in MB 139 following excavation, but that after installation of the panel-closure system, an increase in barrier-confining stress and a reduction in shear stress would result. The concrete barrier would provide substantial uniform confining stresses as the barrier is subjected to secondary salt creep.

- The removal of the fractured salt prior to installation of the main concrete barrier would reduce the potential for flexure. With the removal of MB 139, the fractured salt stiffens the surrounding rock and results in the development of more uniform compression.

- The trade-off study also showed that a panel-closure system with an enlarged concrete barrier with the removal of the fractured salt roof and anhydrite in the floor was found to be the most protective.

Table G1-4
Compliance of the Design with the Design Requirements

Type of Requirement	Requirement	Section	Compliance with Requirement	Notes on Compliance
Operational	Individual panels shall be closed in accordance with the schedule of actual waste emplacement.	2.1.1	Complies	Gas-flow models used for design are based on the waste-emplacement operational schedule.
	The panel-closure system shall provide assurance that the limit for the migration of volatile organic compounds (**VOC**) of concern will be met at the point of compliance. To achieve this assurance, the design shall consider the potential flow of VOCs through the several components of the disturbed rock zone and the panel-closure system.	2.1.1, 2.1.2	Complies	Gas-flow modeling shows that the VOC flow is less than the design migration limit.
	The panel-closure system shall comply with its intended functional requirements under loads generated from creep closure and any internal pressure that might develop in the disposal panel under reasonably anticipated conditions.	2.1.2, 4.0	Complies	Stress analyses and design calculations show that the panel-closure system performs as intended.
	The panel-closure system shall comply with its intended functional requirements under a postulated methane explosion.	2.2.3, 2.2.4, 4.0	Complies	The methane explosion studies, fracture propagation studies, and supporting design calculations show that the panel-closure system performs as intended.
	The operational life of the panel-closure system shall be at least 35 years.	2.1.1	Complies	Gas-flow modeling and analyses shows satisfactory performance for at least 35 years.
	The panel-closure system for each individual panel shall not require routine maintenance during its operational life.	3.2	Complies	Passive design components require no routine maintenance.
	The panel-closure system shall address the most severe ground conditions expected in the panel entries. If actual conditions are found to be more favorable, this design can be simplified and still satisfy the operational requirements of the system.	2.1.1 2.1.3 3.2	Complies	Design is based upon flow and structural analyses for the most severe expected ground conditions. If conditions are less severe, simpler design options are used. The various design options accommodate all expected conditions.

Type of Requirement	Requirement	Section	Compliance with Requirement	Notes on Compliance
Design configuration and essential features	The panel-closure system shall be emplaced in the air-intake and air-exhaust drifts identified by Westinghouse (1995c)	3.2	Complies	The design shows placement in the designated areas for panel closure.
	The panel-closure system shall consist of a concrete barrier and construction-isolation and explosion-isolation walls with dimensions to satisfy the operational requirements of the system.	3.2, 3.3	Complies	The panel-closure system design uses the identified components with dimensions to satisfy the operational requirements of the system.
Safety	The design class for the panel-closure system shall be IIIb. Design and construction shall follow conventional mining and construction practices.	3.4	Complies	Components are designed according to Class IIIb. The construction sequence for the design followed conventional mining practices.
	The structural analysis for the underground shall use the empirical data acquired from the WIPP Excavation Effects Program.	2.1.2	Complies	The structural analysis uses properties that model creep closure for stress analyses from data acquired in the WIPP Excavation Effects Program.
Structural and material	The panel-closure system materials shall be compatible with their emplacement environment and function. Surface treatment between the host rock and the panel-closure system shall be considered in the design.	2.2.1	Complies	The material compatibility studies showed no degradation of materials and no need for surface treatment.
	The selection and placement of concrete in the concrete barrier shall address potential thermal cracking due to the heat of hydration.	2.2.2	Complies	The heat generation studies show that hydration temperatures are controlled by appropriate selection of cement type and placement temperature.
	The panel-closure system shall sustain the dynamic pressure and subsequent temperature generated by a postulated methane explosion.	2.2.3, 2.2.4, 4.0	Complies	The methane explosion study shows that the explosion-isolation wall protects the concrete barrier from pressure loading and thermal loading. The fracture propagation study shows that the system performs as intended.

Type of Requirement	Requirement	Section	Compliance with Requirement	Notes on Compliance
Construction	The panel-closure system shall use to the extent possible normal construction practices according to existing standards.	3.4	Complies	The specifications include normal construction practices used in the underground at WIPP and according to the most current steel and concrete specifications.
	During construction of the panel-closure system, a quality assurance/quality control program shall be established to verify material properties and construction practices.	3.4	Complies	The specifications include materials testing to verify material properties and construction practices.
	The construction specification shall take into account the shaft and underground access capacities and services for materials handling.	3.4	Complies	The specifications allow construction within the capacities of underground access.

The conclusions reached from the design evaluations addressing the structural and material requirements of the panel-closure system are as follows:

- Existing information on the heat of hydration of the concrete supports placing concrete with a low cement content to reduce the temperature rise associated with hydration. The slump at the required strength would be achieved through the use of plasticizers. A thermal analysis coupled with a salt creep analysis suggest installation of the enlarged barrier at or below ambient temperatures to adequately control hydration temperatures.

- In addition to installation at or below ambient temperatures, the concrete used in the main concrete barrier would exhibit the following:

  - An 8 inch (0.2 meter) slump after 3 hours of intermittent mixing
  - A less-than-25-degree Fahrenheit heat rise prior to installation
  - An unconfined compressive strength of 4,000 psi (28 MPa) after 28 days
  - Volume stability
  - Minimal entrained air.

- The trace amounts of brine from the salt at the repository horizon should not degrade the main concrete barrier for at least 35 years.

- In 20 years, the open passage above the waste stack would be reduced in size. Further, rooms with bulkheads at each end would be isolated in the panel. It is unlikely that a long passage with an open geometry would exist; therefore, the dynamic analysis considered a deflagration with a peak explosive pressure of 240 psi (1.7 MPa).

- The heat-transfer analysis shows that elevated temperatures would occur within the salt and the explosion-isolation wall; however, the elevated temperatures will be isolated by the panel-closure system. Temperature gradients will not significantly affect the stability of the wall.

- The fractures in the roof and floor could be affected by expanding gas products reaching pressures of the order of 240 psi (1.7 MPa). Because the peak internal pressure from the deflagration is only one fifth of the pressure, fractures could not propagate beyond the wall.

The design options proposed to satisfy the design requirements for the panel-closure system include (1) a standard barrier, rectangular in shape, or (2) an enlarged concrete barrier, approximately spherical in shape. Options (1) and (2) will be grouted at the interface and may contain explosion- or construction-isolation walls. Only the enlarged barrier with an explosion-isolation wall is approved as part of the RCRA facility Permit.

The design provides flexibility to satisfy the design migration limit for the flow of VOCs out of the panels. An enlarged concrete barrier would be selected where the air-intake and air-exhaust drifts have aged and where there is fracturing resulting in significant flow of VOCs. These conditions apply to the most severe ground conditions in the air-intake and air-exhaust drifts of Panel 1. If ground conditions are more favorable, such as might be the case for future panel entries, the design was proposed to be simplified to a standard concrete barrier rectangular in shape, with a construction isolation wall. GPR and observation boreholes are available for detecting the location and extent of fractures in the DRZ. These methods may be used to select the optimum location within each entry and exhaust drift for the enlarged barrier panel-closure system.

The design is presented in this report as a series of calculations, engineering drawings, and technical performance specifications. The drawings illustrate the construction details for the system. The technical performance specifications cover the general requirements of the system, site work, concrete, and masonry. Information on the proposed construction method is also presented.

The design complies with all aspects of the design basis established for the WIPP panel-closure system. The design can be constructed in the underground environment with no special requirements at the WIPP.

8.0 References

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~~FIGURES~~

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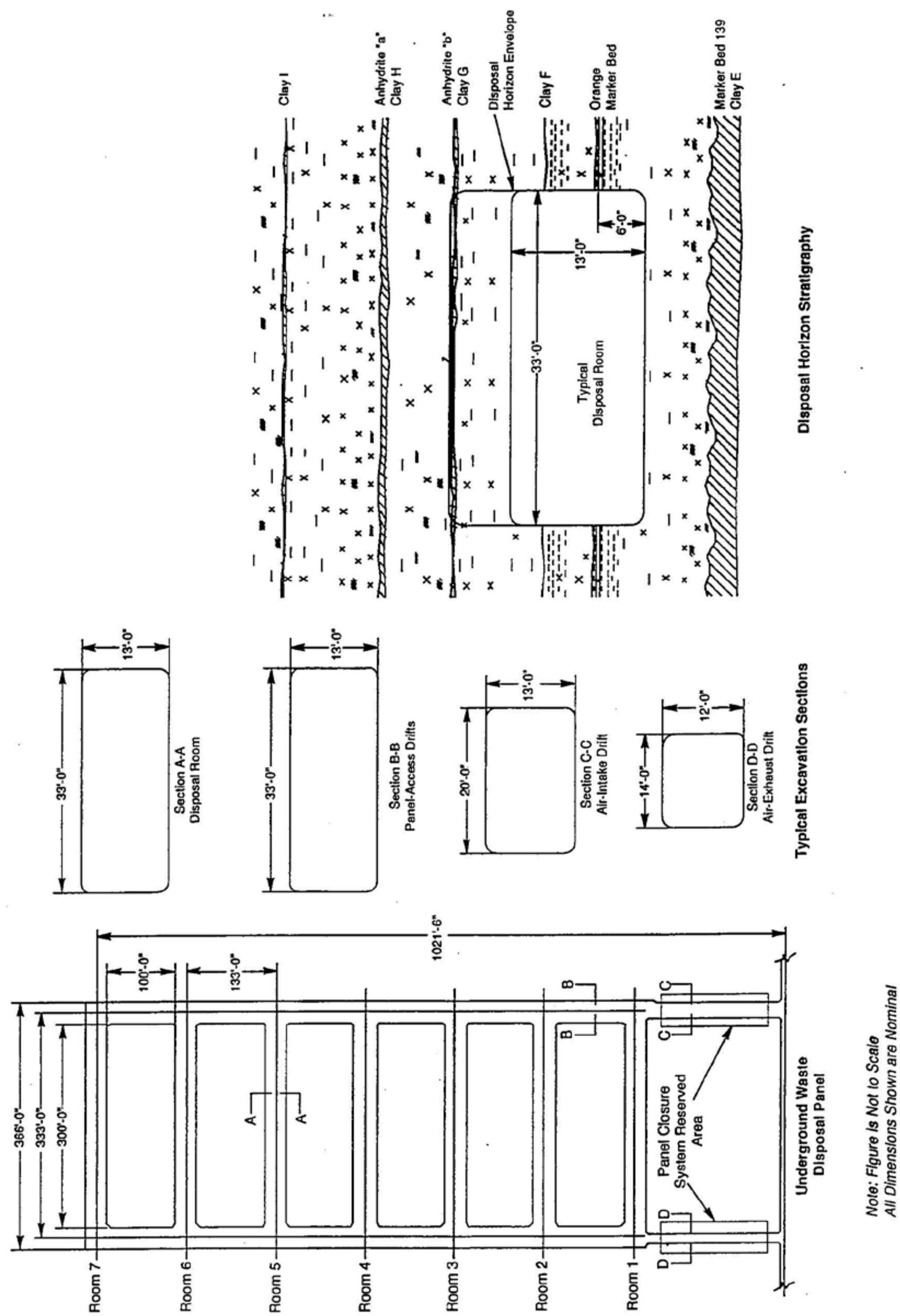
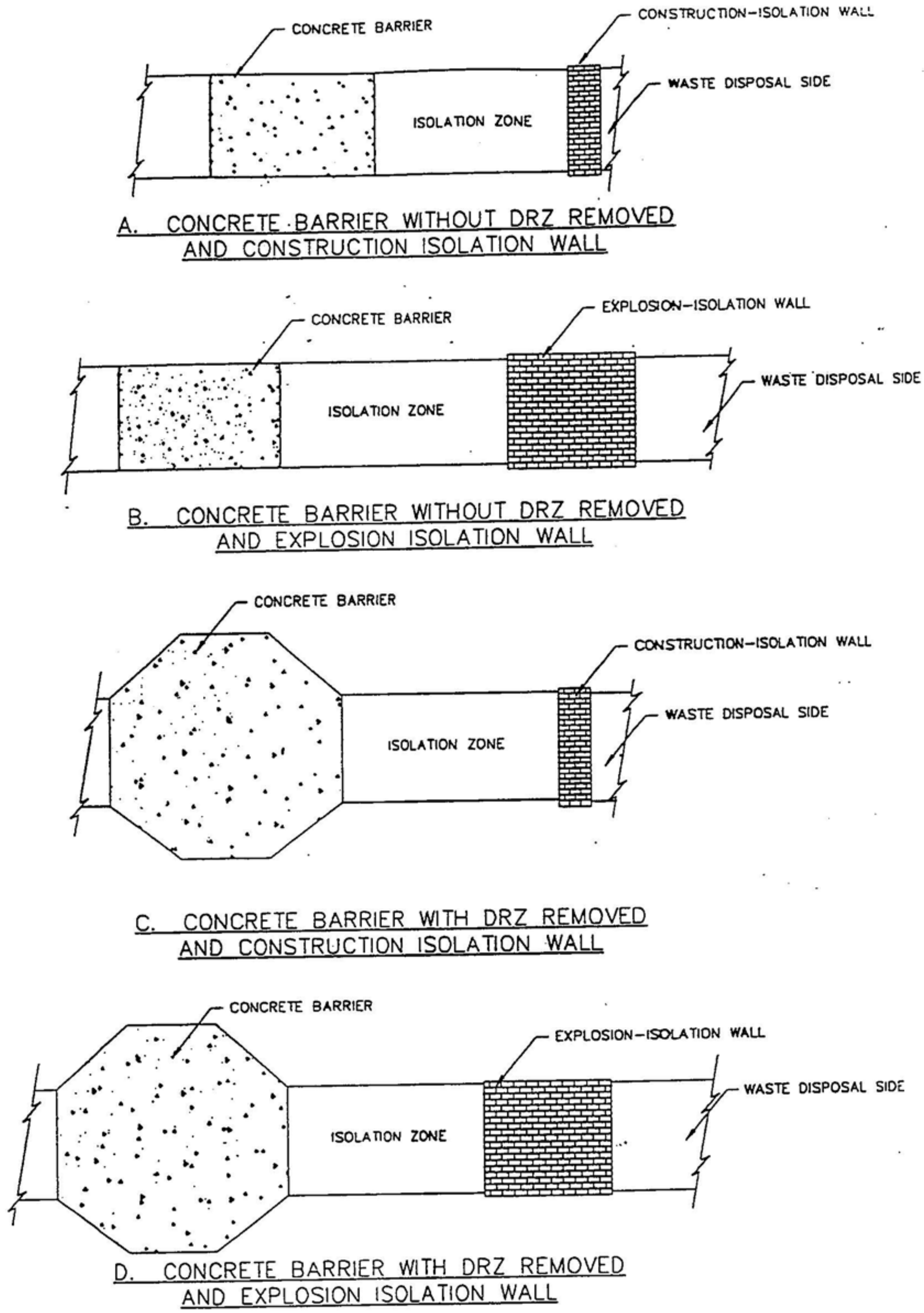
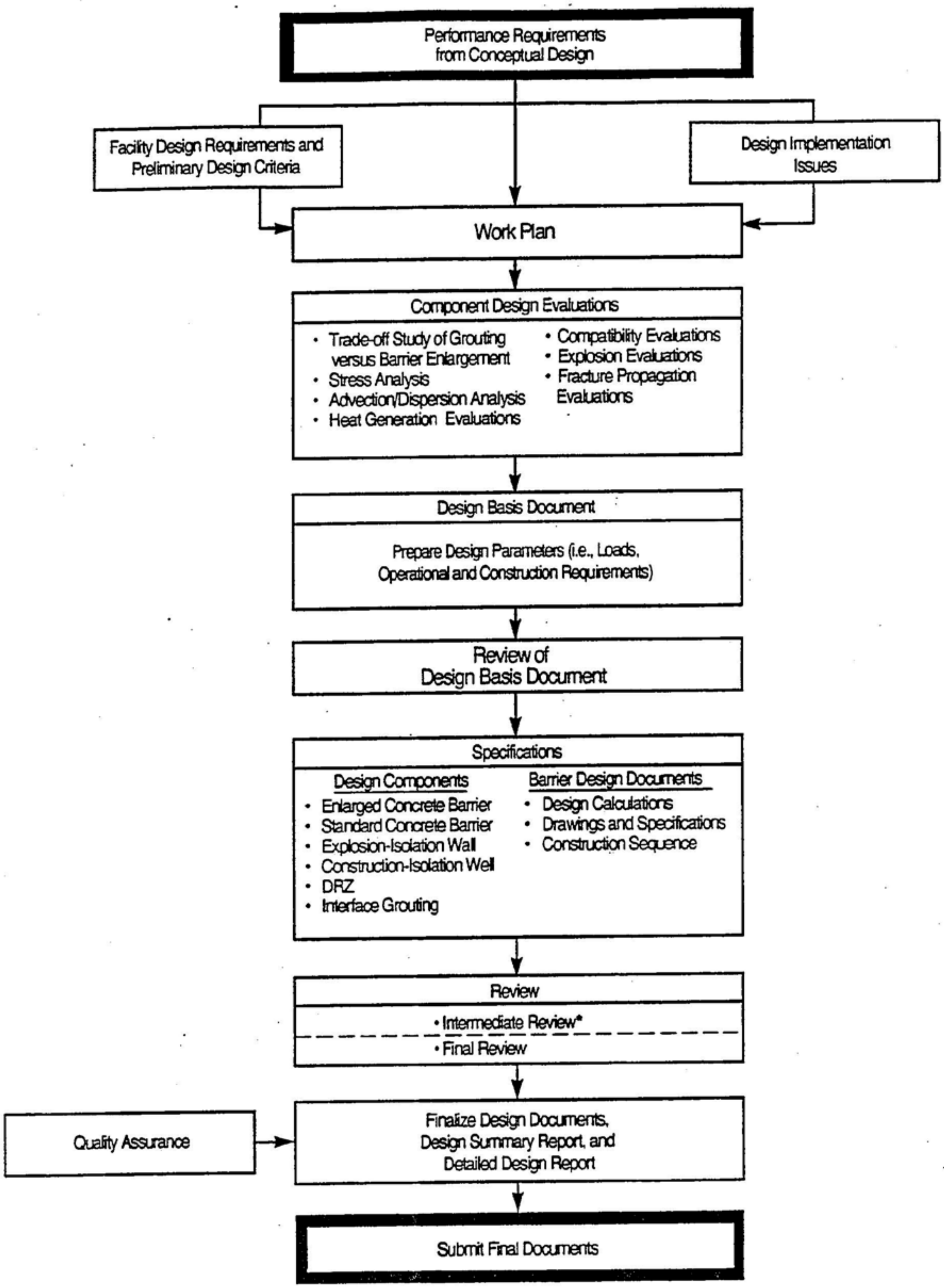


~~**Figure G1-1**~~
~~**Typical Facilities—Typical Disposal Panel**~~



~~Figure G1-2~~
~~Main Barrier with Wall Combinations~~



~~**Figure G1-3**~~
~~**Design Process for the Panel-Closure System**~~

A. Select a system structure or component for classification. (Start with a mitigating item)

B. Is the system, structure, or component required to mitigate the consequences of an accident?

C. Would the system, structure, or component failure result in loss of safety functions of a Design Class I components?

D. Does the system, structure, or component provide any function related to nuclear materials?

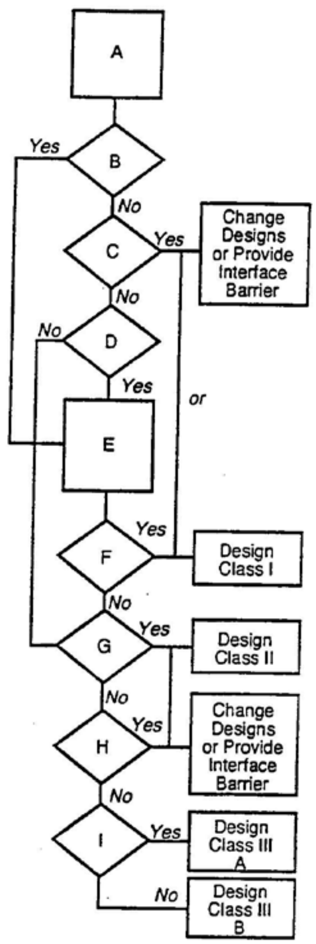
E. Select a conservative accident scenario and perform safety analysis.

F. Does the cumulative radiological consequences following the accident exceed 25 Rem whole body or 75 Rem organ dose commitment to an individual at the Zone I boundary

G. Does the structure, system, operation or component conform to the Class II criteria as defined in Attachment 2?

H. Would the structure, system, operation or component failure result in loss of the required function of a Class II component?

I. Are special design requirements necessary to ensure that failure of the system, structure, or component will NOT result in a significant shutdown of the facility or inhibit accessibility or maintainability of required equipment or have special significance to health and safety of operations personnel?



B. ______YES __X__ NO
Descibe requirement

C. ______YES __X__ NO
Failure mode and affected class I compone

D. ______YES __X__ NO
Describe function

E. ______YES __N/A__ NO
Attach safety analysis

F. ______YES ______NO
Calculate dose rates
N/A

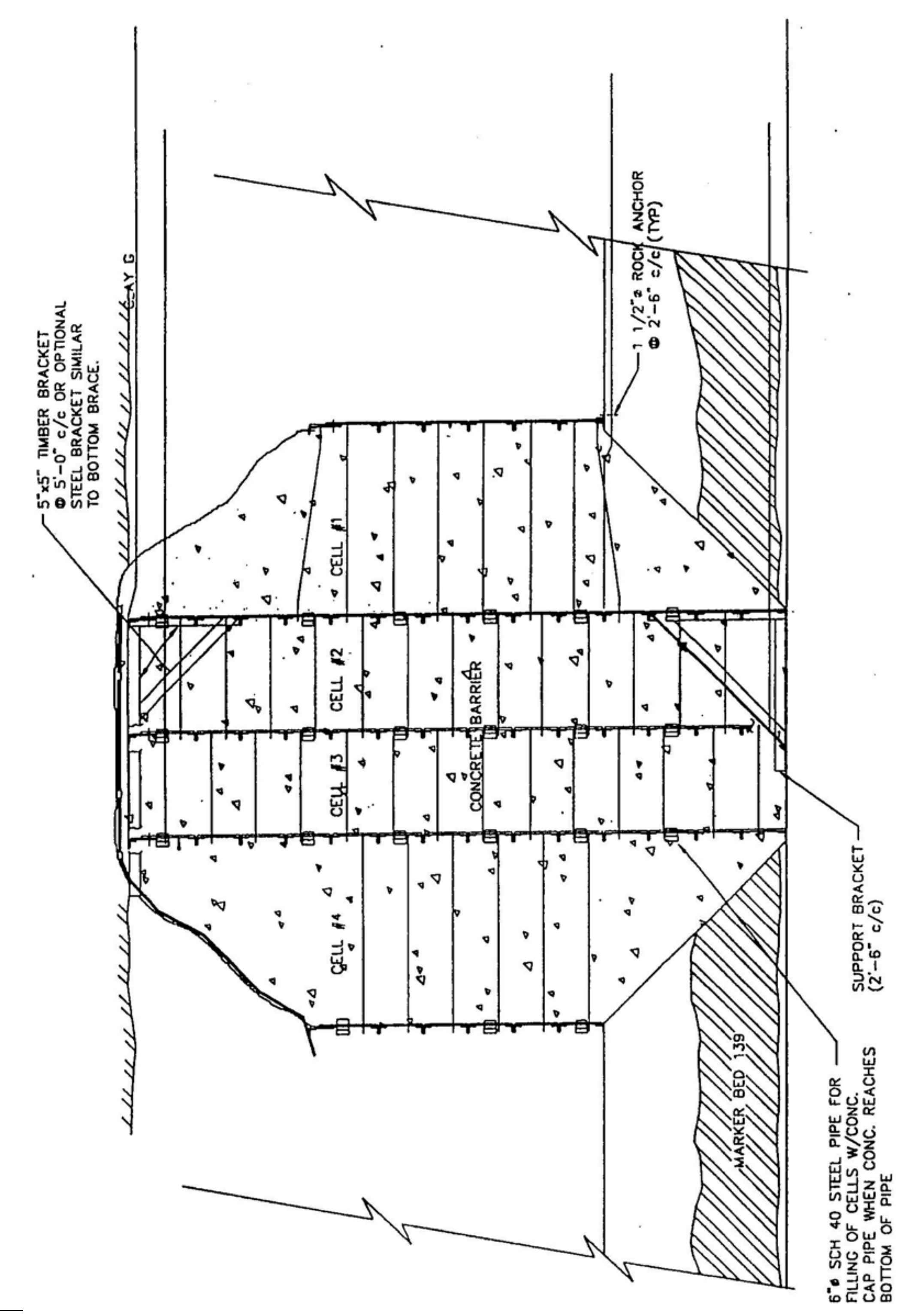
(Attach calculations to this form)

G. ______YES __X__ NO
Criteria
N/A

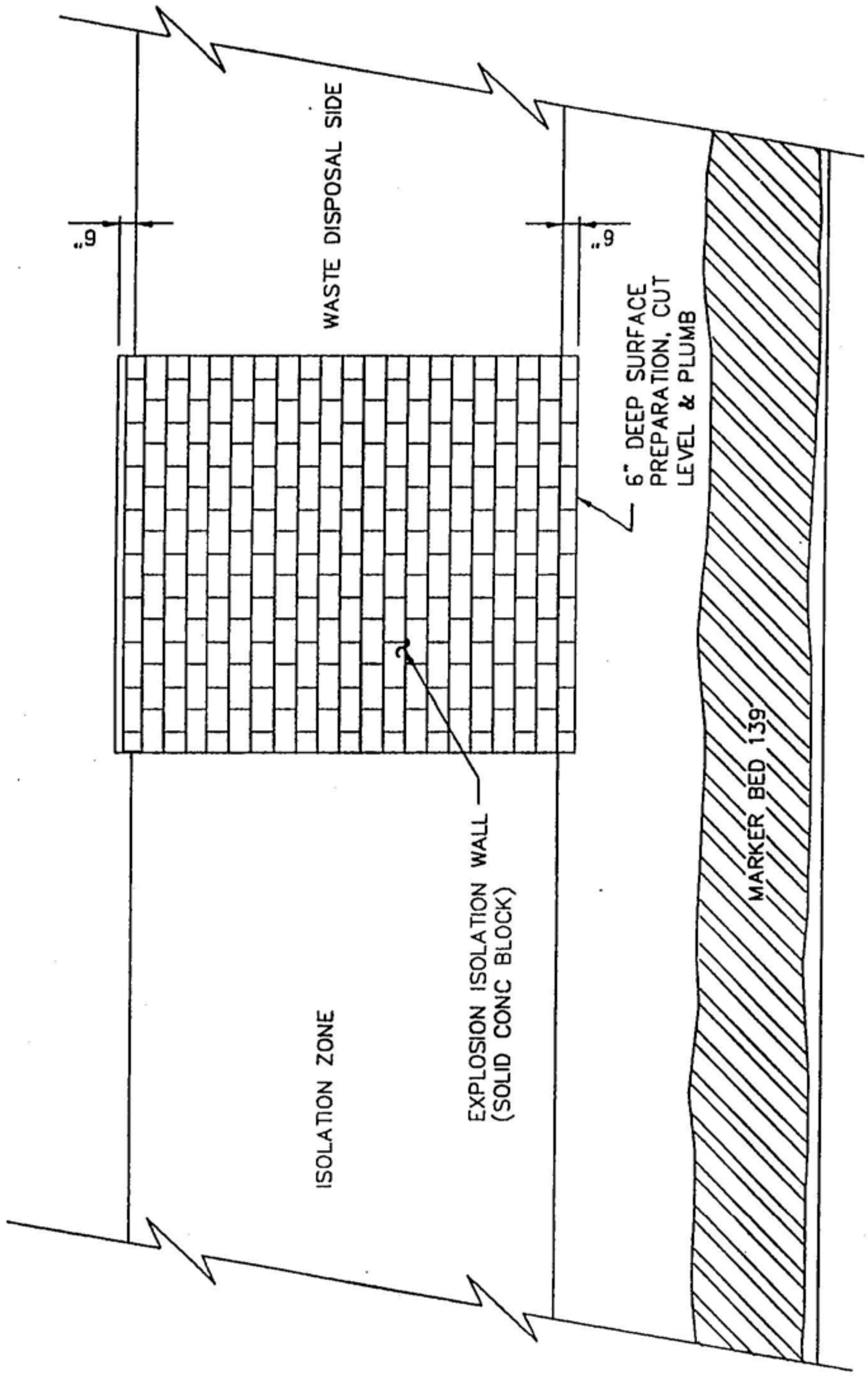
H. ______YES __X__ NO
Failure mode and affected Class II compone

I. ______YES __X__ NO
Requirements

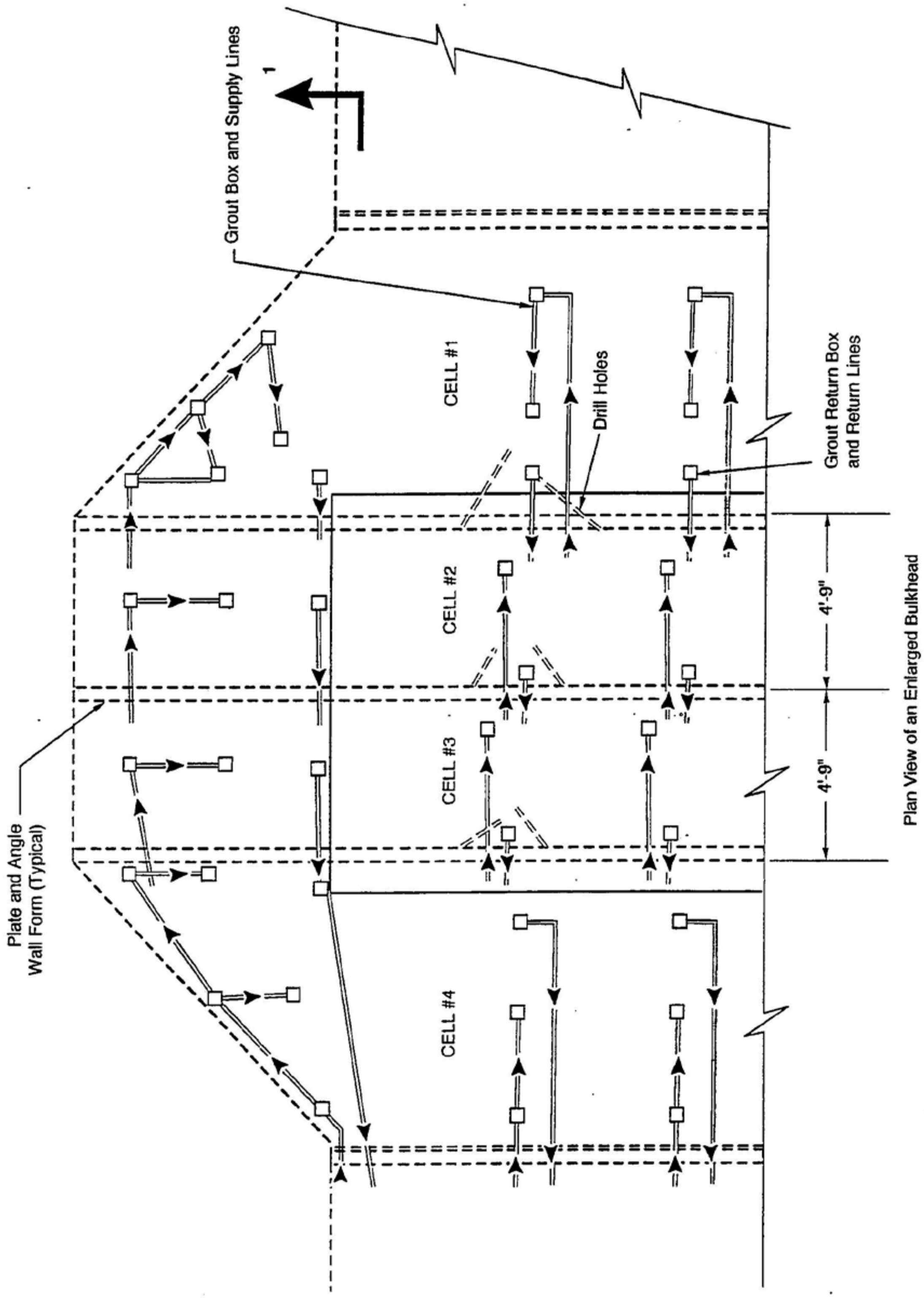
~~Figure G1-4~~
~~Design Classification of the Panel-Closure System~~



~~**Figure G1-5**~~
~~**Concrete Barrier with DRZ Removal**~~



~~Figure G1-6~~
~~Explosion-Isolation Wall~~



~~Figure G1-7~~
~~Grouting Details~~

ATTACHMENT G1
APPENDIX C

TECHNICAL SPECIFICATIONS

PANEL CLOSURE SYSTEM
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

Section 01010

Summary of Work

Part 1 - General

1.1 Scope

This section includes:

- Scope of Work
- Definitions and Abbreviations
- List of Drawings
- Work by Others
- Contractors Use of Site
- Contractors Use of Facilities
- Work Sequence
- Work Plan
- Health and Safety Plan (**HASP**)
- Contractor Quality Control Plan (**CQCP**)
- Submittals

1.2 Scope of Work

The Contractor shall furnish all labor, materials, equipment and tools to construct two (2) WIPP panel closure systems for Panels 1 through 10. Each WIPP Panel closure system consists of two steel bulkheads and ROM salt, one of each to be installed in the air-intake drift and the air-exhaust drift of a waste disposal panel, as shown on the Drawings and described in these Specifications. Unless otherwise agreed by Nuclear Waste Partnership, the Contractor shall use Nuclear Waste Partnership supplied equipment underground. Such use shall be coordinated with Nuclear Waste Partnership and may include the use of Nuclear Waste Partnership qualified operators.

The scope of work shall include but not necessarily be limited to the following units of work:

- Develop work plan, health and safety plan (HASP) and contractors quality control plan (CQCP) and submit it for approval

- Prepare and submit all plans requiring approval

- Mobilize to site

- Coordinate construction with WIPP operations

- Perform the following operations for the air-intake entry and the air-exhaust entries that do not contain block walls:

    1. Construct the inner steel bulkhead
    2. Prepare the surfaces for the ROM salt.
    3. Construct the inner steel bulkhead

4. Place ROM salt material in multiple layers
5. Construct the outer steel bulkhead
6. Clean up construction areas in underground and above ground
7. Submit all required record documents
8. Demobilize from site

- Perform the following operations for the air-intake entry and the air-exhaust entries that do contain block walls:

    1. Prepare the surfaces for the ROM salt
    2. Place ROM salt material in multiple layers
    3. Construct the outer steel bulkhead
    4. Clean up construction areas in underground and above ground
    5. Submit all required record documents
    6. Demobilize from site

1.3 Definitions and Abbreviations

Definitions

Block wall—Existing mortared concrete brick wall adjacent to the panel waste disposal area as shown in the drawings.

Creep—Viscoplastic deformation of salt under deviatoric stress.

Methane explosion—A postulated deflagration caused by methane gas at an explosive level.

Partial closure—The process of rendering a part of the hazardous waste management unit in the underground repository inactive and closed according to approved facility closure plans.

Run-of-Mine Salt (ROM)—A salt backfill obtained from mining operations emplaced in an uncompacted state.

Volatile organic compound (**VOC**)—Any VOC with Hazardous Waste Facility Permit emission limits.

Nuclear Waste Partnership— Nuclear Waste Partnership, LLC as the construction management authority.

Abbreviations/Acronyms

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CQCP	Contractor Quality Control Plan
DOE	U.S. Department of Energy
DWG	drawing

EPA	U.S. Environmental Protection Agency
HASP	Health and Safety Plan
JHA	Job Hazard Analysis
LHD	load haul dump
LLC	Limited Liability Corporation
MSHA	U.S. Mine Safety and Health Administration
RCRA	Resource Conservation and Recovery Act
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant

1.4 List of Drawings

The following drawings are made a part of this specification:

DWG 262-001	WIPP Panel Closure System Title Sheet
DWG 262-002	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (3,4,6,7,8)
DWG 262-003	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (1,2,5)
DWG 262-004	Construction Details

1.5 Work by Others

Survey

All survey work to locate, control, confirm, and complete the work will be performed by Nuclear Waste Partnership. All survey work for record purposes will be performed by Nuclear Waste Partnership. The Contractor shall be responsible for developing the salt backfill to fit the excavation.

Nuclear Waste Partnership may elect to perform certain portions or all of the work. The work performed by the Nuclear Waste Partnership will be defined prior to the contract. Unless otherwise agreed by Nuclear Waste Partnership, the Contractor shall use underground equipment furnished by Nuclear Waste Partnership for construction of the steel bulkheads and placement of ROM salt. Underground mining personnel who are qualified for the operation of such underground construction equipment may be made available to the Contractor. The use of Nuclear Waste Partnership equipment shall be coordinated with Nuclear Waste Partnership.

1.6 Contractor's Use of Site

Site Conditions

The WIPP site is located near Carlsbad in southeastern New Mexico, as shown on the Drawings. The underground arrangements and location of the WIPP waste disposal panels are shown on the Drawings. The work is to construct steel bulkheads and place ROM salt in the air-intake and air-exhaust drifts of one of the panels upon completion of the disposal phase of that panel. The waste disposal panels are located approximately 2,150 ft (655 m) below the ground surface. The Contractor shall visit the site and become familiar with the site and site conditions prior to preparing a bid proposal.

Contractor's Use of Site

Areas at the ground surface will be designated for the Contractor's use in assembling and storing his equipment and materials. The Contractor shall utilize only those areas so designated.

Limited space within the underground area will be designated for the Contractor's use for storage of material and setup of equipment.

Coordination of Contractor's Work

Areas at the ground surface will be designated for the Contractor's use in assembling and storing his equipment and materials. The Contractor shall utilize only those areas so designated.

Limited space within the underground area will be designated for the Contractor's use for storage of material and setup of equipment.

1.7 Contractor's Use of Facilities

Existing facilities at the site available for use by the Contractor are:

- Waste shaft conveyance
- Salt skip hoist
- 460 volt AC, 3 phase power
- Water (underground, at waste shaft only) (above ground, at location designated by Nuclear Waste Partnership)

Additional information on mobilization and demobilization to these facilities is presented in Section 02010.

1.8 Work Sequence

Work Sequence shall be as shown on the Drawings and as directed by Nuclear Waste Partnership.

1.9 Work Plans

The Contractor shall prepare Work Plans fully describing the proposed fabrication, installation and construction for each WIPP Panel Closure System. The work plan shall define all proposed materials, equipment and construction methods. The Work Plan shall state all supporting processes, procedures, materials safety data sheets, and regulations by reference. The work plans shall address precautions related to the Job Hazards Check List. The Work Plan shall address limitations such as hold and witness points. The Work Plans shall address all prerequisites for work. Nuclear Waste Partnership shall approve the Work Plan and no work shall be performed prior to approval of the Work Plan.

1.10 Health and Safety Plan (HASP)

The Contractor shall obtain, review, and agree to applicable portions of the existing WIPP Safety Manual, WP 12-1. The Contractor shall prepare a project-specific HASP taking into account all applicable sections of the WIPP Safety Manual. All personnel shall be qualified to work underground. All personnel operating heavy construction equipment shall be qualified to operate such equipment. The Contractor shall also perform a Job Hazard Analysis (JHA) in accordance with WP 12-111. Nuclear Waste Partnership shall approve the HASP and JHA and no work shall be performed prior to approval of the HASP and JHA.

1.11 Contractor Quality Control Plan (CQCP)

The Contractor shall prepare a CQCP identifying all personnel and procedures necessary to produce an end product, which complies with the contract requirements. The CQCP shall comply with all Nuclear Waste Partnership requirements, including operator training and qualification; and Section 01400, Contractor Quality Control, of this Specification. Nuclear Waste Partnership shall approve the CQCP and no work shall be performed prior to approval of the CQCP.

1.12 Submittals

Submittals shall be in accordance with Nuclear Waste Partnership Submittal Procedures and as required by the individual Specifications.

Part 2 - Products

Not used.

Part 3 - Execution

Not Used.

End of Section

Section 01090

Reference Standards

Part 1 - General

1.1 Scope

This section includes:

- Provision of Reference Standards at Site
- Acronyms used in Contract Documents for Reference Standards

1.2 Quality Assurance

For products or workmanship specified by association, trade, or Federal Standards, the Contractor shall comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

Conform to reference by date of issue current on the date of the owner-contractor agreement.

The Contractor shall obtain, at his own expense, a copy of the standards referenced in the individual Specification sections and shall maintain that copy at the job site until completion and acceptance of the work.

Should specified Reference Standards conflict with the contract documents, the Contractor shall request clarification from Nuclear Waste Partnership before proceeding.

1.3 Schedule of References

Various publications referenced in other sections of the Specifications establish requirements for the work. These references are identified by document number and title. The addresses of the organizations responsible for these publications are listed below.

ANSI	American National Standards Institute 25 West 43rd St. New York NY 10036 Ph: 212-642-4900 Fax: 212-398-0023
ASTM	ASTM International 100 Barr Harbor Drive P.O. Box C700 West Conshohocken, PA 19428-2959 Ph: 610-832-9585 Fax: 610-832-9555

CFR	Code of Federal Regulations Government Printing Office 732 N. Capital Street, NW Washington, DC 20402-0002 Ph: 202-512-1530 Fax: 202 512-1262
EPA	Environmental Protection Agency 1455 Ross Avenue Suite 1200 Dallas, TX 75202-2733 Ph: 214-665-2200 Fax: 800-887-6063
FTM-STD	Federal Test Method Standards Standardization Documents Order Desk Bldg. 4D 700 Robbins Ave. Philadelphia, PA 19111-5094 Ph: 215-697-2179 Fax: 215-697-2978
NIST	National Institute of Standards and Technology 100 Bureau Drive, Stop 1000 Gaithersburg, MD 20899-1000 Ph: 301-975-6478 Fax: 301-975-8295
NTIS	National Technical Information Service U.S. Department of Commerce 5301 Shawnee Rd Alexandria, VA 22312 Ph: 703-605-6000 Fax: 703-321-8547

End of Section

Section 01400

Contractor Quality Control

Part 1 - General

1.1 Scope

This section includes:

- Contractor Quality Control Plan (**CQCP**)
- Reference Standards
- Quality Assurance
- Tolerances
- Testing Services
- Inspection Services
- Submittals

1.2 Related Sections

- 01090 - Reference Standards
- 01600 - Material and Equipment
- 02222 - Excavation
- 04100 - Run-of-Mine Salt

1.3 Contractor Quality Control Plan (CQCP)

The Contractor shall prepare a Contractor Quality Control Plan (CQCP) describing the methods to be used to verify the performance of the engineered components of the Panel Closure System. The quality control plan for the run-of-mine (ROM) salt shall detail the methods the Contractor proposes to meet the minimum requirements, and the standard quality control test methods to be used to verify compliance with minimum requirements. All equipment methods employed shall be traceable to standard quality control tests as approved in the CQCP. No work shall be performed prior to Nuclear Waste Partnership approval of the CQCP.

1.4 References and Standards

Refer to individual specification sections for standards referenced therein, and to Section 01090, Reference Standards, for general listing. Additional standards will be identified in the CQCP.

Standards referenced in this section are as follows:

ASTM E 329-01b	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E 543-02	Standard Practice for Agencies Performing Nondestructive Testing

1.5 Quality Assurance

The Contractor shall:

- Monitor suppliers, manufacturers, products, services, site conditions, and workmanship to produce work of specified quality
- Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship
- Perform work with qualified persons to produce required and specified quality

1.6 Tolerances

The Contractor shall:

- Monitor excavation, fabrication, and tolerances in order to produce acceptable work. The Contractor shall not permit tolerances to accumulate.

1.7 Testing Services

Unless otherwise agreed by Nuclear Waste Partnership, the Contractor shall employ an independent firm qualified to perform the testing services and other services specified in the individual Specification sections, and as may otherwise be required by Nuclear Waste Partnership. Testing and source quality control may occur on or off the project site.

The testing laboratory shall comply with applicable sections of the Reference Standards and shall be authorized to operate in the State of New Mexico.

Testing equipment shall be calibrated at reasonable intervals traceable to either the National Institute of Standards and Technology or accepted values of natural physical constants.

1.8 Inspection Services

The Contractor may employ an independent firm to perform inspection services as a supplement to the Contractor's quality control as specified in the individual Specification sections, and as may be required by Nuclear Waste Partnership. Inspection may occur on or off the project site.

The inspection firm shall comply with applicable sections of the Reference Standards.

1.9 Submittals

The Contractor shall submit a CQCP as described herein.

Prior to start of work, the Contractor shall submit for approval, the testing laboratory name, address, telephone number and name of responsible officer of the firm as well as a copy of the testing laboratory compliance with the reference ASTM standards and a copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Institute of

Standards and Technology with memorandum of remedies of any deficiencies reported by the inspection.

The Contractor shall submit the names and qualifications of personnel proposed to perform the required inspections, along with their individual qualifications and certifications. Once approved by Nuclear Waste Partnership these personnel shall be available as may be required to promptly and efficiently complete the work.

Part 2 - Products

Not used.

Part 3 - Execution

3.1 General

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both on site and off site, and shall be keyed to the proposed construction sequence. The project superintendent will be held responsible for the quality of work on the job. The project superintendent in this context is the individual with the responsibility for the overall management of the project, including quality and production.

3.2 Contractor Quality Control Plan

3.2.1 General

The Contractor shall supply, not later than 30 days after receipt of notice to proceed, the Contractor Quality Control Plan (CQCP) which implements the requirements of the Contract. The CQCP shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. Construction shall not begin until the CQCP is approved by Nuclear Waste Partnership.

3.2.2 Content of the Contractor Quality Control Plan (QCQC)

The CQCP shall cover all construction operations, both on site and off site, including work by subcontractors, fabricators, suppliers, and purchasing agents and shall include, as a minimum, the following items:

- A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the Contractor Quality Control (CQC) staff shall implement the control system for all aspects of the work specified.

- The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.

- A description of CQCP responsibilities and a delegation of authority to adequately perform the functions described in the CQCP, including authority to stop work.

- Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, off-site fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Nuclear Waste Partnership Submittal Procedures.

- Control, verification, and acceptance testing procedures as may be necessary to ensure that the work is completed to the requirements of the Drawings and Specifications.

- Procedures for tracking deficiencies from identification, through acceptable corrective action, to verification that identified deficiencies have been corrected.

- Reporting procedures, including proposed reporting formulas.

3.2.3 Acceptance of Plan

Acceptance of the Contractor's plan is conditional. Nuclear Waste Partnership reserves the right to require the Contractor to make changes in the CQCP and operations, including removal of personnel, if necessary, to obtain the quality specified.

3.2.4 Notification of Changes

After acceptance of the CQCP, the Contractor shall notify Nuclear Waste Partnership in writing of any proposed change. Proposed changes are subject to acceptance by Nuclear Waste Partnership.

3.3 Tests

3.3.1 Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to complete the work to contract requirements. Upon request, the Contractor shall furnish, at his own expense, duplicate samples of test specimens for testing by Nuclear Waste Partnership. The Contractor shall perform, as necessary, the following activities and permanently record the results:

- Verify that testing procedures comply with contract requirements.

- Verify that facilities and testing equipment are available and comply with testing standards.

- Check test instrument calibration data against certified standards.

- Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

- Record the results of all tests taken, both passing and failing. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test will be given. If approved by Nuclear Waste Partnership, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility will be provided directly to Nuclear Waste Partnership.

- The Contractor may elect to develop an equipment specification with construction parameters based upon test results of a test section of compacted salt. The equipment specification based upon construction parameters shall be traceable to standard test results identified in the CQCP. Specification paragraph reference, location where construction parameters were taken, and the sequential control number identifying the construction parameters will be given. If approved by Nuclear Waste Partnership, actual construction parameter reports may be submitted later with a reference to the recording of construction parameters, location, time and date taken.

3.4 Testing Laboratory

The testing laboratory shall provide qualified personnel to perform specified sampling and testing of products in accordance with specified standards, and the requirements of Contract Documents.

Reports indicating results of tests, and compliance or noncompliance with the contract documents will be submitted in accordance with Nuclear Waste Partnership submittal procedures. Testing by an independent firm does not relieve the Contractor of the responsibility to perform the work to the contract requirements.

3.5 Inspection Services

The inspection firm shall provide qualified personnel to perform specified inspection of products in accordance with specified standards.

Reports indicating results of the inspection and compliance or noncompliance with the contract documents will be submitted in accordance with Nuclear Waste Partnership submittal procedures.

Inspection by the independent firm does not relieve the Contractor of the responsibility to perform the work to the contract requirements.

3.6 Completion Inspection

3.6.1 Pre-Final Inspection

At appropriate times and at the completion of all work, the Contractor shall conduct an inspection of the work and develop a punch list of items which do not conform to the Drawings and Specifications. The Contractor shall then notify Nuclear Waste Partnership that the work is ready for inspection. Nuclear Waste Partnership will perform this inspection to verify that the work is satisfactory and appropriately complete. A final punch list will be developed as a result of this inspection. The Contractor shall ensure that all items on this list are corrected and notify Nuclear Waste Partnership so that a final inspection can be scheduled. Any items noted on the final inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph will be accomplished within the time slated for completion of the entire work.

3.6.2 Final Acceptance Inspection

The final acceptance inspection will be formally scheduled by Nuclear Waste Partnership based upon notice from the Contractor. This notice will be given to Nuclear Waste Partnership at least 14 days prior to the final acceptance inspection. The Contractor shall assure that all specific items previously identified as unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection.

3.7 Documentation

The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form approved by Nuclear Waste Partnership.

3.8 Notification of Noncompliance

Nuclear Waste Partnership will notify the Contractor of any noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the worksite, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, Nuclear Waste Partnership may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

End of section.

Section 01600

Material and Equipment

Part 1 - General

1.1 Scope

This section includes:

- Equipment
- Products
- Transportation and Handling
- Storage and Protection
- Substitutions

1.2 Related Sections

- 01010 - Summary of Work
- 01400 - Contractor Quality Control
- 02010 - Mobilization and Demobilization
- 02222 - Excavation
- 04100 - Run-of-Mine Salt

1.3 Equipment

The Contractor shall specify his proposed equipment in the Work Plan. Power equipment for use underground shall be either electrical or diesel engine driven. All diesel engine equipment shall be certified for use underground at the WIPP site.

1.4 Products

The Contractor shall specify in the Work Plan, or in subsequently required submittals, the proposed products including, but not limited to steel bulkheads and ROM salt. The proposed products shall be supported by laboratory test results as required by the Specifications. All products shall be subject to approval by Nuclear Waste Partnership.

1.5 Transportation and Handling

The Contractor shall:

- Transport and handle products in accordance with manufacturer's instructions.

- Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

- Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.6 Storage and Protection

The Contractor shall:

- Store and protect products in accordance with manufacturers' instructions.
- Store with seals and labels intact and legible.
- Store sensitive products in weather-tight, climate-controlled enclosures in an environment favorable to product.
- Provide ventilation to prevent condensation and degradation of products.
- Store loose granular materials on solid flat surfaces in a well-drained area and prevent mixing with foreign matter.
- Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- Arrange storage of products to permit access for inspection and periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.7 Substitutions

1.7.1 Equipment Substitutions

The Contractor may substitute equipment for that proposed in the Work Plan subject to Nuclear Waste Partnership approval.

1.7.2 Product Substitutions

The Contractor may not substitute products after the proposed products have been approved by Nuclear Waste Partnership unless he can demonstrate that the supplier/source of that product no longer exists in which case he shall submit alternate products with lab test results to Nuclear Waste Partnership for approval.

Part 2 - Products

Not used.

Part 3 - Execution

Not used.

End of section.

Section 02010

Mobilization and Demobilization

Part 1 - General

1.1 Scope

This section includes:

- Mobilization of Equipment and Facilities to Site
- Contractor Use of Site
- Use of Existing Facilities
- Demobilization of Equipment and Facilities
- Site Cleanup

1.2 Related Sections

- 01010 - Summary of Work
- 01600 - Material and Equipment

Part 2 - Products

Not used.

Part 3 - Execution

3.1 Mobilization of Equipment and Facilities to Site

Upon authorization to proceed, the Contractor shall mobilize his equipment and facilities to the jobsite. Equipment and facilities shall be as specified and as defined in the Contractor's Work Plan.

Nuclear Waste Partnership will provide utilities at designated locations. The Contractor shall be responsible for all hookups and tie-ins required for his operations.

The Contractor shall be responsible for providing his own office, storage, and sanitary facilities.

Areas will be designated for the Contractor's use in the underground area in the vicinity of the panel closure system installation. These areas are limited.

3.2 Contractor Use of Site

The Contractor shall use only those areas specifically designated for his use by Nuclear Waste Partnership. The Contractor shall limit his on-site travel to the specific routes required for performance of his work, and designated by Nuclear Waste Partnership.

3.3 Use of Existing Facilities

Existing facilities available for use by the Contractor are:

- Waste shaft conveyance
- Salt skip hoist
- 460 Volt AC, 3 phase power
- Water underground at waste shaft only
- Water on surface at location designated by Nuclear Waste Partnership.

The Contractor shall arrange for use of the facilities with Nuclear Waste Partnership and coordinate his actions and requirements with ongoing Nuclear Waste Partnership operations.

Use of water in the underground will be restricted. No washout or cleanup will be permitted in the underground except as designated by Nuclear Waste Partnership. Above ground washout or cleanup of equipment will be allowed in the areas designated by Nuclear Waste Partnership.

The Contractor is cautioned to be aware of the physical dimensions of the waste conveyance and the air lock.

The Contractor shall be responsible for any damage incurred by the existing site facilities as a result of his operations. Any damage shall be reported immediately to Nuclear Waste Partnership and repaired at the Contractor's cost.

3.4 Demobilization of Equipment and Facilities

At completion of this work, the Contractor shall demobilize his equipment and facilities from the job site. All Contractor's equipment and materials shall be removed and all disturbed areas restored. Utilities shall be removed to their connection points unless otherwise directed by Nuclear Waste Partnership.

3.5 Site Cleanup

At conclusion of the work, the Contractor shall remove all trash, waste, debris, excess construction materials, and restore the affected areas to their prior condition, to the satisfaction of Nuclear Waste Partnership. A final inspection will be conducted by Nuclear Waste Partnership and the Contractor before final payment is approved.

End of section.

Section 02222

Excavation

Part 1 - General

1.1 Scope

This section includes:

- Excavation for surface preparation and leveling of surrounding areas for compacted salt
- Disposition of excavated materials
- Field measurement and survey

1.2 Related Sections

- 01010 - Summary of Work
- 01600 - Material and Equipment

1.3 Reference Documents

Krieg, R. D., 1984, *Reference Stratigraphy and Rock Properties for the Waste Isolation Pilot Plant*, SAND83-1908, Sandia National Laboratories, Albuquerque, New Mexico.

1.4 Field Measurements and Survey

All survey required for performance of the work will be provided by Nuclear Waste Partnership.

Part 2 - Products

Not used.

Part 3 - Execution

3.1 Excavation for Surface Preparation and Leveling of Surrounding Areas for Salt

The Contractor shall inspect the panel entry excavations for loose material at locations where the panel closure system is emplaced. If loose material is found, the contractor shall excavate and prepare the surface for the panel closure system component by removing all loose material, and cleaning all rock surfaces. The surface preparation of the floor shall produce a surface suitable for placing the first layer of ROM salt. Excavation may be performed by either mechanical or manual means. Use of explosives is prohibited.

3.2 Disposition of Excavated Materials

The Contractor shall dispose of all excavated materials as directed by Nuclear Waste Partnership.

3.3 Field Measurements and Survey

All survey required for performance of the work will be provided by Nuclear Waste Partnership. The Contractor shall protect all survey control points, benchmarks, etc., from damage by his operations. Nuclear Waste Partnership will verify that the Contractor has excavated to the required lines and grades. No salt shall be emplaced until approved by Nuclear Waste Partnership.

End of section.

Section 04100

Run-of-Mine Salt

Part 1 - General

1.1 Scope

This section includes:

- Salt Placement

1.2 Related Sections

- 01010 - Summary of Work
- 01400 - Contractor Quality Control
- 01600 - Material and Equipment

1.3 Submittals for Review and Approval

The salt emplacement method, dust control plan and other safety-related material shall be approved by Nuclear Waste Partnership.

1.4 Quality Assurance

The Contractor shall perform the work in accordance with the CQCP.

Part 2 - Products

2.1 Salt Material

The salt is ROM salt and requires no grading or compaction. The salt shall be free of organic material.

Part 3 - Execution

3.1 General

The Contractor shall furnish all labor, material, equipment and tools to handle and place the salt.

The Contractor shall use underground equipment and underground mine personnel as required in Part 1.5, Work by Others in Section 01010 Summary of Work. Nuclear Waste Partnership will supply ROM salt. The Contractor shall make suitable arrangements for transporting and placing the ROM salt.

3.2 Installation

ROM salt shall be transported to the panel closure area after the construction of the inner steel bulkhead. The ROM salt is not required to achieve a specified density. The salt shall be free of organic material.

Salt may be emplaced in layers to facilitate the construction. The ROM Salt is emplaced in layers with a 2:1 slope near the ends of the WIPP Panel Closure System. The inner and outer salt emplacements are designated on the drawings.

For the inner emplacement of the ROM Salt, the salt is emplaced at the angle of repose, of 1 (rise) to 2 (run) as designated on the drawings. There shall be no gap left between salt and roof or sidewalls. Hand placement or the use of push plates can be used to fill all the voids if necessary.

3.3 Field Quality Control

The Contractor shall provide a Quality Control Inspector to inspect the emplacement of salt.

End of Section.

ATTACHMENT G1
APPENDIX D

DESIGN DRAWINGS

PANEL CLOSURE SYSTEM
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

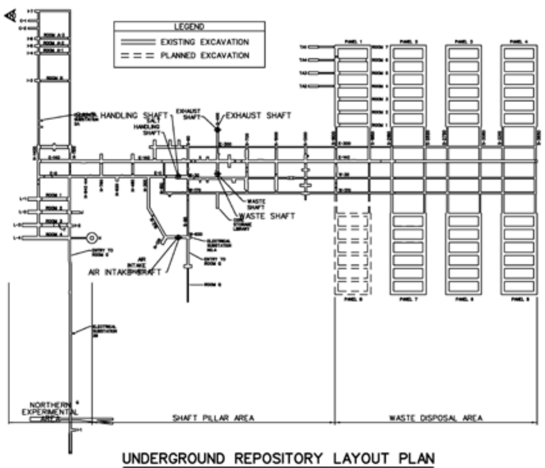
ATTACHMENT G1
APPENDIX D

DESIGN DRAWINGS

PANEL CLOSURE SYSTEM
WASTE ISOLATION PILOT PLANT
CARLSBAD, NEW MEXICO

Drawing	Title
262-001	WIPP Panel Closure System Title Sheet
262-002	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (3, 4, 6, 7, 8)
262-003	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (1, 2, 5)
262-004	WIPP Panel Closure System, Construction Details

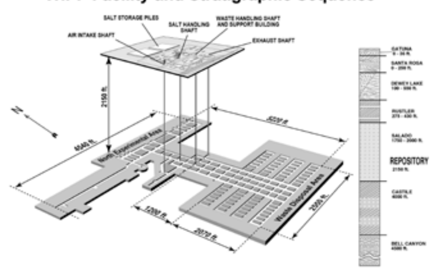
INDEX OF DRAWINGS	
DRAWING NO.	TITLE
262-001	TITLE SHEET
262-002	UNDERGROUND WASTE DISPOSAL PANEL CONFIGURATIONS (3,4,6,7,8)
262-003	UNDERGROUND WASTE DISPOSAL PANEL CONFIGURATIONS (1,2,5)
262-004	PANEL CLOSURE SYSTEM CONSTRUCTION DETAILS

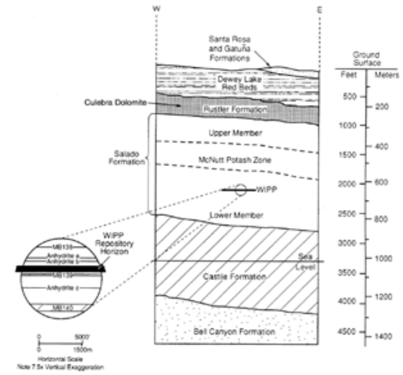


UNDERGROUND REPOSITORY LAYOUT PLAN

SCALE: NOT TO SCALE

WIPP Facility and Stratigraphic Sequence





GENERAL STRATIGRAPHY AT THE REPOSITORY HORIZON

SCALE: NOT TO SCALE

GENERAL LOCATION OF THE WIPP FACILITY

WASTE ISOLATION PILOT PLANT
PANEL CLOSURE SYSTEM
CARLSBAD, NEW MEXICO

PREPARED BY
ROCKSOL CONSULTING GROUP INC.

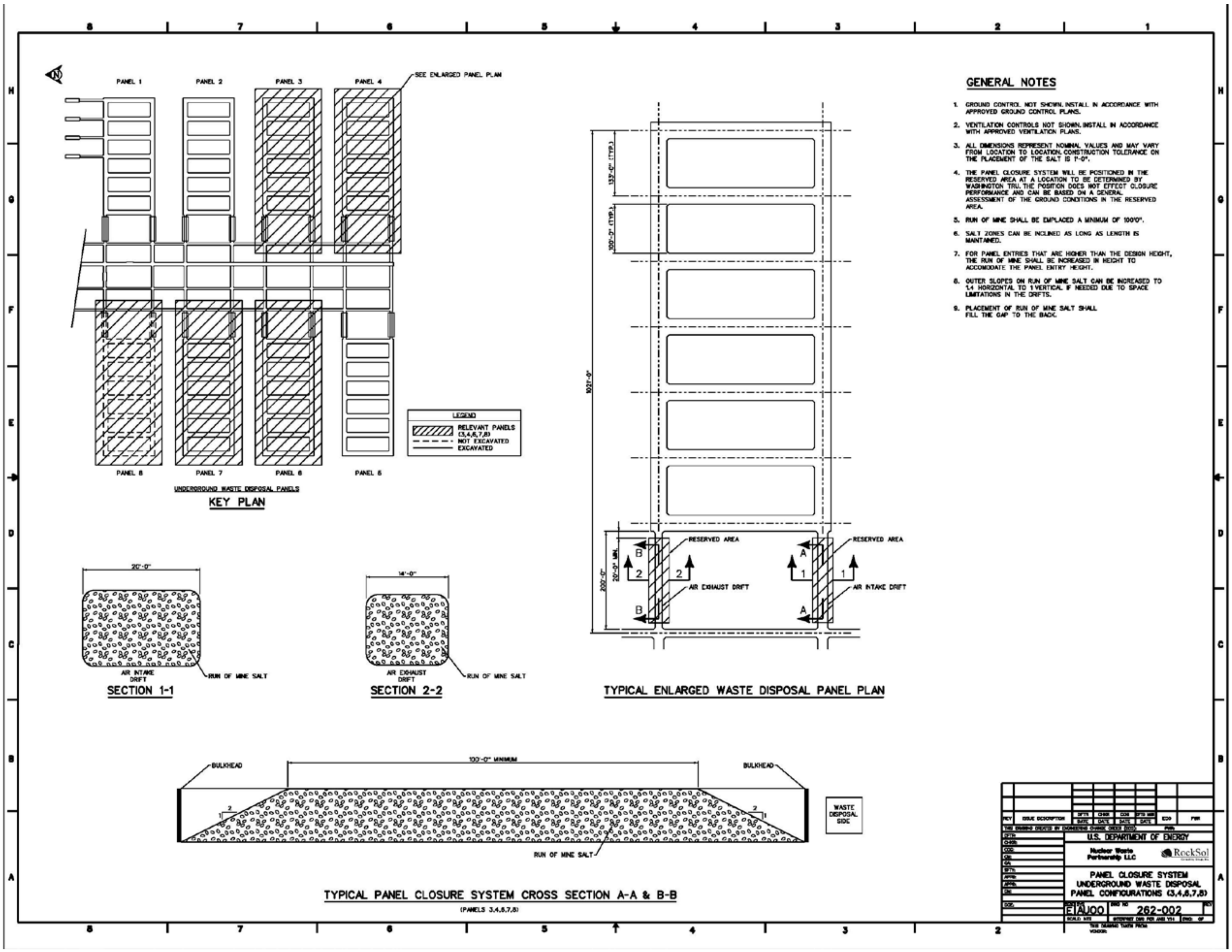
U.S. DEPARTMENT OF ENERGY

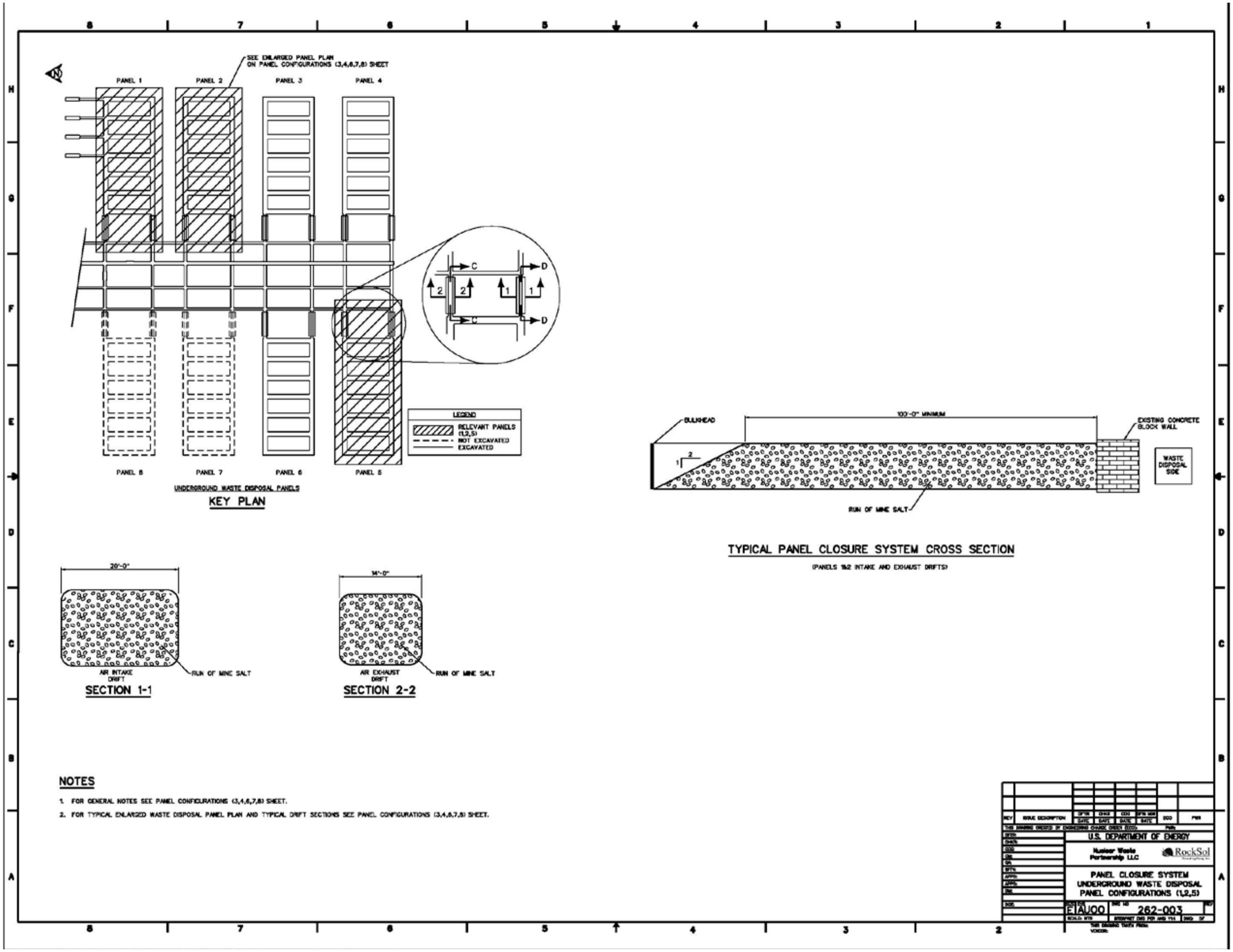
Nuclear Waste Partnership LLC

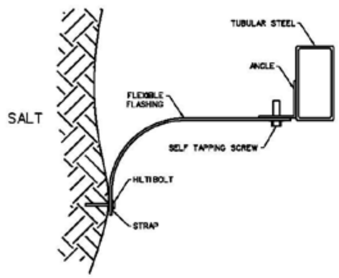
RockSol

PANEL CLOSURE SYSTEM
TITLE SHEET

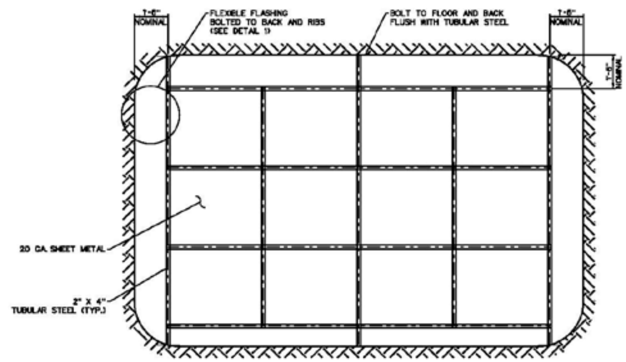
E AU00 262-001


PANEL 1
PANEL 2
PANEL 3
PANEL 4
SEE ENLARGED PANEL PLAN
PANEL 8
PANEL 7
PANEL 6
PANEL 5
LEGEND
RELEVANT PANELS (3,4,6,7,8)
NOT EXCAVATED
EXCAVATED
UNDERGROUND WASTE DISPOSAL PANELS
KEY PLAN
20'-0"
AIR INTAKE DRIFT
RUN OF MINE SALT
SECTION 1-1
14'-0"
AIR EXHAUST DRIFT
RUN OF MINE SALT
SECTION 2-2
RESERVED AREA
AIR EXHAUST DRIFT
RESERVED AREA
AIR INTAKE DRIFT
TYPICAL ENLARGED WASTE DISPOSAL PANEL PLAN
GENERAL NOTES
1. GROUND CONTROL NOT SHOWN. INSTALL IN ACCORDANCE WITH APPROVED GROUND CONTROL PLANS.
2. VENTILATION CONTROLS NOT SHOWN. INSTALL IN ACCORDANCE WITH APPROVED VENTILATION PLANS.
3. ALL DIMENSIONS REPRESENT NOMINAL VALUES AND MAY VARY FROM LOCATION TO LOCATION. CONSTRUCTION TOLERANCE ON THE PLACEMENT OF THE SALT IS 1'-0".
4. THE PANEL CLOSURE SYSTEM WILL BE POSITIONED IN THE RESERVED AREA AT A LOCATION TO BE DETERMINED BY WASHINGTON TRU. THE POSITION DOES NOT EFFECT CLOSURE PERFORMANCE AND CAN BE BASED ON A GENERAL ASSESSMENT OF THE GROUND CONDITIONS IN THE RESERVED AREA.
5. RUN OF MINE SHALL BE EMPLACED A MINIMUM OF 100'0".
6. SALT ZONES CAN BE INCLINED AS LONG AS LENGTH IS MAINTAINED.
7. FOR PANEL ENTRIES THAT ARE HIGHER THAN THE DESIGN HEIGHT, THE RUN OF MINE SHALL BE INCREASED IN HEIGHT TO ACCOMODATE THE PANEL ENTRY HEIGHT.
8. OUTER SLOPES ON RUN OF MINE SALT CAN BE INCREASED TO 1.4 HORIZONTAL TO 1 VERTICAL IF NEEDED DUE TO SPACE LIMITATIONS IN THE DRIFTS.
9. PLACEMENT OF RUN OF MINE SALT SHALL FILL THE GAP TO THE BACK.
BULKHEAD
100'-0" MINIMUM
BULKHEAD
WASTE DISPOSAL SIDE
RUN OF MINE SALT
TYPICAL PANEL CLOSURE SYSTEM CROSS SECTION A-A & B-B
(PANELS 3,4,6,7,8)
U.S. DEPARTMENT OF ENERGY
Nuclear Waste Partnership LLC
RockSol
PANEL CLOSURE SYSTEM
UNDERGROUND WASTE DISPOSAL
PANEL CONFIGURATIONS (3,4,6,7,8)
E AU00
262-002


SEE ENLARGED PANEL PLAN ON PANEL CONFIGURATIONS (3,4,6,7,8) SHEET
PANEL 1
PANEL 2
PANEL 3
PANEL 4
PANEL 8
PANEL 7
PANEL 6
PANEL 5
LEGEND
RELEVANT PANELS (1,2,5)
NOT EXCAVATED
EXCAVATED
UNDERGROUND WASTE DISPOSAL PANELS
KEY PLAN
BULKHEAD
100'-0" MINIMUM
EXISTING CONCRETE BLOCK WALL
WASTE DISPOSAL SIDE
RUN OF MINE SALT
TYPICAL PANEL CLOSURE SYSTEM CROSS SECTION
(PANELS 1&2 INTAKE AND EXHAUST DRIFTS)
20'-0"
AIR INTAKE DRIFT
RUN OF MINE SALT
SECTION 1-1
14'-0"
AIR EXHAUST DRIFT
RUN OF MINE SALT
SECTION 2-2
NOTES
1. FOR GENERAL NOTES SEE PANEL CONFIGURATIONS (3,4,6,7,8) SHEET.
2. FOR TYPICAL ENLARGED WASTE DISPOSAL PANEL PLAN AND TYPICAL DRIFT SECTIONS SEE PANEL CONFIGURATIONS (3,4,6,7,8) SHEET.
U.S. DEPARTMENT OF ENERGY
Nuclear Waste Partnership LLC
RockSol
PANEL CLOSURE SYSTEM
UNDERGROUND WASTE DISPOSAL
PANEL CONFIGURATIONS (1,2,5)
E AU00
262-003



DETAIL 1
(FLEXIBLE FLASHING ATTACHMENT)



TYPICAL BULKHEAD DETAIL

CONSTRUCTION SEQUENCE

1. CONTRACTOR SHALL ENSURE THAT ROOM 1 CLOSURES ARE TIGHT AND EFFECTIVE IN ACCORDANCE WITH ROOM CLOSURE PLANS BEFORE COMMENCING WORK.
2. CONTRACTOR SHALL PLAN THE WORK IN CONSULTATION WITH WASHINGTON TRU AND SHALL EXECUTE IT ONLY AFTER APPROVAL BY WASHINGTON TRU.
3. PREPARE ALL SURFACES BY REMOVING ALL LOOSE MATERIAL AND GENERALLY SQUARING THE EXCAVATION CROSS-SECTION. THE FLOOR SURFACE SHOULD BE FLAT AND CLEAN AND SUITABLE FOR SALT PLACEMENT. OTHER SURFACES SHOULD BE CLEAN, TIGHT AND SOUND IN ACCORDANCE WITH SECTION 02222 OF THE SPECIFICATIONS.
4. RUN OF MINE SALT SHALL BE CONSTRUCTED AS REQUIRED BY SECTION 04100 OF THE SPECIFICATIONS. ASSUMED INTACT DENSITY OF COMPACTED SALT SHALL BE 135 PCF.
5. SALT SHALL BE EMPLACED FLUSH WITH THE RIBS.
6. THE VENTILATION BULKHEAD SHALL ACHIEVE 2,200 PRACTICAL UNITS.

REV	ISSUE DESCRIPTION	DFTR / DATE	CHKR / DATE	COG / DATE	DFTG MGR / DATE	ECO	PWR

U.S. DEPARTMENT OF ENERGY

Nuclear Waste Partnership LLC — RockSol

PANEL CLOSURE SYSTEM
CONSTRUCTION DETAILS

E AU00 262-004

~~ATTACHMENT G1~~
~~APPENDIX G~~

~~TECHNICAL SPECIFICATIONS~~

~~PANEL CLOSURE SYSTEM~~
~~WASTE ISOLATION PILOT PLANT~~
~~CARLSBAD, NEW MEXICO~~

~~ATTACHMENT G1~~
~~APPENDIX G~~

~~TECHNICAL SPECIFICATIONS~~

~~PANEL CLOSURE SYSTEM~~
~~WASTE ISOLATION PILOT PLANT~~
~~CARLSBAD, NEW MEXICO~~

~~TABLE OF CONTENTS~~

~~LIST OF FIGURES~~

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~~DIVISION 1 - GENERAL REQUIREMENTS~~

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Section 01010 - Summary of Work

Part 1 - General

1.1 Scope

This section includes:

- Scope of Work
- Definitions and Abbreviations
- Drawings
- Work by Others
- Contractors Use of Site
- Contractors Use of Facilities
- Work Sequence
- Work Plan
- Submittals

1.2 Scope of Work

The Contractor shall furnish all labor, materials, equipment and tools to perform operations in connection with the construction of two (2) panel closure systems for each panel, one of each to be installed in the air intake drift and the air exhaust drift of a waste-emplacement panel, as shown on the drawings and called for in these specifications.

Four (4) possible arrangements of the concrete barrier and isolation walls are shown on the attached Figure G1-1 "Plan Variations."

- Concrete barrier without disturbed rock zone (**DRZ**) removal in combination with construction isolation wall (Sketch A).

- Concrete barrier without DRZ removal in combination with an explosion isolation wall (Sketch B).

- Concrete barrier with DRZ removal up through clay seam G and down through marker bed 139 (**MB 139**) in combination with a construction isolation wall (Sketch C).

- Concrete barrier with DRZ removal in combination with an explosion isolation wall (Sketch D) (This is the only approved configuration in this Permit).

The scope of work shall include but not be limited to the following units of work:

- Develop work plan, health and safety plan (**HASP**) and contractors quality control plan (**CQCP**)

- Prepare and submit all plans requiring approval

- Mobilize to site

- Coordinate construction with operations

- Perform the following for the air intake entry and the air exhaust entry.
  - Excavate the surface preparation for the explosion isolation wall
  - Construct the explosion isolation wall
  - Excavate the DRZ
  - Install the form work for the concrete barrier
  - Place concrete for the concrete barrier
  - Grout the interface of concrete barrier/back wall
  - Provide contact grouting along the contact surface (if required by the engineer)
- Clean up construction areas in underground and above ground
- Submit all required record documents
- Demobilize from site

1.3 Definitions and Abbreviations

Definitions

Contact-handled waste—Contact-handled defense transuranic (**TRU**) waste with a surface dose rate not to exceed 200 millirem per hour.

Concrete barrier—A barrier placed in the access drifts of a panel to restrict the mass flow rate of volatile organic compounds (**VOC**).

Concrete block—Concrete used for construction of either an explosion-isolation wall or a construction-isolation wall.

Construction-isolation wall—A wall immediately adjacent to the panel waste-emplacement area that is made of concrete block, with mortar or steel frame to isolate construction personnel from coming into contact with the waste.

Creep—Plastic deformation of salt under deviatoric stress.

Design migration limit—A mass flow rate that is at least 1 order of magnitude below the health-based levels for VOCs during the Waste Isolation Pilot Plant (**WIPP**) operational period.

Disturbed rock zone (**DRZ**)—A zone surrounding underground excavations where stress redistribution occurs with attendant dilation and fracturing.

Explosion-isolation wall—A concrete-block wall adjacent to the panel waste-emplacement area with mortar that can sustain the pressure and temperature transients of a methane explosion.

Health-based concentration level—The concentration level for a VOC in air that must not be exceeded at the point of compliance during the WIPP operational period.

Health-based migration limit—The mass flow rate of a VOC from all closed panels that results in the health-based concentration level at the point of compliance.

Hydration temperature—The temperature developed by a cementitious material due to the hydration of the cement.

Interface grouting—Grouting performed through grout boxes and pipe lines to fill the void at the concrete barrier/back-wall interface.

Methane explosion—A postulated deflagration caused by the buildup of methane gas to explosive levels.

Partial closure—The process of rendering a part of the underground repository inactive and closed according to approved facility closure plans. The partial-closure process is considered complete after partial-closure activities are performed in accordance with approved Resource Conservation and Recovery Act (**RCRA**) partial closure plans.

Point of compliance—The operating point of compliance for VOC levels at the WIPP, which is the 16-section land withdrawal boundary.

Remote-handled waste—Any of the various forms of high beta-gamma defense TRU waste requiring remote-handling and with a surface dose rate exceeding 200 millirem per hour.

Standard barrier—A concrete barrier emplaced into the panel-access drifts without major excavation of the surrounding rock.

Volatile Organic Compound (**VOC**)—Any VOC comprising the land-disposal-restricted indicator VOC constituents in the WIPP waste inventory.

Abbreviations/Acronyms

ACI	American Concrete Institute
AISC	American Institute for Steel Construction
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DRZ	Disturbed rock zone
EPA	U.S. Environmental Protection Agency
MB 139	Marker Bed 139
MSHA	U.S. Mine Safety and Health Administration
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
MOC	Management and Operating Contractor (Permit Section 1.5.3)
RCRA	Resource Conservation and Recovery Act
SMC	Salado Mass Concrete
USACE	U.S. Army Corps of Engineers
WIPP	Waste Isolation Pilot Plant

1.4 List of Drawings

The following drawings are made apart of this specification:

762447-E1	Panel closure system, air intake and exhaust drifts, title sheet
762447-E2	Panel closure system, underground waste-emplacement panel plan
762447-E3	Panel closure system, air intake drift, construction details
762447-E4	Panel closure system, air exhaust drift, construction details
762447-E5	Panel closure system, construction and explosion walls, construction details
762447-E6	Panel closure system, air intake and exhaust drifts, grouting and miscellaneous details

1.5 Work by Others

Survey

All survey work to locate the barriers and walls, control and confirm excavation, and complete the work will be supplied by the Permittees. All survey measurements for record purposes will also be performed/supplied by the Permittees. The Contractor shall be responsible for verifying the excavation dimensions to develop the form work to fit the excavation.

Excavation

The Permittees may elect to perform certain portions of the work, notably the excavation. The work performed by the Permittees will be defined prior to the contract.

1.6 Contractor's Use of Site

Site Conditions

The site is located near Carlsbad, New Mexico, as shown on the site location maps and the title sheet drawing. The underground arrangements and location of the WIPP waste-emplacement panels are shown on the plan view drawing. The work described above is to construct the concrete barriers in the air intake and exhaust drifts of one of the panels upon completion of the disposal phase of that panel. The waste-emplacement panels are located approximately 2,150 feet below the ground surface. The Contractor shall visit the site and become familiar with the site and site conditions prior to preparing his bid proposal.

Contractor's Use of Site

Areas at the ground surface will be designated for the Contractor's use in assembling and storing his equipment and materials. The Contractor shall utilize only those areas designated.

Limited space within the underground area will be designated for the Contractor's use for storage of material and setup of equipment.

Coordination of Contractor's Work

The Contractor is advised that on-going waste emplacement and excavation operations are being conducted throughout the period of construction of the panel barrier system. The Contractor shall coordinate his construction operations with that of the waste emplacement and mining operations. All coordination shall be through the Engineer.

~~1.7 Contractor's Use of Facilities~~

~~Existing facilities at the site which are available for use by the Contractor are:~~

- ~~WIPP roadheader~~
- ~~Waste shaft conveyance~~
- ~~Salt skip hoist~~
- ~~(1) 20 ton forklift~~
- ~~(1) 40 ton forklift~~
- ~~460 volt AC, 3 phase power~~
- ~~Water (underground, at waste shaft only) (above ground, at location designated by Engineer)~~

~~Additional information on these facilities is presented in Section 02010.~~

~~1.8 Work Sequence~~

~~Work Sequence shall be as shown on the drawings and directed by the Engineer.~~

~~1.9 Work Plan~~

~~The Contractor shall prepare and submit for approval by the Engineer a Work Plan fully describing his proposed construction operation. The work plan shall define all proposed equipment. The work plan shall also include the method of excavation, grouting, and pumping concrete. The work plan shall also contain such items as control of surface dust emissions. No work shall be performed prior to approval of the Work Plan.~~

~~1.10 Submittals~~

~~Submittals to the Permittees shall be in accordance with the Permittees' Submittal Procedures and as required by the individual specifications. Approval by the Permittees shall not constitute approval by NMED. Any submittals that propose a change to the panel closure requirements of this Permit (e.g., changes in grout composition, detailed design, etc.) shall be submitted to NMED as required by 20.4.1.900 NMAC (incorporating 40 CFR §270.42).~~

~~Part 2 - Products~~

~~Not used.~~

~~Part 3 - Execution~~

~~Not Used.~~

~~End of Section~~

Section 01090 - Reference Standards

Part 1 - General

1.1 Scope

This section includes:

- Provision of Reference Standards at Site.
- Acronyms used in Contract Documents for Reference Standards. Source of Reference Standards.

1.2 Quality Assurance

For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

Conform to reference by date of issue current on the date of the agreement between the Permittees and the contractor.

The Contractor shall obtain copy of the standards referenced in the individual specification sections. Maintain a copy at jobsite during submittals, planning, and progress of the specific work, until completion of work.

Should specified reference standards conflict with the contract documents, request clarification from the Engineer before proceeding.

1.3 Schedule of References

Various publications are referenced in other sections of the specifications to establish requirements for the work. These referenced are identified by documents number and title. The addresses of the organizations whose publications are referenced are listed below.

ACI	ACI International P.O. Box 19150 Detroit, MI 48219-0150 Ph: 313-532-2600 Fax: 313-533-4747
AITC	American Institute of Timber Construction 7012 So. Revere Parkway, Suite 140 Englewood, CO 80112 Ph: 303-792-9559 Fax: 303-792-0669
AISC	American Institute of Steel Construction One E. Wacker Dr., Suite 3100 Chicago, IL 60601-2001 Ph: 312-670-2400

	Fax: 312-670-5403
ANSI	American National Standards Institute 11 West 42nd St. New York NY 10036 Ph: 212-642-4900 Fax: 212-302-1286
API	American Petroleum Institute 1220 L. St., NW Washington, DC 20005 Ph: 202-682-8375 Fax: 202-962-4776
ASTM	American Society for Testing and Materials 1916 Race St. Philadelphia, PA 19103 Ph: 215-299-5585 Fax: 215-977-9679
AWS	American Welding Society 550 LeJeune Road Miami, FL 33135 Ph: 800-443-9353 Fax: 305-443-7559
CFR	Code of Federal Regulations Government Printing Office Washington, DC 20402 Ph: 202-783-3238 Fax: 202-223-7703
EPA	Environmental Protection Agency Public Information Center Ariel Rios Building 1200 Pennsylvania Avenue, NW Washington, DC 20460 Ph: 202-272-0167
FTM-STO	Federal Test Method Standards Standardization Documents Order Desk Bldg. 4D 700 Robbins Ave. Philadelphia, PA 19111-5094 Ph: 215-697-2179 Fax: 215-697-2978
NRMCA	National Ready-Mixed Concrete Association 900 Spring St. Silver Spring, MD 20910 Ph: 301-587-1400

	~~Fax: 301-585-4219~~
~~NTIS~~	~~National Technical Information Service~~ ~~U.S. Department of Commerce~~ ~~Springfield, VA 22161~~ ~~(703) 487-4650~~
~~PCA~~	~~Portland Cement Association~~ ~~5420 Old Orchard Road~~ ~~Skokie, IL 60077~~
~~USACE~~	~~U.S. Army Corps of Engineers~~ ~~U.S. Army Engineer Waterway Experiment Station~~ ~~ATTN: Technical Report Distribution Section, Services Branch, TIC~~ ~~3909 Halls Ferry Rd.~~ ~~Vicksburg, MS 39180-6199~~ ~~Ph: 601-634-2355~~ ~~Fax: 601-634-2506~~
~~MOC~~	~~Washington TRU Solutions LLC~~ ~~PO Box 2078~~ ~~Carlsbad, New Mexico 88221~~

~~End of Section~~

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Section 01400 - Contractor Quality Control

Part 1 - General

1.1 Scope

This section includes:

- Contractor Quality Control Plan (**CQCP**)
- Reference Standards
- Quality Assurance
- Tolerances
- Testing Services
- Inspection Services
- Submittals

1.2 Related Sections

- 01090 - Reference Standards
- 01600 - Material and Equipment
- 02222 - Excavation
- 02722 - Grouting
- 03100 - Concrete Formwork
- 03300 - Cast-in-Place Concrete
- 04100 - Mortar
- 04300 - Unit Masonry System

1.3 Contractor Quality Control Plan

The Contractor shall prepare and submit for approval by the Engineer, a Quality Control Plan, as described in Section 3.2. No work shall be performed prior to approval of the Contractor's Quality Control Plan.

1.4 References and Standards

Refer to individual specification sections for standards referenced therein, and to Section 01090 - Reference Standards for general listing.

Standards referenced in this section are as follows:

ASTM C1077	Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C1093	Practice for Accreditation of Testing Agencies for Unit Masonry
ASTM E329	Practice for Use in the Evaluation of Inspection and Testing Agencies as Used in Construction

ASTM E543	Practice for Determining the Qualification of Nondestructive Testing Agencies
ASTM E548	Practice for Preparation of Criteria for Use in the Evaluation of Testing Laboratories and Inspection Bodies

1.5 Quality Assurance

- Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality
- Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship
- Perform work by persons qualified to produce required and specified quality
- Verify that field measurements are as indicated on shop drawings
- Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.6 Tolerances

Monitor excavation fabrication and installation tolerance control of work and products to produce acceptable work. Do not permit tolerances to accumulate.

Adjust products to appropriate dimensions; position before securing products in place.

1.7 Testing Services

Unless otherwise indicated by the Engineer, the Contractor shall employ an independent firm to perform the testing services and other services specified in the individual specification sections, and as required by the Engineer. Testing and source quality control may occur on or off the project site.

The testing laboratory shall comply with applicable sections of the reference standards and shall be authorized to operate in the state in which the project is located.

Testing equipment shall be calibrated at reasonable intervals with devices of an accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.

1.8 Inspection Services

The Contractor shall employ an independent firm to perform inspection services as a supplement to the Contractor’s quality control as specified in the individual specification sections, and as required by the Engineer. Inspection may occur on or off the project site.

The inspection firm shall comply with applicable sections of the reference standards.

~~1.9 Submittals~~

~~The Contractor shall submit a Contractors' Quality Control Plan as described herein.~~

~~Prior to start of work, the Contractor shall submit for approval, the testing laboratory name, address, telephone number and name of responsible officer of the firm. He shall also submit a copy of the testing laboratory compliance with the reference ASTM standards, and a copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Bureau of Standards with memorandum of remedies of any deficiencies reported by the inspection.~~

~~Prior to start of work, the Contractor shall submit for approval the inspection firm name, address, telephone number and name of responsible officer of the firm. He shall also submit the personnel proposed to perform the required inspection, along with their individual qualifications and certifications (Example: Certified AWS Welding Inspector.)~~

~~Part 2 - Products~~

~~Not used.~~

~~Part 3 - Execution~~

~~3.1 General~~

~~The Contractor is responsible for quality control and shall establish and maintain an effective quality control system. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both on site and off site, and shall be keyed to the proposed construction sequence. The project superintendent will be held responsible for the quality of work on the job. The project superintendent in this context shall mean the individual with the responsibility for the overall management of the project including quality and production.~~

~~3.2 Quality Control Plan~~

~~3.2.1 General~~

~~The Contractor shall furnish for review and approval by the Engineer, not later than 30 days after receipt of notice to proceed, the Contractor Quality Control (**CQC**) Plan proposed to implement the requirements of the Contract. The plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used. Construction will be permitted to begin only after acceptance of the CQC Plan.~~

~~3.2.2 Content of the CQC Plan~~

~~The CQC Plan shall include, as a minimum, the following to cover all construction operations, both on site and off site, including work by subcontractors, fabricators, suppliers, and purchasing agents:~~

- ~~A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff shall implement the control system~~

~~for all aspects of the work specified. The staff shall include a CQC System Manager who shall report to the project superintendent.~~

- ~~The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.~~

- ~~Description of the CQC System Manager's responsibilities and delegation of authority to adequately perform the functions of the CQC System Manager, including authority to stop work which is not in compliance with the contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities.~~

- ~~Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, off site fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with the Permittees' Submittal Procedures.~~

- ~~Control, verification, and acceptance testing procedures for each specific test to include the test name, specification paragraph requiring test, feature of work to be tested, test frequency, and person responsible for each test. (Laboratory facilities will be subject to approval by the Engineer.)~~

- ~~Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.~~

- ~~Reporting procedures, including proposed reporting formats.~~

- ~~A list of the definable features of work. A definable feature of work is a task which is separate and distinct from other tasks and has separate control requirements. It could be identified by different trades or disciplines, or it could be work by the same trade in a different environment. Although each section of the specifications may generally be considered as a definable feature of work, there are frequently more than one definable feature under a particular section. This list will be agreed upon by the Engineer.~~

~~3.2.3 Acceptance of Plan~~

~~Acceptance of the Contractor's plan is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. The Permittees reserve the right to require the Contractor to make changes in his CQC Plan and operations including removal of personnel, as necessary, to obtain the quality specified.~~

~~3.2.4 Notification of Changes~~

~~After acceptance of the CQC Plan, the Contractor shall notify the Engineer in writing of any proposed change. Proposed changes are subject to acceptance by the Engineer.~~

~~3.3 Quality Control Organization~~

~~3.3.1 General~~

The requirements for the CQC organization are a CQC System Manager and sufficient number of additional qualified personnel supplemented by independent testing and inspection firms as required by the specifications, to ensure contract compliance. The Contractor shall provide a CQC organization which shall be at the site at all times during progress of the work and with complete authority to take any action necessary to ensure compliance with the contract. All CQC staff members shall be subject to acceptance by the Engineer.

3.3.2 CQC System Manager

The Contractor shall identify as CQC System Manager an individual within his organization at the site of the work who shall be responsible for overall management of CQC and have the authority to act in all CQC matters for the Contractor. The CQC System Manager shall be a graduate engineer, with a minimum of five years construction experience on construction similar to this contract. This CQC System Manager shall be on the site at all times during construction and will be employed by the prime Contractor. The CQC System Manager shall be assigned no other duties. An alternate for the CQC System Manager will be identified in the plan to serve in the event of the System Manager's absence. The requirements for the alternate will be the same as for the designated CQC System Manager.

3.3.3 CQC Personnel

In addition to CQC personnel specified elsewhere in the contract, the Contractor shall provide as part of the CQC organization specialized personnel or third party inspectors to assist the CQC System Manager. These individuals shall be employed by the prime Contractor; be responsible to the CQC System Manager; be physically present at the construction site during work on their areas of responsibility; have the necessary education and/or experience. These individuals shall have no other duties other than quality control.

3.3.4 Organizational Changes

The Contractor shall maintain his CQC staff at full strength at all times. When it is necessary to make changes to the CQC staff the Contractor shall revise the CQC Plan to reflect the changes and submit the changes to the Engineer for acceptance at the Contractors' expense.

3.4 Tests

3.4.1 Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to provide a product which conforms to contract requirements. Upon request, the Contractor shall furnish to the Engineer duplicate samples of test specimens for possible testing by the Engineer. Testing includes operation and/or acceptance tests when specified. The Contractor shall procure the services of an approved testing laboratory. The Contractor shall perform the following activities and record and provide the following data:

- Verify that testing procedures comply with contract requirements.
- Verify that facilities and testing equipment are available and comply with testing standards.
- Check test instrument calibration data against certified standards.

- Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.

- Results of all tests taken, both passing and failing tests, will be recorded on the CQC report for the date taken. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test will be given. If approved by the Engineer, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an off site or commercial test facility will be provided directly to the Engineer. Failure to submit timely test reports as stated may result in nonpayment for related work performed and disapproval of the test facility for this contract.

3.5 Testing Laboratory

The testing laboratory shall provide qualified personnel to perform specified sampling and testing of products in accordance with specified standards, and ascertain compliance of materials and mixes with requirements of Contract Documents. The testing laboratory shall promptly notify the Engineer and Contractor of any observed irregularities or non-conformance of Work or Products.

Reports indicating results of tests, and compliance (or noncompliance) with the contract documents will be submitted in accordance with the Permittees' submittal procedures.

The Contractor shall cooperate with the independent testing firm, furnish samples, storage, safe access, and assistance by incidental labor as required. Testing by the independent firm does not relieve the contractor of the responsibility to perform the work to the contract requirements.

The laboratory may not:

- Release, revoke, alter, or enlarge on requirements of the contract
- Approve or accept any portion of the work
- Assume any duties of the Contractor.

The laboratory has no authority to stop the work.

3.6 Inspection Services

The inspection firm shall provide qualified personnel at site to supplement the Contractor's Quality Control Program to perform specified inspection of Products in accordance with specified standards. He shall ascertain compliance of materials and mixes with requirements of Contract Documents, and promptly notify the CQC System Manager, the Engineer and the Contractor of observed irregularities or non-conformance of Work or Products. The inspector does not have the authority to stop the work. The inspector shall refer such cases to the CQC System Manager who has the authority to stop work (see Section 3.2.2).

Reports indicating results of the inspection and compliance (or noncompliance) with the contract documents will be submitted in accordance with the Permittees' submittal procedures.

The Contractor shall cooperate with the independent inspection firm, furnish samples, storage, safe access and assistance by incidental labor, as requested.

~~Inspection by the independent firm does not relieve the Contractor of the responsibility to perform the work to the contract requirements.~~

~~3.7 Completion Inspection~~

~~3.7.1 Pre-Final Inspection~~

~~At the completion of all work the CQC System Manager shall conduct an inspection of the work and develop a "punch list" of items which do not conform to the approved drawings and specifications. Once this is accomplished the Contractor shall notify the Engineer that the facility is complete and is ready for the "Prefinal" inspection. The Engineer will perform this inspection to verify that the facility is complete. A "Final Punch List" will be developed as a result of this inspection. The Contractor's CQC System Manager shall ensure that all items on this list have been corrected and notify the Engineer so that a "Final" inspection can be scheduled. Any items noted on the "Final" inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph will be accomplished within the time slated for completion of the entire work.~~

~~3.7.2 Final Acceptance Inspection~~

~~The final acceptance inspection will be formally scheduled by the Engineer based upon notice from the Contractor. This notice will be given to the Engineer at least 14 days prior to the final acceptance inspection and must include the Contractor's assurance that all specific items previously identified to the Contractor as being unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection.~~

~~3.8 Documentation~~

~~The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form that includes, as a minimum, the following information:~~

- ~~Contractor/subcontractor and their area of responsibility.~~
- ~~Operating plant/equipment with hours worked, idle, or down for repair.~~
- ~~Work performed each day, giving location, description, and by whom.~~
- ~~Test and/or quality control activities performed with results and references to specifications/drawings requirements. List deficiencies noted along with corrective action.~~
- ~~Quantity of materials received at the site with statement as to acceptability, storage, and reference to specifications/drawings requirements.~~
- ~~Submittals reviewed, with contract reference, by whom, and action taken.~~
- ~~Off-site surveillance activities, including actions taken.~~

- ~~Instructions given/received and conflicts in plans and/or specifications.~~
- ~~Contractor's verification statement.~~

~~These records shall indicate a description of trades working on the project; the number of personnel working; weather conditions encountered; and any delays encountered. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in the work and workmanship comply with the contract. The original and one copy of these records in report form shall be furnished to the Engineer daily. Reports shall be signed and dated by the CQC System Manager. The report from the CQC System Manager shall include copies of test reports and copies of reports prepared by all subordinate quality control personnel.~~

~~3.9 Notification of Noncompliance~~

~~The Engineer will notify the Contractor of any detected noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the worksite, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, the Engineer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.~~

~~End of section.~~

Section 01600 - Material and Equipment

Part 1 - General

1.1 Scope

This section includes:

- Equipment
- Products
- Transportation and handling
- Storage and protection
- Substitutions

1.2 Related Sections

- 01010 - Summary of Work
- 01400 - Contractor Quality Control
- 02010 - Mobilization and Demobilization
- 02222 - Excavation
- 02722 - Grouting
- 03100 - Concrete Formwork
- 03300 - Cast-in-Place Concrete
- 04100 - Mortar
- 04300 - Unit Masonry System

1.3 Equipment

The Contractor shall specify his proposed equipment in the Work Plan. Power equipment for use underground shall be either electrical or diesel engine driven. All diesel engine equipment shall be certified for use underground.

1.4 Products

The Contractor shall specify in the Work Plan, or in subsequently required submittals the proposed products including, but not limited to the grout mix and its components, concrete mix and its components, mortar mix and its components, formwork, and masonry. The proposed products shall be supported by laboratory test results as required by the specifications. All products shall be subject to approval by the Engineer.

1.5 Transportation and Handling

- Transport and handle products in accordance with manufacturer's instructions.

- Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

- Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

~~1.6 Storage and Protection~~

- ~~Store and protect products in accordance with manufacturers' instructions.~~
- ~~Store with seals and labels intact and legible.~~
- ~~Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.~~
- ~~For exterior storage of fabricated products, place on sloped supports above ground.~~
- ~~Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.~~
- ~~Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.~~
- ~~Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.~~
- ~~Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.~~

~~1.7 Substitutions~~

~~1.7.1 Equipment Substitutions~~

~~The Contractor may substitute equipment for that proposed in the Work Plan subject to the Engineer's approval. The Contractor shall demonstrate the need for the substitution, and the applicability of the proposed substitute equipment.~~

~~1.7.2 Product Substitutions~~

~~The Contractor may not substitute products after the proposed products have been approved by the Engineer unless he can demonstrate that the supplier/source of that product no longer exists in which case he shall submit alternate products with lab test results to the Engineer for approval. In the case that product is a component in a mix, the Contractor shall perform mix testing using that component and submit laboratory test results.~~

~~Part 2 - Products~~

~~Not used.~~

~~Part 3 - Execution~~

~~Not used.~~

~~End of section.~~

DIVISION 2 - SITE WORK

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Section 02010 - Mobilization and Demobilization

Part 1 - General

1.1 Scope

This section includes:

- Mobilization of equipment and facilities to site
- Contractor use of site
- Use of existing facilities
- Demobilization of equipment and facilities
- Site cleanup

1.2 Related Sections

- 01010 - Summary of Work
- 01600 - Material and Equipment

Part 2 - Products

Not used.

Part 3 - Execution

3.1 Mobilization of Equipment and Facilities to Site

Upon authorization to proceed, the Contractor shall mobilize his equipment and facilities to the jobsite. Equipment and facilities shall be as specified, and as defined in the Contractor's Work Plan. The Contractor shall erect the batch plant and assemble his equipment and materials in the areas designated by the Engineer. Facilities shall be located as near as practical to the existing utilities.

The Permittees will provide utilities (460 volt AC, 3 phase, and water) at designated locations. The Contractor shall be responsible for all hookups and tie-ins required for his operations.

The Contractor shall be responsible for providing his own office, storage, and sanitary facilities.

Areas will be designated for the Contractor's use in the underground area in the vicinity of the panel closure system installation. These areas are limited.

3.2 Use of Site

The Contractor shall use only those areas specifically designated for his use by the Engineer. The Contractor shall limit his on-site travel to the specific routes required for performance of his work, and designated by the Engineer.

~~3.3 Use of Existing Facilities~~

~~Existing facilities at the site which are available for use by the Contractor are:~~

- ~~WIPP roadheader~~
- ~~Waste shaft conveyance~~
- ~~Salt skip hoist~~
- ~~(1) 20 ton forklift~~
- ~~(1) 40-ton forklift~~
- ~~460 Volt AC, 3 phase power~~
- ~~Water (in mine, at waste shaft only-above ground at location designated by the Engineer).~~

~~The Contractor shall arrange for use of the facilities with the Engineer and coordinate his actions/requirements with that of the ongoing operations.~~

~~Use of water in the underground will be restricted. No washout or cleanup will be permitted in the underground. Above ground washout/cleanup or equipment will be allowed in the areas designated by the Engineer.~~

~~The Contractor is cautioned to be aware of the physical dimensions of the waste conveyance and the air lock (see Figures G1-2 and G1-3, attached).~~

~~The Contractor shall be responsible for any damage incurred by the existing site facilities as a result of his operations. Any damage shall be reported immediately to the Engineer and repaired at the Contractor's cost.~~

~~3.4 Demobilization of Equipment and Facilities~~

~~At completion of this work, the Contractor shall demobilize his equipment and facilities from the job site. The batch plant shall be disassembled and removed along with any unused material. All Contractor's equipment and materials shall be removed from the mine and all disturbed areas restored. Utilities shall be removed to their connection points unless otherwise directed by the Engineer.~~

~~3.5 Site Cleanup~~

~~At conclusion of the work, the Contractor shall remove all trash, waste, debris, excess construction materials, and restore the affected areas to its prior condition, to the satisfaction of the Engineer. A final inspection of the areas will be conducted by the Engineer and the Contractor before final payment is approved.~~

~~End of section.~~

Section 02222 - Excavation

Part 1 - General

1.1 Scope

This section includes:

- Excavation for main concrete barrier
- Excavation for surface preparation and leveling of base areas for isolation walls
- Disposition of excavated materials.

1.2 Related Sections

- 01010 - Summary of Work
- 01600 - Material and Equipment
- 03100 - Concrete Form Work
- 04300 - Unit Masonry System.

1.3 Reference Documents

"Reference Stratigraphy and Rock Properties for the Waste Isolation Pilot Plant (WIPP) Project" by R.D. Krieg-Sandia National Laboratory Document Sand 83-1908. [Available through National Technical Information Service (**NTIS**).]

1.4 Field Measurements and Survey

All surveys required for performance of the work will be provided by the Permittees. To develop the concrete formwork to fit the excavation, the Contractor shall be responsible for verifying the excavation dimensions.

Part 2 - Products

Not used.

Part 3 - Execution

3.1 Excavating for Concrete Barrier

Excavation for the main concrete barrier shall be performed to the lines and grades shown on the drawings. Excavate the back a minimum of 1 inch to 3 inches beyond clay seam G, and the floor a minimum of 1 inch to 3 inches below the anhydride marker bed 139 (**MB-139**) to assure removal of the disturbed rock zone (**DRZ**). Excavation shall be performed utilizing mechanical means such as a cutting head on a suitable boom, by drilling boreholes and using an expansive agent to fragment the rock or other competent equipment or methods submitted to the Engineer for review and approval. The use of explosives is prohibited. The existing WIPP roadheader mining machine may also be available for use. The Contractor is to determine availability and coordinate proposed use of the roadheader with the Engineer. The existing roadheader is capable of excavating the back and the portions of the ribs above the floor level. However, it is not capable of excavating the portion below floor level.

~~The tolerances for the concrete barrier excavation shall be +6 inches, to 0 inch. In addition, the Contractor is to remove all loose or spalling rock from the excavation surface to provide a sound surface abutting the concrete barrier. The Contractor shall provide and install roof bolts for support as required for personnel protection and approved ground control plans.~~

~~3.2 Excavating for Surface Preparation and leveling of Base Areas for Isolation Walls~~

~~The Contractor shall excavate a 6-inch surface preparation around the entire perimeter of the isolation walls. The surface preparation in the floor shall be made level to produce a surface for placing the first course of block in the isolation walls. Tolerances for the leveled portion of the surface preparation are ±1 inch. Excavation may be performed by either mechanical or manual means. Use of explosives is prohibited.~~

~~3.3 Disposition of Excavated Materials~~

~~The Contractor shall remove all excavated materials from the panel-access drift where they are excavated. Excavated materials shall be removed from the mine via the salt skip to the surface, where they will be disposed on site at a location as directed by the Engineer.~~

~~3.4 Field Measurements and Survey~~

~~All survey required for performance of the work will be provided by the Permittees. The Contractor shall protect all survey control points, bench marks, etc., from damage by his operations. MOC will verify by survey that the Contractor has excavated to the required lines and grades. The Contractor shall be responsible for verifying the excavation dimensions to develop concrete formwork to fit the excavation. No form work or block work is to be erected until this survey is completed. The Contractor is to coordinate the survey work with his operations to assure against lost time. The Contractor shall notify the Engineer at least 24 hours prior to the time surveying is required~~

~~End of section.~~

Section 02722 - Grouting

Part 1 - General

1.1 Scope

This section includes:

- Grouting of concrete barrier.

1.2 Related Sections

- 01010 - Summary of Work
- 01400 - Contractor Quality Control
- 01600 - Material and Equipment
- 03100 - Concrete Form Work
- 03300 - Cast-in-Place Concrete

1.3 References

ASTM C1107 Standard Specification for Nonshrink Grout

ASTM C109 Test Method for Compressive Strength of Hydraulic Cement Mortars

1.4 Submittals for Review and Approval

Thirty days prior to the initiation of grouting, the Contractor shall submit to the Engineer for review and approval, the following:

- Type of grout proposed
- Product data:
  - Manufacturer's specification and certified laboratory tests for the manufactured grout, if proposed
  - Certified laboratory tests for the salt-saturated grout, if proposed, using project-specific materials
- Proposed grouting method, including equipment and materials and construction sequence in Work Plan.

1.5 Submittals for Construction

Daily grouting report indicating the day, date, time of mixing and delivery, quantity of grout placed, water used, pressure required, problems encountered, action taken, quality control data, testing results, etc., no later than 24 hours following construction.

Part 2 - Products

2.1 Grout Materials

Grout used for grouting in connection with fresh water/plain cement concrete shall be nonshrink, cement-based grout, Five Star 110 as manufactured by Five Star Products Inc., 425 Stillson Road, Fairfield, Connecticut 06430 or approved equal. Mixing and installation shall be in accordance with the manufacturer's recommendations.

As an alternate to the above grout, in connection with the Salado Mass concrete mix, the Contractor shall use, subject to the approval of the Engineer, a salt saturated grout. The following formulation is suggested to the Contractor as an initiation point for selection of the grout mix. Salt saturated grout strength shall be 4500 psi at 28 days.

Salt-Saturated Grout (BCT-1F)

Component	Percent of total Mass (wt.)
Class H Cement	48.3
Class C Fly Ash	16.2
Cal Seal (Plaster - from Halliburton)	5.7
Sodium chloride	7.9
Dispersant	0.78
Defoamer	0.02
Water	21.1

Water for mixing shall be of potable quality, free from injurious amounts of oil, acid, alkali, salt, or organic matter, sediments, or other deleterious substances, as specified for concrete, Section 03300-2.3.

2.2 Product Data

If the Contractor proposes to utilize a manufactured nonshrink cement-based grout, he shall submit complete manufacturer's specifications for the product, along with certified laboratory test results of the material.

If the Contractor proposes to utilize the salt-saturated grout in connection with the Salado Mass concrete mix, he shall submit manufacturer's/supplier's specifications for the component materials, and certified laboratory test results for the resultant mix.

Part 3 - Execution

3.1 General

The Contractor shall furnish all labor material, equipment, and tools to perform all operations in connection with the grouting.

Grout delivery and return lines for interface grouting shall be installed in the form work or in the area to be grouted to provide uniform distribution of the grout as shown on the drawings. The exact location of the boxes and lines shall be determined in the field. Additional grout delivery and return lines and boxes may be required by the Engineer.

Pumps shall be positive displacement piston type pump designed for grouting service capable of operating at a discharge pressure of 100 psi. The Contractor shall supply a standby pump to be utilized in the event of a breakdown of the primary unit.

Mixers shall be high velocity "colloidal" type with a rotary speed of 1,200 to 1,500 rpm. Grout shall be mixed to a pumpable mix as per the manufacturer's recommendations.

Mixing water shall be accurately metered to control the consistency of the grout.

The Contractor shall provide all necessary valves, gages, and pressure hoses.

Water for mixing is available at the waste shaft. The Contractor is cautioned that no free water discharges or spills are permitted in the mine. All cleanup and washout operations shall be performed at the ground surface.

Potential spill areas in the underground shall be identified by the Contractor in the work plan. The Contractor shall provide adequate containment for potential spills. Isolation measures shall include, but are not limited to, lining with a membrane material (PVC, hypalon, HDPE), draped curtains (polyethylene, PVC, etc.), corrugated sheet metal protective walls or a combination of these and other measures.

If salt-saturated grout is selected for use, the Contractor shall make provisions to accurately proportion the components. Proportioning shall be by weighing. Sufficient quantities of dry components shall be developed prior to initiation of the grouting to perform the work so as not to incur delays during the mixing/placing sequence.

3.2 Interface Grouting of Concrete Barrier

After each cell of the concrete barrier has been allowed to cure for a period of seven days, or as directed by the Engineer, the Contractor shall interface grout the remaining space between the back wall and the top surface of the concrete barrier.

Each cell of the concrete barrier shall be grouted before the next adjacent cell is formed and concrete placed. Grout delivery and return lines shall be installed with the form work as shown and called for on the drawings, or as directed by the Engineer.

The placing of grout, unless otherwise directed by the Engineer shall be continuous until completed. Grouting shall progress from lower to higher grout pipes. Grouting shall proceed through a single delivery line until grout escapes from the adjacent return line. The Contractor shall then secure these lines and move to the next adjacent set of delivery and return lines. Pressure shall be adjusted to adequately deliver the grout to the forms, as witnessed by grout in the return line.

The grouting operation shall be conducted in a manner such that it does not affect the stability of the concrete barrier structure.

3.3 Contact Grouting

After completion of interface grouting if directed by the Engineer, the Contractor shall contact grout to fill any remaining voids at the concrete barrier/back wall interface. Contact grouting includes all operations to drill, clean, and grout holes installed in the concrete barrier.

The Contractor shall drill and grout the interface zone to the main concrete barrier as directed by the Engineer.

The location, direction, and depth of each grout hole shall be as directed by the Engineer. The order in which the holes are drilled and the manner in which each hole is drilled and grouted, the proportions of the water used in the grout, the time of grouting, the pressures used in grouting, and all other details of the grouting operations shall be as directed by the Engineer.

Wherever required, contact grouting will entail drilling the hole to a limited depth, installing a packer, and performing grouting.

3.3.1 Drilling

The holes shall be drilled with rotary-type drills. Drilling grout holes with percussion-type drills will not be permitted except as approved by the Engineer.

The requirements as to location, depth, spacing, and direction of the holes shall be as directed by the Engineer.

The minimum diameter shall be approximately 11/2 inches.

When the drilling of each hole or stage of has been completed, compressed air will be used to flush out drill cuttings. The hole shall then be temporarily capped or otherwise suitably protected to prevent the hole from becoming clogged or obstructed until it is grouted.

3.3.2 Materials for Contact Grouting

Standard weight black steel pipe conforming to ASTM A-53 shall be set in the concrete in the locations as directed by the Engineer. All pipe and fittings shall be furnished by the Contractor.

The size of the grout pipe for each hole and the depth of the holes for setting pipe for grouting shall be as directed by the Engineer. Care shall be taken to avoid clogging or obstructing the pipes before being grouted, and any pipe that becomes clogged or obstructed from any cause shall be cleaned satisfactorily or replaced.

The packers shall be furnished by the Contractor and shall consist of expansible tubes or rings of rubber, leather, or other suitable material attached to the end of the grout supply pipe. The packers shall be designed so that they can be expanded to seal the drill hole at the specified locations and when expanded shall be capable of withstanding without leakage, for a period of 5 minutes, air pressure equal to the maximum grout pressures to be used.

3.3.3 Grouting Procedures

Different grouting pressures will be required for grouting different sections of the grout holes. Pressures as high as necessary to deliver the grout but which, as determined by trial, are safe against concrete displacement shall be used in the grouting.

If, during the grouting of any hole, grout is found to flow from adjacent grout holes or connections in sufficient quantity to interfere seriously with the grouting operation or to cause appreciable loss of grout, such grout holes and connections shall be capped temporarily. Where such capping is not essential, inaugurated holes shall be left open to facilitate the escape of air as the grout is forced into other holes. Before the grout has set, the grout pump shall be connected to adjacent capped holes and to other holes from which grout flow was observed, and grouting of all holes shall be completed. If during the grouting of any hole, grout is found to flow from points in the barrier, any parts of the concrete structure, or other locations, such flows or leaks shall be plugged or caulked by the Contractor as directed by the Engineer.

As a safeguard against concrete displacement, excessive grout travel, or while grout leaks are being caulked, the Engineer may require the reduction of the pumping pressure, intermittent pumping, or the discontinuance of pumping.

The consistency of the grout mix shall be varied, as directed by the Engineer, depending on the conditions encountered. Where the grout hole or connection continues to take a large amount of grout after the mix has been thickened, the Engineer may require that pumping be done intermittently, waiting up to 8 hours between pumping periods to allow grout in the barrier to set. After the grouting is complete, the pressure shall be maintained by means of stopcocks, or other suitable valve that it will be retained in the holes or connections being grouted.

3.4 Cleanup

No clean-up or washing of equipment with water is allowed in the underground. No free water spills are permitted. All clean out or wash out requiring water will be performed above ground at the location approved by the Engineer. See note above regarding potential spill areas in Section 3.1 - General.

3.5 Quality Control

The Contractor shall provide a third-party quality control inspector at the site throughout the grout placement operations. The inspector shall determine that the grout mix is properly proportioned and properly mixed to the approved consistency. The inspector shall sample and make one set of grout cubes for compression testing for every 50 cubic feet of grout placed, or fraction thereof, for each day of grout placement.

End of section.

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~~DIVISION 3 - CONCRETE~~

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Section 03100 - Concrete Formwork

Part 1 - General

1.1 Scope

This section includes:

- Formwork for cast-in-place concrete with shoring, bracing, and anchorage
- Accessory items, grout pipes, concrete delivery pipes.

1.2 Related Sections

- 01010 - Summary of Work
- 01400 - Contractor Quality Control
- 01600 - Material and Equipment
- 02722 - Grouting
- 03300 - Cast-in-Place Concrete
- 04300 - Unit Masonry System

1.3 References

ACI 301	Specifications for Structural Concrete for Buildings
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Recommended Practice for Concrete Formwork
ASTM A-36	Standard Specification for Structural Steel
ASTM A-53	Standard Specification for Pipe, Steel, Black, and Hot-Dipped Zinc Coated
ASTM A-325	High Strength, Structural Bolts
ASTM A-615	Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcements
AWS A3.0	Welding Terms and Definitions
AWS A5.1	Specification for Mild Steel Covered Arc Welding Electrodes
AWS D1.1	Structural Welding Code-Steel
AISC	Manual of Steel Construction Latest Edition

1.4 Submittals

The Contractor shall submit the following 30 days prior to initiation of work at site.

Shop detail drawings with appropriate calculations to support the adequacy or the formwork.

~~Mill test certification of materials utilized in construction of the forms.~~

~~Details of installation contained in the Contractor's Work Plan.~~

~~1.5 Quality Assurance~~

~~Design and detail the formwork under direct supervision of a professional structural Engineer experienced in design of this work and licensed in the state of New Mexico.~~

~~Perform work in accordance with ACI 301, 318, and 347, AISC and AWS standards. Maintain one copy of all standards at site.~~

~~Perform all fabrication in accordance with AISC manual of steel construction.~~

~~Perform all welding in accordance with AWS D1.1 structural welding code.~~

~~Perform all bolting in accordance with AISC specification for structural joints using ASTM A325 or A490 bolts.~~

~~Part 2 - Products~~

~~2.1 Form Materials~~

~~Forms for the concrete barrier shall be constructed of ASTM A-36 steel.~~

~~Pipe inserts shall be ASTM A-53 black standard weight pipe.~~

~~Form spacers shall be ASTM A-36 round stock.~~

~~Bolts shall be ASTM A325 high strength structural bolts.~~

~~Grout pipes shall be ASTM A-53 standard weight pipe or flex conduit as shown on the drawings.~~

~~Rock anchors shall develop strength equal to or greater than ASTM A-36 round stock.~~

~~Welding electrodes shall conform to AWS A5.1.~~

~~Part 3 - Execution~~

~~3.1 General~~

~~The Contractor shall furnish all labor material equipment and tools to perform all operations in connection with the design, detail, fabrication and erection of the formwork and the fabrication and installation of grout pipes for the main concrete barrier.~~

~~The Contractor may, at his option submit an alternate design or modify the design shown on the drawings, subject to the approval of the Engineer. All designs must be supported by design calculations stamped and sealed by a registered professional engineer.~~

~~The Contractor shall furnish, fabricate and install all grout pipes and grout boxes for both the concrete barrier and the isolation walls.~~

~~3.2 Shop Drawings~~

~~The Contractor shall design and detail all formwork for the concrete barrier, complete with any required bracing and shoring for the concrete barrier as shown on the drawings, in accordance with ACI 318 and 347 and the AISC manual of steel construction.~~

~~The details shall incorporate provision for adjusting and modifying the formwork to suit the excavation. Excavation tolerances are given in Section 02222 Excavation.~~

~~The Contractor shall be responsible for verifying the excavation dimensions to develop the concrete formwork to fit the excavation.~~

~~Prior to fabrication, the Contractor shall submit shop drawings complete with supporting calculations for review/approval by the Engineer 30 days prior to initiating work. The contractor shall incorporate all Engineer's comments, revisions, resolve all questions and resubmit drawings for final approval prior to proceeding with fabrication.~~

~~3.3 Fabrication~~

~~The Contractor shall fabricate all formwork and ancillary items in accordance with the latest edition of the AISC Manual of Steel Construction and the approved detail drawings.~~

~~Formwork shall contain all inserts for grouting and pumping concrete. Sufficient valving shall be provided on inserts to allow shut off of concrete and grout to prevent back flow through the form work.~~

~~All welding shall be in accordance with AWS D1.1 structural welding code including operator and procedure certifications. Elements shall be welded using E-7018 low hydrogen electrodes. Panels shall be piece marked to correspond to the erection drawing(s) and sequence at fabrication.~~

~~3.4 Installation~~

~~3.4.1 Grout Pipes~~

~~The Contractor shall furnish, fabricate, and install all grout pipes and boxes as approved by the Engineer. Grout pipes and boxes shall be attached to the back surface using masonry anchors as shown on the drawings or other approved methods. Grout pipes shall be connected to the inserts installed in the permanent forms and securely fastened to the formwork. All grout pipes will be blown out with compressed air after installation and prior to closure of the formwork to assure they are clean and free from debris or obstructions. Grout pipes shall then be temporarily capped to prevent entry of foreign matter until ready for grouting. The Contractor shall apply masking tape to the grout box openings to prevent concrete infiltration during concrete placement.~~

~~3.4.2 Formwork~~

~~The steel formwork for the concrete barrier is to remain in place at completion of each segment of the barrier, therefore all formwork shall be free from oil, grease, rust, dirt, mud or other material that would prevent bonding by the concrete. Forms will not be oiled or receive application of release agent.~~

The Contractor shall install formwork at the locations shown on the drawings to the lines and grades shown. Forms are to be mortar tight. The Contractor shall adjust the formwork to suit the contour of the excavation. Rock may be trimmed or chipped to suit where interferences are encountered. Where overexcavation has occurred in excess of the designed-in adjustability of the formwork, modifications shall be proposed to the Engineer for his approval prior to installation. Installation of the formwork shall be reviewed and approved by the Engineer prior to proceeding with concrete installation.

The Contractor shall provide a sealant or gasket material on mating surfaces to provide mortar-tite joints.

3.5 Quality Control

The Contractor shall arrange for and contract with an approved third party inspector to provide inspection/testing services for the fabrication and installation of the formwork and ancillary items, as required by the QA/QC plan.

The Contractor shall furnish certified mill test reports for all materials utilized in the fabrication.

All welding shall be in accordance with AWS D1.1 structural welding code. The Contractor shall furnish welding operator and procedure certifications for all operators and procedures utilized.

Fabricated components shall be inspected for dimension and overall quality. Welds shall be inspected by an AWS certified welding inspector.

The inspector shall visually inspect the installation for fit-up and dimensionally for location.

3.6 Handling, Shipping, Storage

The Contractor shall handle, ship, and store fabricated components with care to avoid damage. Stored components shall be placed on timbers or pallets off the ground to keep the units clean. Components shall be tarped while in outdoor storage. Components that become spattered or contaminated with mud will be thoroughly cleaned before delivering to the mine for installation. Damaged components will be rejected by the inspector and replaced by the contractor at his cost.

End of section.

Section 03300 - Cast-in-Place Concrete

Part 1 - General

1.1 Scope

This section includes:

- Cast-in-place concrete for concrete barrier
- Concrete mix design.

1.2 Related Sections

- 01010 - Summary of Work
- 01400 - Contractor Quality Control
- 01600 - Material and Equipment
- 02222 - Excavation
- 02722 - Grouting
- 03100 - Concrete Formwork

1.3 References

ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavy Weight, and Mass Concrete
ACI 318.1	Building Code Requirements for Structural Plain Concrete
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143	Standard Specification for Slump of Portland Cement Concrete
ASTM C 150	Standard Specification for Portland Cement
ASTM C 186	Standard Test Method for Heath of Hydration of Hydraulic Cement
ASTM C 403	Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C 618	Fly ash and Raw or Calcined Natural Pozzolan for Use as an Admixture in Portland Cement Concrete

ASTM D 2216	Standard Test Method for Laboratory Determination of Water (moisture) Content of Soil and Rock
USACE CRD-C 36	Method of Test for Thermal Diffusivity of Concrete
USACE CRD-C 48	Standard Test Method for Water Permeability of Concrete
API 10	Cements
NRMCA	Check List for Certification of Ready Mixed Concrete Production Facilities
NRMCA	Concrete Plant Standards

MOC Standards

WIPP-DOE-71	Design Criteria Waste Isolation Pilot Plant, Revised Mission Concept -- IIA (DOE, 1984)
WP 03-1	WIPP Startup and Acceptance Test Program (Westinghouse, 1993b)
WP 09-010	Design Development Testing (Westinghouse, 1991)
WP 09-CN3021	Component Numbering (Westinghouse, 1994a)
WP 09-024	Configuration Management Board/Engineering Change Proposal (**ECP**) (Westinghouse, 1994b)

1.4 Submittals for Review/Approval

The Contractor shall submit the following for approval 30 days prior to initiating any work at the site.

Specific sources of supply and detailed product information for each component of the concrete mix is specified in Section 2.6 below.

Product Data - Laboratory test data and trial mix data for the proposed concrete to be utilized for the concrete barrier.

Proposed method of installation, including equipment and materials in work plan.

1.5 Submittals at Completion

Laboratory test data developed during the installation of the concrete barrier.

1.6 Quality Assurance

Perform work in accordance with the Contractor's Quality Control Plan and referenced ACI and ASTM standards.

Acquire cement, aggregate and component materials from the same source throughout the work.

Part 2 - Products

2.1 Cement

Portland cement shall conform to API 10 Class H oil well cements. The source of the cement to be used shall be indicated and manufacturer's certification that the cement complies to the applicable standard shall be provided with each shipment.

2.2 Aggregates

Aggregates shall be quartz aggregates conforming to the requirements of ASTM C33.

Fine aggregate shall meet the requirements of ASTM C33 having a fineness modules in the range of 2.80 to 3.00.

Coarse aggregate maximum size shall be 1 ½ inches and shall be clean, cubical, angular, 100 percent crushed aggregate without flat or elongated particles.

The source of the aggregate is to be indicated and test reports certifying that the aggregate complies with the applicable standard are to be submitted for approval with the trial mix data.

2.3 Water

Water used in mixing concrete shall be of potable quality, free of injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

Water shall conform to the provisions in ASTM C94, and in addition, shall conform to the following:

- pH not less 6.0 or greater than 8.0
- Carbonates and/or bicarbonates of sodium and potassium: 1000 ppm maximum
- Chloride ions (C1): 250 ppm maximum
- Sulfate ions (SO_4): 1000 ppm maximum
- Iron content: 0.3 ppm maximum
- Total solids: 2000 ppm maximum

When ice is used in concrete mix, the water used for making ice shall meet all of the above requirements.

The source of water is to be indicated and certified copies of test data from an approved laboratory confirming that the water to be used meets the above requirements shall be submitted for approval with the trial mix data.

2.4 Admixtures

Pozzolan shall conform to ASTM C618. Sampling and testing of pozzolans shall conform to ASTM C311. Approximately 5 percent by weight of pozzolan may be used to replace cement in the mixes when approved.

The source of any admixtures proposed are to be indicated and certified copies of test data from an approved laboratory shall be submitted for approval with the trial mix.

2.5 Concrete Mix Properties

The Contractor shall develop and proportion a Salado Mass Concrete mix for use in constructing the concrete barrier. Cement utilized in the mix shall be Class H. The Contractor shall demonstrate by trial mix that the proposed concrete meets the following properties:

Target properties for Barrier Concrete

Property	Comment
4-hr working time	Indicated by 8-inch slump (ASTM C 142) after 3-hr intermittent mixing. Max 10-inch slump at mixing.
Nonsegregating	Aggregates do not readily separated from cement paste during handling
Less than 25°F heat rise prior to placement	Difference between initial condition and temperature after 4 hr.
4,500 psi compressive strength (f'_c)	At 28 days after casting (ASTM C39)
Volume stability	Length change between +0.05 percent and -0.02 percent (ASTM C 490)
Minimal entrained air	2 percent to 3 percent air

The Contractor shall provide certified copies of test data from an approved laboratory demonstrating compliance with the above target properties.

In addition to the target properties the Contractor shall provide certified test data for the trial mix for the following properties:

- Heat of hydration ASTM C-186
- Concrete Set ASTM C-403
- Thermal Diffusivity USACE CRD-C36
- Water Permeability USACE CRD-C43

2.6 Salado Mass Concrete

The Contractor shall utilize the Salado Mass concrete. The Contractor shall demonstrate that the Salado Mass concrete meets the target properties shown above. Recommended initial proportioning of the Salado Mass concrete is as follows:

Component	Percent of Total Mass
Class H Cement	4.93
Chem Comp III	2.85
Class F fly ash	6.82
Fine aggregate	33.58
Coarse aggregate	43.02
Sodium chloride	2.18
Defoaming agent	0.15
Sodium citrate	0.09

~~Water~~	~~6.38~~

~~The Contractor shall prepare a trial mix and provide certified test data from an approved testing laboratory for slump, compressive strength, heat rise, heat of hydration, concrete set time, thermal diffusivity, and water permeability as indicated above for the plain concrete mix.~~

~~Part 3 - Execution~~

~~3.1 General~~

~~The Contractor shall provide all labor material, equipment and tools necessary to develop, supply, mix, transport and place mass concrete in the forms as shown on the drawings and called for in these specifications~~

~~The Contractor will be required to provide and erect on the site a batch plant, suitable to store, handle, weight and deliver the proposed concrete mix. The batch plant shall be certified to NRMCA standards. The batch plant shall be erected on site in the location as directed by the Engineer.~~

~~The Contractor shall batch, mix, and deliver to the underground, sufficient quantity of concrete to complete placement of concrete within one form section, as shown on the drawings. Once begun, placement of concrete in a section shall be continuous until completed. The time for concreting one section will not exceed ten hours.~~

~~It is expected that addition of water to the dry materials and mixing of the concrete will occur at the ground surface with transport of wet concrete to a pump at the underground level where it will be pumped into the forms.~~

~~The Contractor is to provide all transport vehicles or means to transfer the wet concrete from the mixer truck to the pump. It is expected that the Contractor will use the waste conveyance hoist to transfer from the ground surface to the mine level. The Contractor is to familiarize himself with the dimensions of the waste conveyance and the airlock in order to provide suitable transport vehicles. The Contractor is also to familiarize himself with the capacity and speed of the conveyance to allow transfer of sufficient concrete to sustain the continuing placement of concrete. (See Figures G1-2 and G1-3, attached).~~

~~The Contractor shall determine the horizontal distance to the entry where placement of the concrete barrier is to occur, and develop a route, with the approval of the Engineer for traffic flow within the underground.~~

~~Details of the logistics for handling the concrete shall be included in the Contractors' Work Plan, and submitted to the Engineer for approval prior to start of work at the site.~~

~~Potential spill areas in the underground shall be identified by the Contractor in the Work Plan. The Contractor shall provide measures to contain and isolate any water from contact with the halite in these areas. Suitable containment isolation measures shall include but are not limited to, lining with a membrane material (PVC, hypalon, HDPE), draped curtains (polyethylene, PVC, etc.), corrugated sheet metal protective walls or a combination of these and other measures.~~

~~3.2 Pumping Concrete~~

~~The Contractor shall provide pumping equipment suitable for placing the concrete into the forms. The Contractor at a minimum, shall provide an operating and a spare pump, to be used in the event of breakdown of the primary unit. After transporting and prior to pumping the concrete shall be remixed to compensate for segregation of aggregate during transport. The Contractor shall indicate the equipment proposed for pumping (manufacturer, model, type, capacity, pressure and remixing at the point of delivery in the Work Plan).~~

~~Each batch of concrete shall be checked at the surface at the time of mixing and again at the point of transfer to the pump for slump and temperature, and shall conform to the following:~~

- ~~Maximum slump at mixing - 10 inches~~
- ~~Maximum slump at delivery to pump - 8 inches~~
- ~~Maximum mix temperature at placement = 70°F~~

~~Note: No water is to be added to the mix after the initial mixing and slump are determined.~~

~~The Contractor shall connect to the pipe ports fabricated into the forms for delivery of the concrete, beginning with the lowest ports first. Pumping shall continue until concrete is seen in the adjacent port at which time the delivery hose will be transferred to that port and the first port capped.~~

~~Pumping shall continue moving laterally then upward until the entire form is filled and the pour is completed.~~

~~3.3 Coordination of Work~~

~~The Contractor is to coordinate his work mixing, transporting, and placing the mass concrete with the on-going operations in the underground. Coordination of use of the facilities and existing equipment shall be through the Engineer.~~

~~3.4 Clean-Up~~

~~No clean up or washing of equipment with water will be allowed in the underground. No free water spills are permitted in the underground. All clean-out or wash-out requiring water will be performed above ground at the location approved by the Engineer.~~

~~3.5 Quality Control~~

~~The Contractor shall provide a third-party quality control inspector at the site throughout the concrete placement. The inspector shall be responsible for determining that the batch plant is proportioning the mix according to the approved proportions. The batch plant shall provide a print out of batch quantities for each truck delivered to the mine. The inspector shall also determine the slump for each batch as it is mixed and allow additional water to be added until the initial slump is achieved. No additional water is to be added after this time. Temperature will also be recorded at this time.~~

~~The inspector shall also determine the slump and temperature following the remixing when concrete is transferred to the pump. Concrete not meeting or exceeding the specification is to be rejected and removed from the underground.~~

~~Concrete test cylinders to determine unconfined compression strength shall be taken by the inspection at the delivery from remixer to the pump in the underground. Four (4) cylinders shall be made for each 50 cubic yards of concrete placed. Cylinders shall be sealed with polyethylene and taped and field cured at ambient temperatures in the mine adjacent to the concrete barrier area. Two (2) samples shall be tested at 7 days and the remaining two (2) at 28 days.~~

~~End of section.~~

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~~DIVISION 4 - MASONRY~~

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Section 04100 - Mortar

Part 1 - General

1.1 Scope

This section includes:

- Mortar for Isolation Wall Construction.

1.2 Related Sections

- 01010 - Summary of Work
- 01400 - Contractor Quality Control
- 01600 - Material and Equipment
- 04300 - Unit Masonry System

1.3 References

ASTM C91 Standard Specification for Masonry Cement

ASTM C144 Standard Specification for Aggregate for Masonry Mortar

ASTM C150 Standard Specification for Portland Cement

ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes

ASTM C270 Standard Specification for Mortar for Unit Masonry

ASTM C7805 Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry

ASTM C1142 Ready-Mixed Mortar for Unit Masonry

ASTM E447 Test Methods for Compressive Strength of Masonry Prisms

1.4 Submittals for Review and Approval

The Contractor shall submit for approval the following 30 days prior to the initiation of work at the site:

Design mix.

Certified laboratory tests for the proposed design mix, indicating conformance of mortar to property requirements of ASTM C270, and test and evaluation reports to ASTM C780.

1.5 Submittals at Completion

Certified laboratory test results for the construction testing of mortar mix.

1.6 Quality Assurance

Perform work in accordance with the Contractor's Quality Control Plan and referenced ASTM standards. Acquire cement, aggregate, and component materials from the same source throughout the work.

1.7 Delivery Storage Handling

Maintain packaged materials clean, dry and protected against dampness, freezing and foreign matter.

Part 2 - Products

2.1 Mortar Mix

The Contractor shall provide mortar for Isolation Walls, which shall be in conformance with ASTM C270 type M, using the property specification (3,000 psi at 28 days).

Sand for mortar shall conform to ASTM C144.

Water used for mixing mortar shall be of potable quality, free of injurious amounts of oil, acid alkali, organic matter, sediments, or other deleterious substances, as specified for Concrete, Section 03300 2.3.

The supply of materials as defined in the design mix shall remain the same throughout the job.

Part 3 - Execution

3.1 General

The Contractor shall furnish all labor material equipment and tools to perform all operations in connection with supplying and mixing mortar for constructing the isolation walls.

The Contractor shall fully describe his proposed mortar mixing operation, including proposed equipment and materials in the Work Plan.

3.2 Mortar Mixing

Mortar shall be machine-mixed with sufficient water to achieve satisfactory workability. Maintain sand uniformly damp immediately before the mixing process. If water is lost by evaporation, retemper only within one and one half hours of mixing. Use mortar within two hours of mixing at ambient temperature of 85° in the mine.

3.3 Installation

The Contractor shall install mortar to the requirements of Section 04300 Unit Masonry System.

3.4 Field Quality Control

The Contractor shall provide a third party Quality Control Inspector to perform all sampling and testing to confirm that the mortar mix conforms to the proposed mix properties developed in the design mix.

~~Construction testing of mortar mix shall be in accordance with ASTM C780 for compression strength. Four (4) prism specimens shall be taken for each 50 cu. ft. of mortar or fraction thereof placed each day.~~

~~End of Section.~~

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Section 04300 - Unit Masonry System

Part 1 - General

1.1 Scope

This section includes:

- Concrete Masonry Units

1.2 Related Sections

- 01010 Summary of Work
- 01400 Contractor Quality Control
- 01600 Material and Equipment
- 02722 Grouting
- 03100 Concrete Formwork
- 04100 Mortar

1.3 References

ASTM C55 Standard Specification for Concrete Building Brick

ASTM C140 Standard Method of Sampling and Testing Concrete Masonry Units

1.4 Submittals for Revision and Approval

The Contractor shall submit for approval the following 30 days prior to initiation of the work at the site.

Certified laboratory test results for the proposed solid masonry units.

1.5 Quality Assurance

Perform the work in accordance with the Contractor's Quality Control Plan.

Part 2 - Products

2.1 Concrete Masonry Units

Concrete masonry units shall be solid (no cavities or cores), load bearing high-strength units having a minimum compressive strength of 3500 psi. Concrete masonry units shall be tested in accordance with ASTM C140. All other aspects of the concrete masonry units shall comply with ASTM C55, Type I Moisture Controlled.

Nominal modular size shall be 8 x 8 x 16 inches, or as otherwise approved by the Engineer.

Concrete brick shall comply with ASTM C55, Grade N, Type I (moisture controlled) having a minimum compressive strength of 3500 psi (Avg. 3 units) or 3000 psi for individual unit.

~~2.2 Mortar~~

~~Mortar shall be as specified in Section 04100 Mortar.~~

~~Part 3 - Execution~~

~~3.1 General~~

~~The Contractor shall furnish all labor, material, equipment and tools to perform all operations of installing Unit Masonry Isolation Walls to the lines and grades shown on the drawings.~~

~~The Contractor shall examine the excavation of the entry to affirm that the keys have been properly leveled and cut to the appropriate depths, at the proper locations prior to any to any work.~~

~~3.2 Installation~~

~~The Contractor shall install the isolation walls using concrete masonry units as specified above. Masonry units shall be installed with 3/8-inch mortar joints with full mortar bedding and full head joints. Masonry units shall be installed in running bond with headers every third course. Masonry units shall be mortared tight to the ribs and the back wall to provide a seal all around the isolation wall.~~

~~Concrete brick may be used as required for fit-up around grout pipes, or minimizing the dimensional fit-up at the top or sides of the isolation walls as approved by the Engineer. The interface between the top of the isolation wall and the back wall shall be completely mortared to provide full contact between the back and the block wall.~~

~~3.3 Field Quality Control~~

~~The Contractor shall provide a third-party Quality Control Inspector to inspect the installation of the Concrete Masonry Unit Isolation Walls. Inspection and testing of the mortar shall be in accordance with Section 04100 Mortar.~~

~~End of Section~~

~~FIGURES~~

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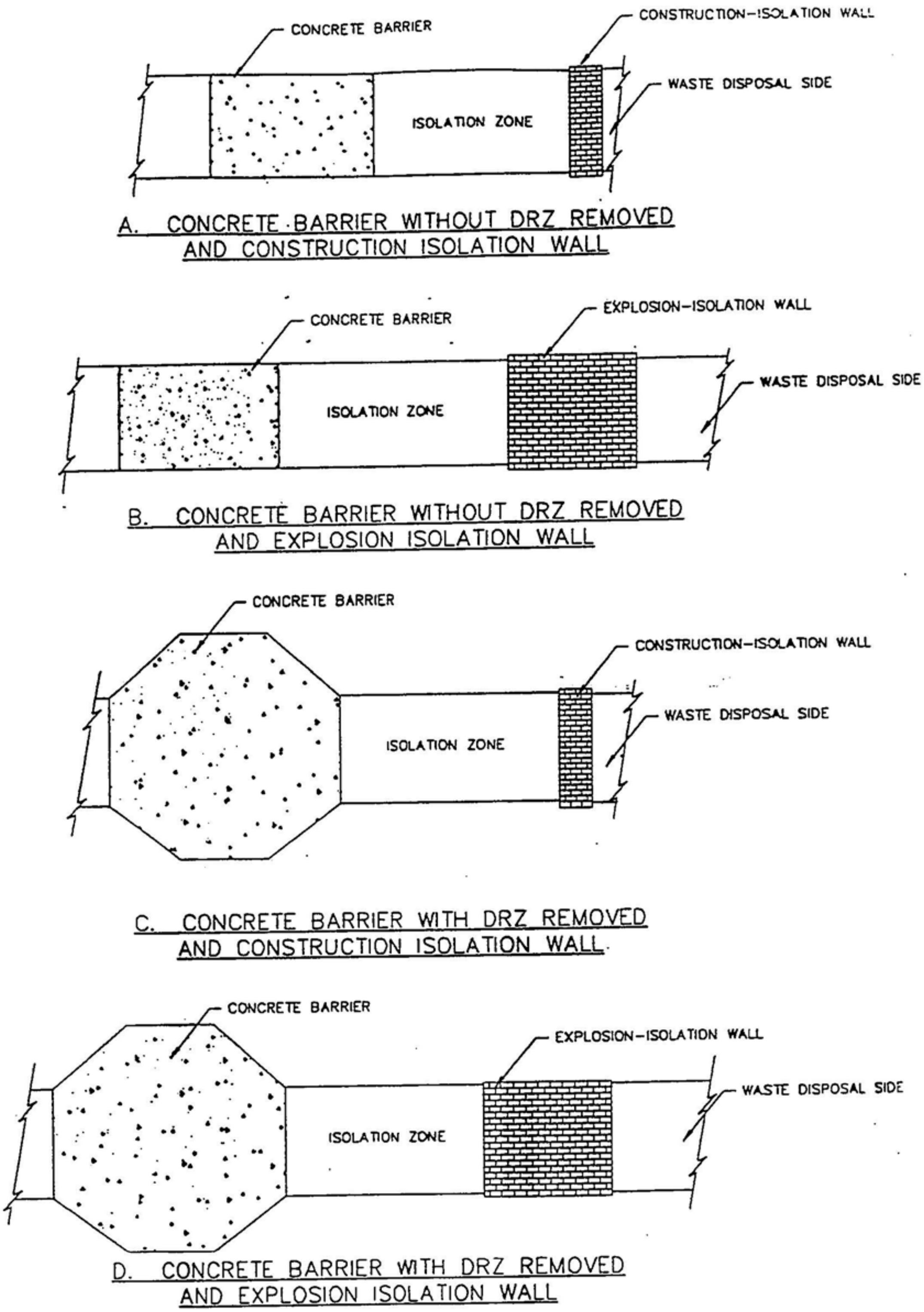
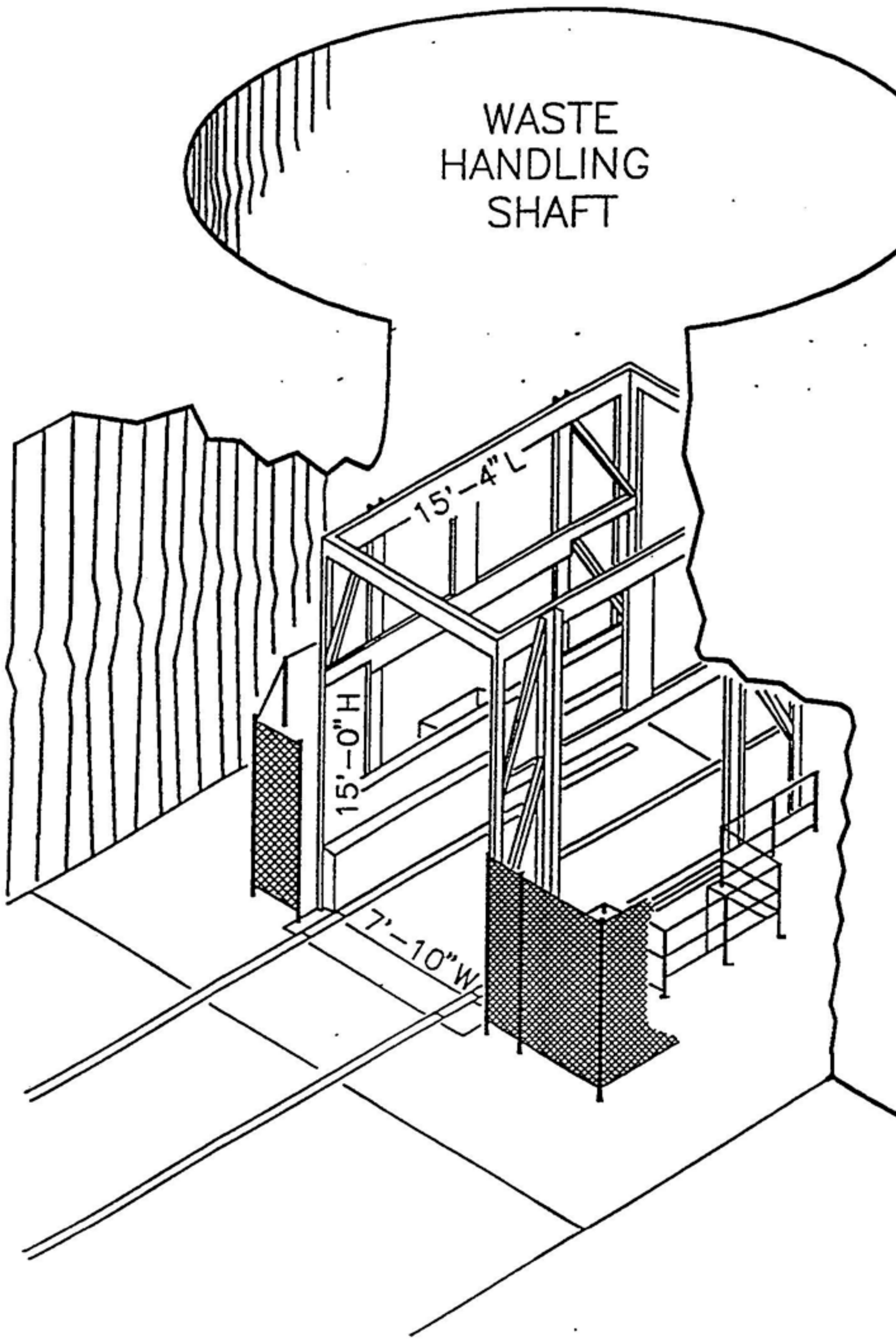
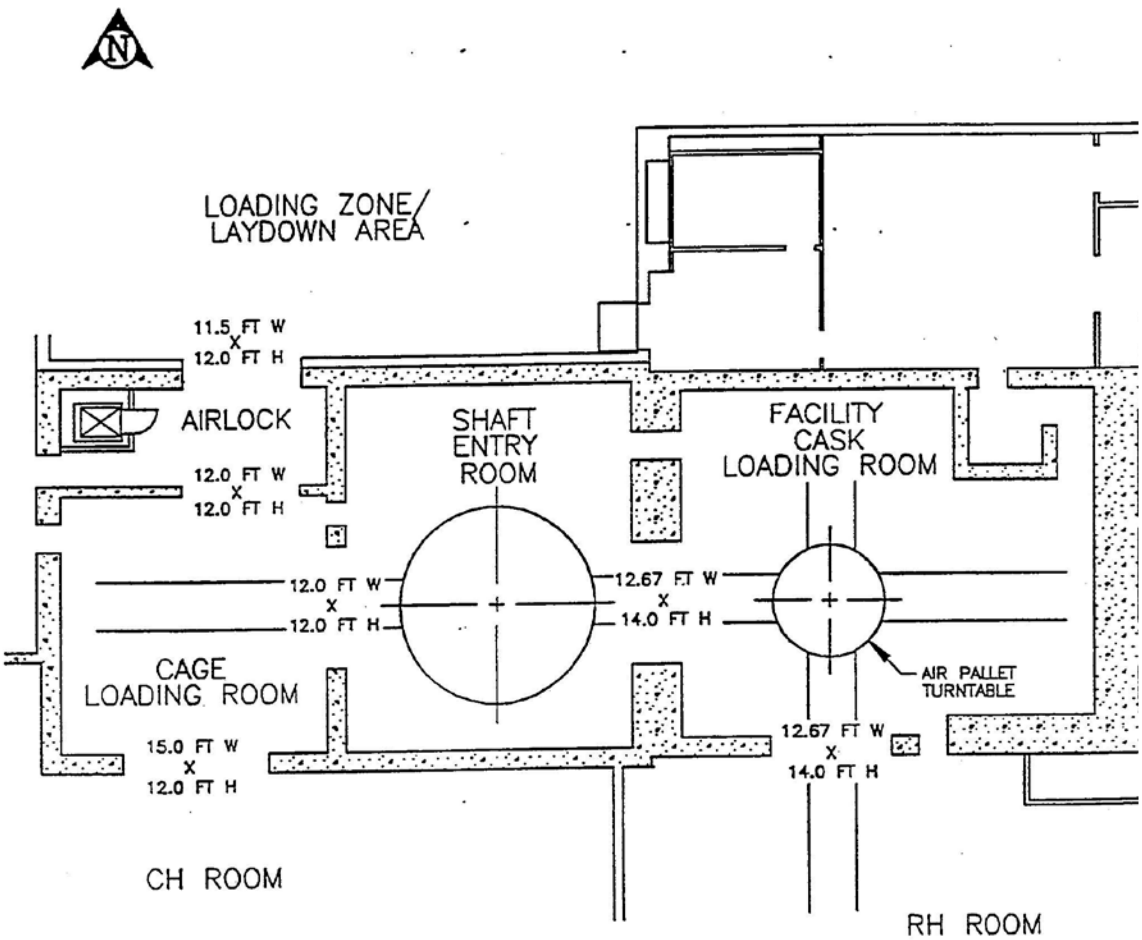


~~Figure G1G-1~~
~~Plan Variations~~



~~Figure G1G-2~~
~~Waste Handling Shaft Cage Dimensions~~



~~Figure G1G-3~~
~~Waste Shaft Collar and Airlock Arrangement~~

~~ATTACHMENT G1~~
~~APPENDIX H~~

~~DESIGN DRAWINGS~~

~~PANEL CLOSURE SYSTEM~~
~~WASTE ISOLATION PILOT PLANT~~
~~CARLSBAD, NEW MEXICO~~

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~~ATTACHMENT G1~~
~~APPENDIX H~~

~~DESIGN DRAWINGS~~

~~PANEL CLOSURE SYSTEM~~
~~WASTE ISOLATION PILOT PLANT~~
~~CARLSBAD, NEW MEXICO~~

~~**Drawing**~~	~~**Title**~~
~~762447-E1~~	~~Panel closure system, air intake and exhaust drifts, title sheet~~
~~762447-E2~~	~~Panel closure system, underground waste-emplacement panel plan~~
~~762447-E3~~	~~Panel closure system, air intake drift, construction details~~
~~762447-E4~~	~~Panel closure system, air exhaust drift, construction details~~
~~762447-E5~~	~~Panel closure system, construction and explosion walls, construction details~~
~~762447-E6~~	~~Panel closure system, air intake and exhaust drifts, grouting and miscellaneous details~~

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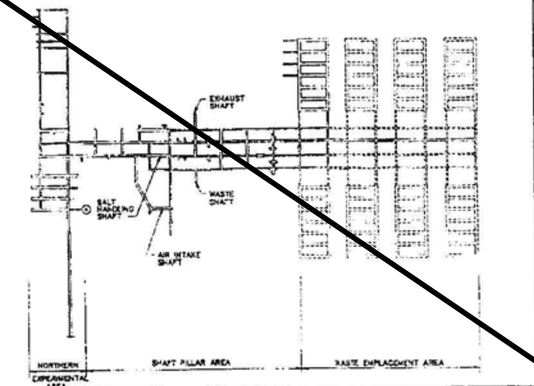
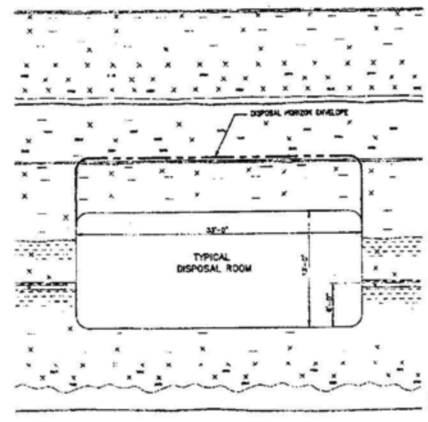


UNDERGROUND REPOSITORY LAYOUT PLAN
NTS

762447–E1	TITLE SHEET
762447–E2	UNDERGROUND WASTE DISPOSAL PANEL–PLAN
762447–E3	PANEL CLOSURE SYSTEM–AIR INTAKE DRIFT–CONSTRUCTION DETAILS
762447–E4	PANEL CLOSURE SYSTEM–AIR EXHAUST DRIFT–CONSTRUCTION DETAILS
762447–E5	PANEL CLOSURE SYSTEM–CONSTRUCTION AND EXPLOSION WALLS–CONSTRUCTION DETAILS
762447–E6	PANEL CLOSURE SYSTEM–AIR ENTRANCE AND EXHAUST DRIFT GROUTING AND MISCELLANEOUS DETAILS



DETAILED STRATIGRAPHY AT THE REPOSITORY HORIZC
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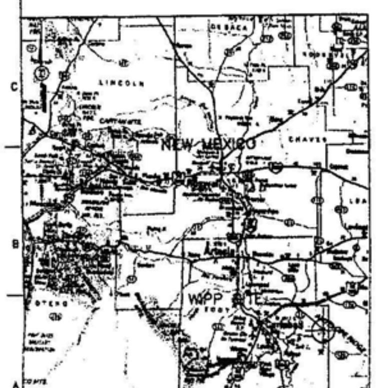
DRAWN BY | STRT 09-08-95
CHECKED BY
APPROVED BY

WASTE ISOLATION PILOT PLANT
PANEL CLOSURE SYSTEM
CARLSBAD, NEW MEXICO

prepared by

IT CORPORATION
ALBUQUERQUE, NEW MEXICO



GENERAL LOCATION MAP
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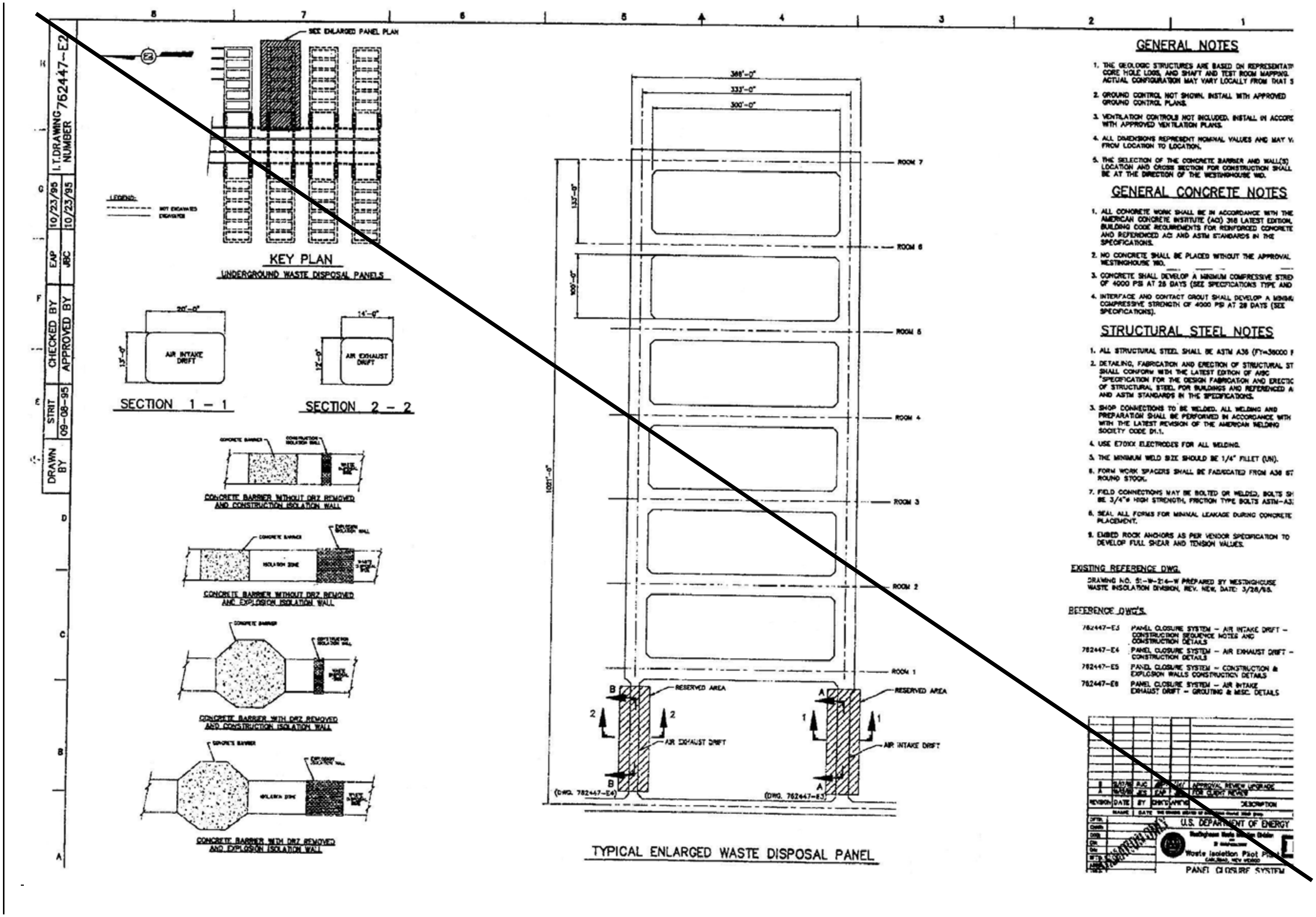
GENERAL NOTES
GENERAL CONCRETE NOTES
STRUCTURAL STEEL NOTES
KEY PLAN
UNDERGROUND WASTE DISPOSAL PANELS
SECTION 1 - 1
SECTION 2 - 2
AIR INTAKE DRIFT
AIR EXHAUST DRIFT
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CONCRETE BARRIER WITHOUT DRZ REMOVED AND EXPLOSION ISOLATION WALL
CONCRETE BARRIER WITH DRZ REMOVED AND CONSTRUCTION ISOLATION WALL
CONCRETE BARRIER WITH DRZ REMOVED AND EXPLOSION ISOLATION WALL
TYPICAL ENLARGED WASTE DISPOSAL PANEL
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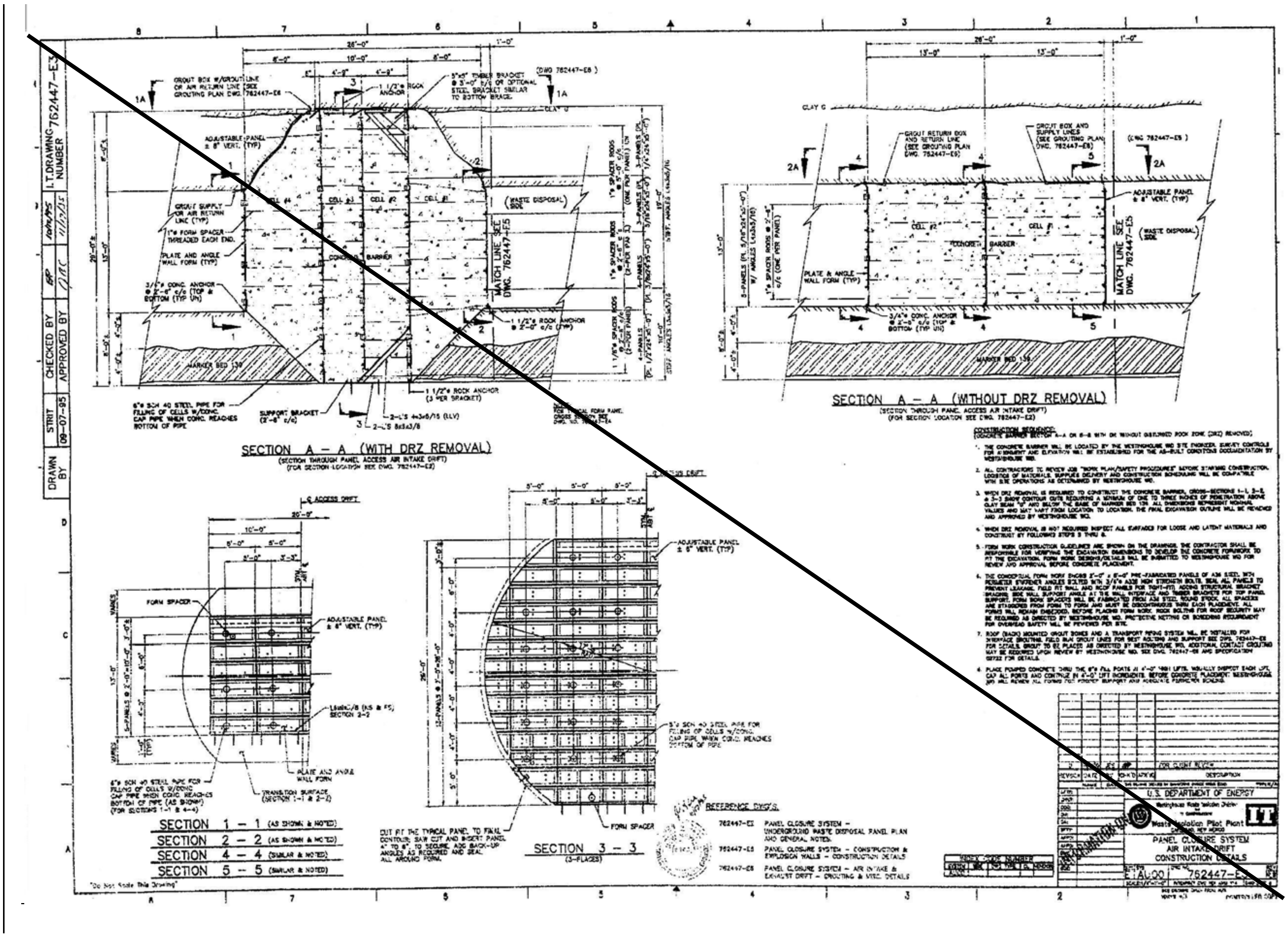
ROOM 6
ROOM 5
ROOM 4
ROOM 3
ROOM 2
ROOM 1
RESERVED AREA
AIR EXHAUST DRIFT
AIR INTAKE DRIFT
EXISTING REFERENCE DWG.
REFERENCE DWG'S.
U.S. DEPARTMENT OF ENERGY
Waste Isolation Pilot Plant
PANEL CLOSURE SYSTEM
I.T. DRAWING NUMBER 762447-E2
DRAWN BY
CHECKED BY
APPROVED BY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SECTION A – A (WITHOUT DRZ REMOVAL)
SECTION 1 – 1
SECTION 2 – 2
SECTION 3 – 3
SECTION 4 – 4
SECTION 5 – 5
MARKER BED 139
CONSTRUCTION SEQUENCE:
REFERENCE DWG'S
U.S. DEPARTMENT OF ENERGY
Waste Isolation Pilot Plant
PANEL CLOSURE SYSTEM
AIR INTAKE DRIFT
CONSTRUCTION DETAILS
762447-E3
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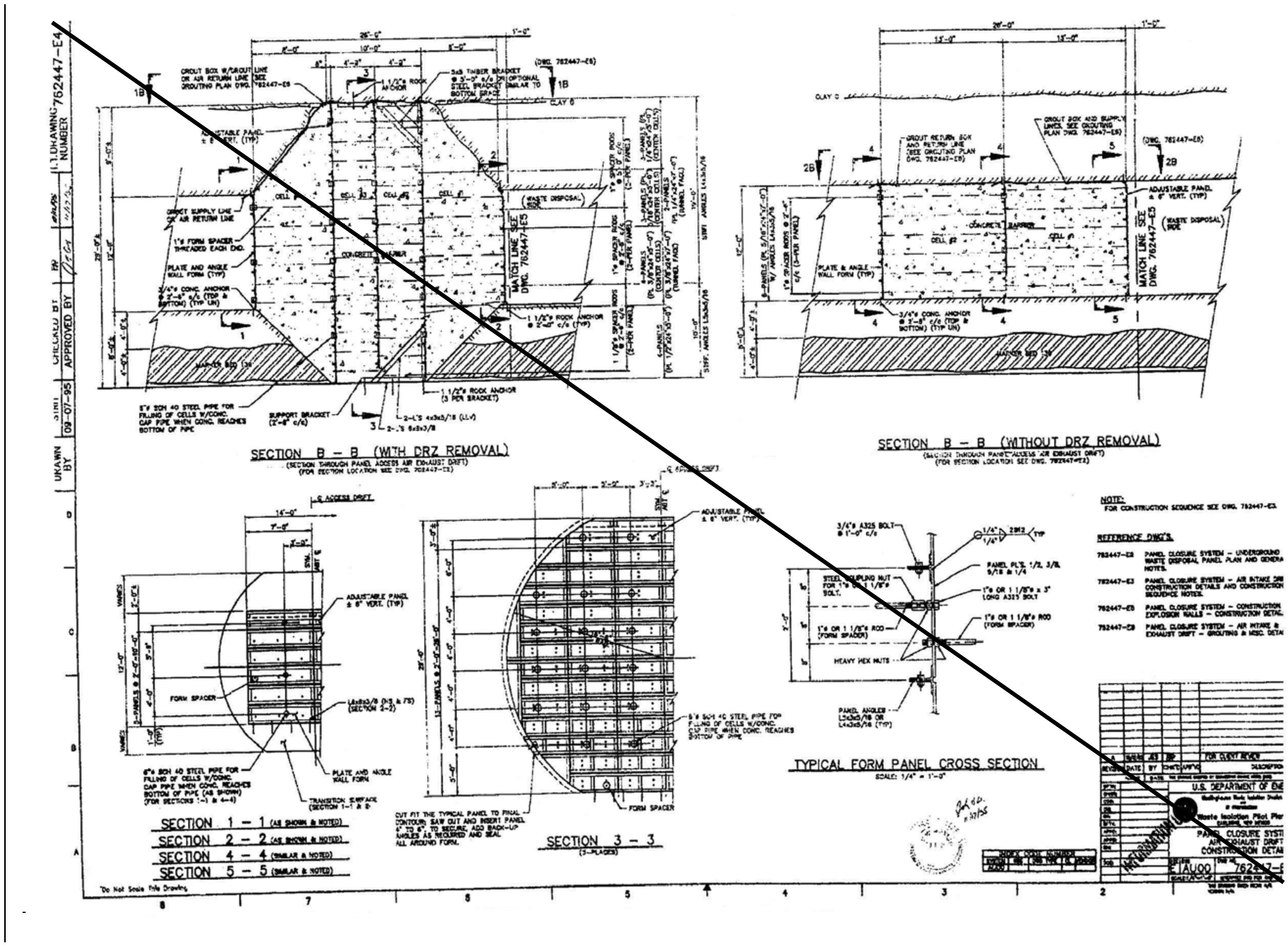
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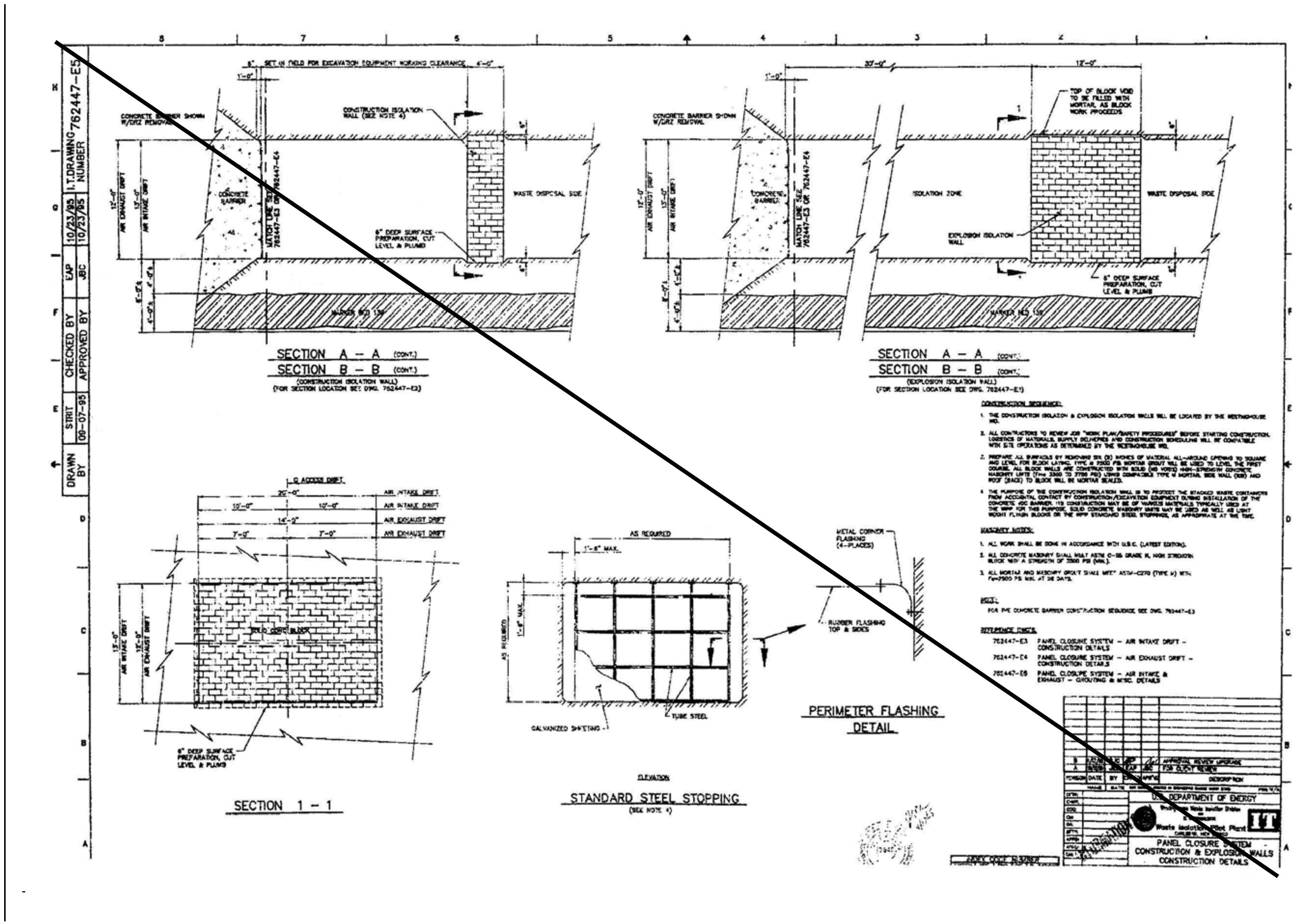
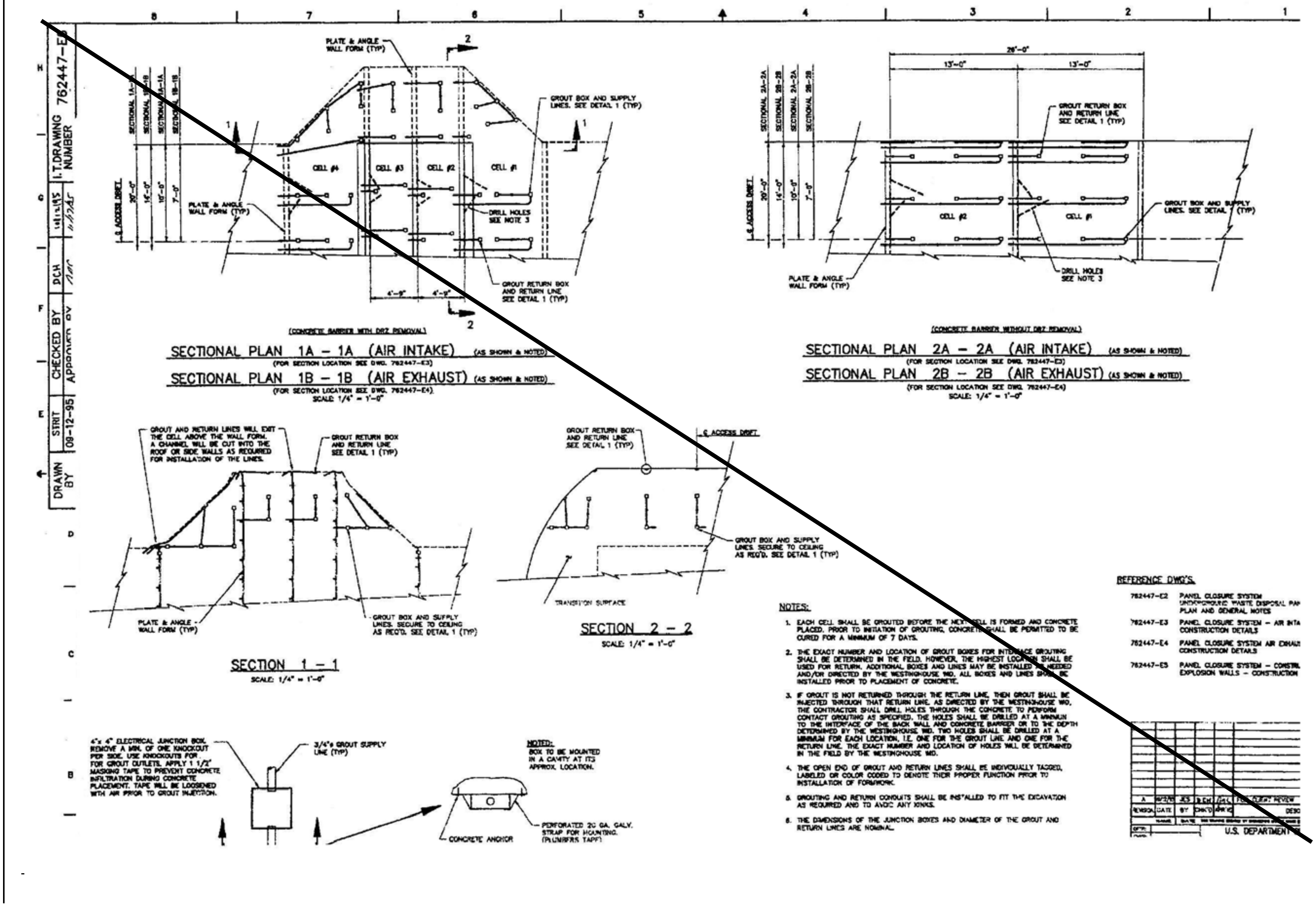
SECTION B – B (WITHOUT DRZ REMOVAL)
TYPICAL FORM PANEL CROSS SECTION
SECTION 1 – 1
SECTION 2 – 2
SECTION 4 – 4
SECTION 5 – 5
SECTION 3 – 3
U.S. DEPARTMENT OF ENERGY
PANEL CLOSURE SYSTEM


SECTION A – A (CONT.)
SECTION B – B (CONT.)
(CONSTRUCTION ISOLATION WALL)
(EXPLOSION ISOLATION WALL)
SECTION 1 – 1
STANDARD STEEL STOPPING
PERIMETER FLASHING DETAIL
U.S. DEPARTMENT OF ENERGY
Waste Isolation Pilot Plant
PANEL CLOSURE SYSTEM
CONSTRUCTION & EXPLOSION WALLS
CONSTRUCTION DETAILS
I.T. DRAWING NUMBER 762447-E5



SECTIONAL PLAN 1A – 1A (AIR INTAKE) (AS SHOWN & NOTED)
SECTIONAL PLAN 1B – 1B (AIR EXHAUST) (AS SHOWN & NOTED)
SECTIONAL PLAN 2A – 2A (AIR INTAKE) (AS SHOWN & NOTED)
SECTIONAL PLAN 2B – 2B (AIR EXHAUST) (AS SHOWN & NOTED)
SECTION 1 – 1
SECTION 2 – 2
SCALE: 1/4" = 1'-0"
CELL #1
CELL #2
CELL #3
CELL #4
PLATE & ANGLE WALL FORM (TYP)
GROUT BOX AND SUPPLY LINES. SEE DETAIL 1 (TYP)
GROUT RETURN BOX AND RETURN LINE SEE DETAIL 1 (TYP)
DRILL HOLES SEE NOTE 3
NOTES:
1. EACH CELL SHALL BE GROUTED BEFORE THE NEXT CELL IS FORMED AND CONCRETE PLACED. PRIOR TO INITIATION OF GROUTING, CONCRETE SHALL BE PERMITTED TO BE CURED FOR A MINIMUM OF 7 DAYS.
2. THE EXACT NUMBER AND LOCATION OF GROUT BOXES FOR INTERFACE GROUTING SHALL BE DETERMINED IN THE FIELD. HOWEVER, THE HIGHEST LOCATION SHALL BE USED FOR RETURN. ADDITIONAL BOXES AND LINES MAY BE INSTALLED AS NEEDED AND/OR DIRECTED BY THE WESTINGHOUSE WID. ALL BOXES AND LINES SHALL BE INSTALLED PRIOR TO PLACEMENT OF CONCRETE.
3. IF GROUT IS NOT RETURNED THROUGH THE RETURN LINE, THEN GROUT SHALL BE INJECTED THROUGH THAT RETURN LINE AS DIRECTED BY THE WESTINGHOUSE WID. THE CONTRACTOR SHALL DRILL HOLES THROUGH THE CONCRETE TO PERFORM CONTACT GROUTING AS SPECIFIED. THE HOLES SHALL BE DRILLED AT A MINIMUM TO THE INTERFACE OF THE BACK WALL AND CONCRETE BARRIER OR TO THE DEPTH DETERMINED BY THE WESTINGHOUSE WID. TWO HOLES SHALL BE DRILLED AT A MINIMUM FOR EACH LOCATION, I.E. ONE FOR THE GROUT LINE AND ONE FOR THE RETURN LINE. THE EXACT NUMBER AND LOCATION OF HOLES WILL BE DETERMINED IN THE FIELD BY THE WESTINGHOUSE WID.
4. THE OPEN END OF GROUT AND RETURN LINES SHALL BE INDIVIDUALLY TAGGED, LABELED OR COLOR CODED TO DENOTE THEIR PROPER FUNCTION PRIOR TO INSTALLATION OF FORMWORK.
5. GROUTING AND RETURN CONDUITS SHALL BE INSTALLED TO FIT THE EXCAVATION AS REQUIRED AND TO AVOID ANY KINKS.
6. THE DIMENSIONS OF THE JUNCTION BOXES AND DIAMETER OF THE GROUT AND RETURN LINES ARE NOMINAL.
REFERENCE DWG'S.
762447-E2 PANEL CLOSURE SYSTEM
762447-E3 PANEL CLOSURE SYSTEM – AIR INTAKE CONSTRUCTION DETAILS
762447-E4 PANEL CLOSURE SYSTEM AIR EXHAUST CONSTRUCTION DETAILS
762447-E5 PANEL CLOSURE SYSTEM – CONSTR. EXPLOSION WALLS – CONSTRUCTION
I.T. DRAWING NUMBER 762447-E5
DRAWN BY STRIT 09-12-95
CHECKED BY DCH
U.S. DEPARTMENT

H-1 Post-Closure Plan

This post-closure plan focuses on activities following final facility closure. However, some discussion of post-closure following panel closure is warranted since some panel closures will occur long before final facility closure. As discussed in Attachment G (Closure Plan), Section G-1e(1), panel closures have been designed to require no post-closure maintenance of the disposal unit. The Permittees have defined a post-closure care program for closed panels that has three aspects. These are routine inspection of the openings in the vicinity of the closures, the sampling of ventilation air for harmful constituents, and a Repository Volatile Organic Compound Monitoring Program. The rules of the Mine Safety Health Administration drive the implementation of the first two programs. These rules require that underground mines monitor air quality to assure good breathing air whenever personnel are underground and that mine operators provide safe ground conditions for personnel in areas that require access. Routine monitoring of the openings in the access ways to panels will be continued and these openings will be maintained for as long as access into them is needed. This includes continued reading of installed geomechanical instrumentation, sounding the areas, visual inspection and maintenance activities such as scaling, mining, or bolting as required and as described in Permit Attachment A2. In addition, all areas in the underground that are occupied by personnel are checked prior to each day's work activities for accumulations of harmful gases, including methane. Action levels for increasing ventilation to areas that show high levels of harmful gases are specified as described in Permit Attachment D.

ATTACHMENT N

VOLATILE ORGANIC COMPOUND MONITORING PLAN

TABLE OF CONTENTS

N-3a(3) Sampling Locations for Ongoing Disposal Room VOC Monitoring ~~in Panels 3 through 8~~

The Permittees shall continue VOC monitoring in Room 1 of ~~Panels 3 through 8 after completion of waste emplacement~~a filled panel until final panel closure unless an explosion-isolation wall is installed in the panel.

~~ATTACHMENT N1~~

~~HYDROGEN AND METHANE MONITORING PLAN~~

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ATTACHMENT N1

HYDROGEN AND METHANE MONITORING PLAN

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LIST OF FIGURES

~~ATTACHMENT N1~~

~~VOLATILE ORGANIC COMPOUND MONITORING PLAN~~

~~N1-1 Introduction~~

~~This Permit Attachment describes the monitoring plan for hydrogen and methane generated in Underground Hazardous Waste Disposal Units (**HWDUs**) 3 through 8, also referred to as Panels 3 through 8.~~

~~Monitoring for hydrogen and methane in Panels 3 through 8 until final panel closure, unless an explosion-isolation wall is installed, may be an effective way to gather data to establish realistic gas generation rates. This plan includes the monitoring design, a description of sampling and analysis procedures, quality assurance (**QA**) objectives, and reporting activities.~~

~~N1-2 Parameters to be Analyzed and Monitoring Design~~

~~The Permittees will monitor for hydrogen and methane in filled Panels 3 through 8 until final panel closure, unless an explosion-isolation wall is installed. A "filled panel" is an Underground HWDU that will no longer receive waste for emplacement.~~

~~Monitoring of a filled panel will commence after installation of the following items in each filled panel:~~

- ~~substantial barriers~~
- ~~bulkheads~~
- ~~five additional monitoring locations.~~

~~The substantial barriers serve to protect the waste from events such as ground movement or vehicle impacts. The substantial barrier will be constructed from available non-flammable materials such as mined salt (Figure N1-1).~~

~~The bulkheads (Figure N1-2) serves to block ventilation at the intake and exhaust of the filled panel and prevent personnel access. The bulkhead is constructed as a typical WIPP bulkhead with no access doors or panels. The bulkhead will consist of a steel member frame covered with galvanized sheet metal, and will not allow personnel access. Rubber conveyor belt will be used as a gasket to attach the steel frame to the salt, thereby providing an effective yet flexible blockage to ventilation air. Over time, it is possible that the bulkhead may be damaged by creep closure around it. If the damage is such as to indicate a possible loss of functionality, then the bulkhead will be repaired or an additional bulkhead will be constructed outside of the original one.~~

~~The existing VOC monitoring lines as specified in Attachment N, Section N-3a(2), "Sampling Locations for Disposal Room VOC Monitoring", will be used for sample collection in each disposal room for Panels 3 and 4. The sample lines and their construction are shown in Figure N1-3. In addition to the existing VOC monitoring lines, five more sampling locations will be used to monitor for hydrogen and methane. These additional locations include:~~

- ~~the intake of room 1~~
- ~~the waste side of the exhaust bulkhead,~~
- ~~the accessible side of the exhaust bulkhead,~~

- the waste side of the intake bulkhead,
- the accessible side of the intake bulkhead.

These additional sampling locations (Figure N1-4) will use a single inlet sampling point placed near the back (roof) of the panel access drifts. This will maximize the sampling efficiency for these lighter compounds.

N1-3 Sampling Frequency

Sampling frequency will vary depending upon the levels of hydrogen and methane that are detected.

- If monitored concentrations are at or below Action Level 1 as specified in Permit Part 4, Table 4.6.5.3, monitoring will be conducted monthly.

- If monitored concentrations exceed Action Level 1 as specified in Permit Part 4, Table 4.6.5.3, monitoring will be conducted weekly in the affected filled panel.

N1-4 Sampling

Samples for hydrogen and methane will be collected using subatmospheric pressure grab sampling as described in Environmental Protection Agency (**EPA**) Compendium Method TO-15 (EPA, 1999). The TO-15 sampling method uses passivated stainless-steel sample canisters to collect integrated air samples at each sample location. Flow rates and sampling duration may be modified as necessary to meet data quality objectives.

Sample lines shall be purged prior to sample collection.

N1-5 Sampling Equipment

N1-5a SUMMA® Canisters

Stainless-steel canisters with passivated or equivalent interior surfaces will be used to collect and store gas samples for hydrogen and methane analyses collected as part of the monitoring processes. These canisters will be cleaned and certified prior to their use in a manner similar to that described by Compendium Method TO-15 (EPA, 1999). The vacuum of certified clean canisters will be verified upon initiation of a sample cycle. Sampling will be conducted using subatmospheric pressure grab sampling techniques as described in TO-15.

N1-5b Sample Tubing

Treated stainless steel tubing shall be used as a sample path and treatment shall prevent the inner walls from absorbing contaminants.

Any loss of the ability to purge a sample line will be evaluated. The criteria used for evaluation are shown in Figure N1-5.

The Permittees will first suspect that a line is not useable when it is purged prior to sampling. If the line cannot be purged, then it will not be used for sampling unless the line is a bulkhead line that can be easily replaced. Replacement of bulkhead lines will occur before the next scheduled sample. Non-bulkhead lines will be evaluated by first determining if adjacent sampling lines are

~~working. If the answer is no, then the previous sample from the failed line will be examined. If the previous sample was between the first and second action levels, then the explosion-isolation wall will be installed since without the ability to monitor it is unknown whether the area is approaching the second action level or decreasing. If the previous sample was below the first action level then continued sampling is acceptable without the lost sample.~~

~~If an adjacent line is working, the prior concentrations measured in that line will be evaluated to determine if it is statistically similar to the prior measurements from the lost line. If the prior sampling results are statistically similar, the lines can be grouped. Statistical similarity will be determined using the Student's "t" test to evaluate differences.~~

~~The magnitude of *t* will be compared to the critical *t* value from SW-846, Table 9-2 (EPA, 1996), for this statistical test.~~

~~If the lost line can be grouped with an adjacent line, no further action is necessary because the unmonitored area is considered to be represented by the adjacent areas. If the lost sample line cannot be grouped with an adjacent line, the previous concentration measurement will be compared to the Action Levels. If the concentration is below Action Level 1, monitoring will continue. If the concentration is between Action Level 1 and Action Level 2, the explosion-isolation wall will be installed in the panel.~~

~~N1-6 Sample Management~~

~~Sample containers shall be sealed and uniquely marked at the time of collection of the sample. A Request-for-Analysis Form shall be completed to identify the sample canister number(s), sample type, and type of analysis requested.~~

~~N1-7 Analytical Procedures~~

~~The samples will be analyzed using gas chromatography equipped with the appropriate detector under an established QA/quality control (**QC**) program. Analysis of samples shall be performed by a laboratory that the Permittees select and approve through established QA processes.~~

~~N1-8 Data Evaluation and Notifications~~

~~Analytical data from sampling events will be evaluated to determine whether the sample concentrations of flammable gases exceed the Action Levels.~~

~~If any Action Level is exceeded, notification will be made to NMED and the notification posted to the WIPP web page and accessed through the email notification system within seven calendar days of obtaining validated analytical data.~~

~~If any sampling line loss occurs, notification will be made to NMED and the notification posted to the WIPP web page and accessed through the email notification system within seven calendar days of learning of a sampling line loss. After the evaluation of the impact of sampling line loss as shown in Figure N1-5, notification will be made to NMED and the notification posted to the WIPP web page and accessed through the email notification system within seven calendar days of completing the sampling line loss evaluation.~~

N1-9 References

U.S. Environmental Protection Agency (EPA), 1996. SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. 3rd Edition. Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1999. *Compendium Method TO-15: Determination of Volatile Organic Compounds (VOCs) In Air Collected in Specially Prepared Canisters and Analyzed by Gas Chromatography/Mas Spectrometry*, EPA 625/R-96/010b. Center for Environmental Research Information, Office of Research and Development, Cincinnati, OH, January 1999.

~~FIGURES~~

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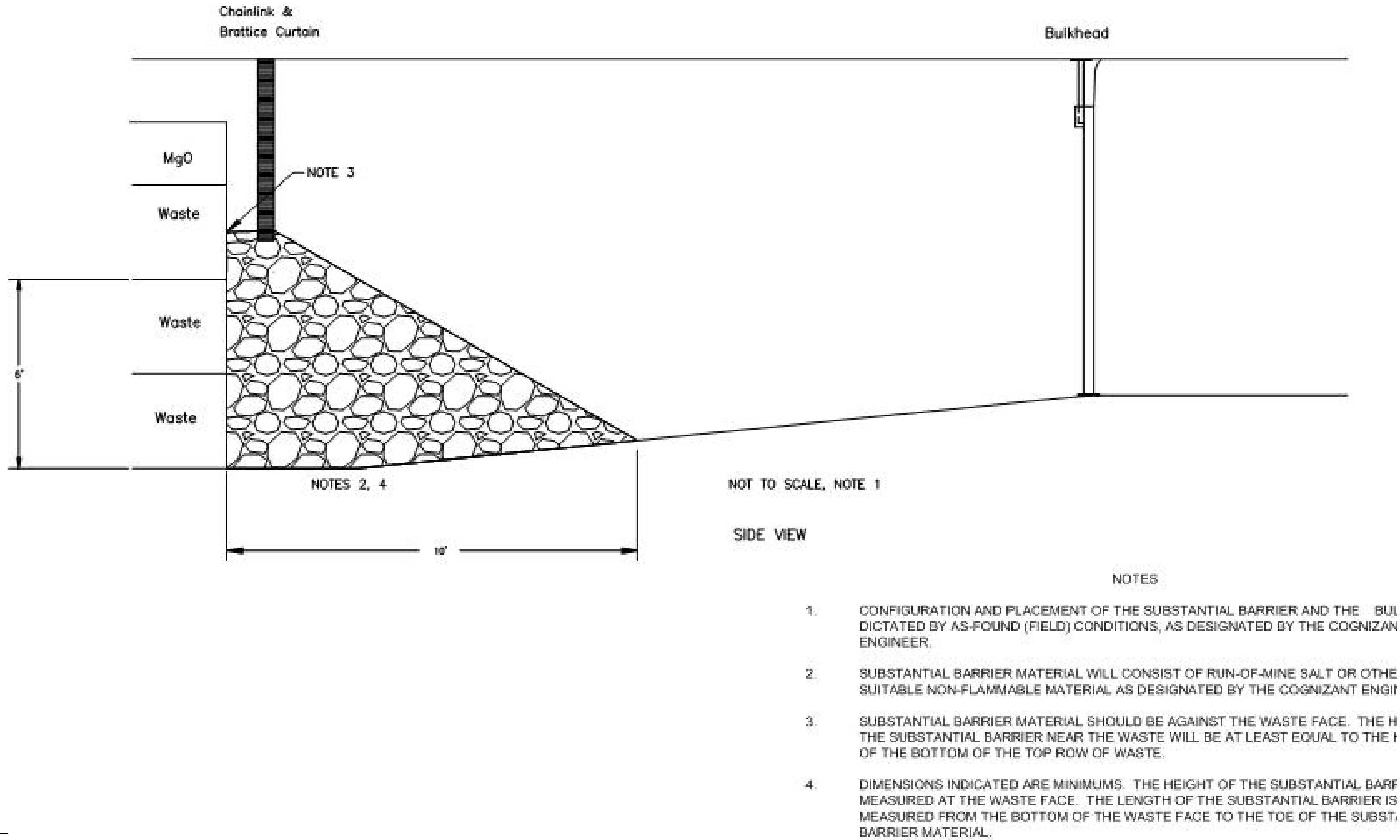
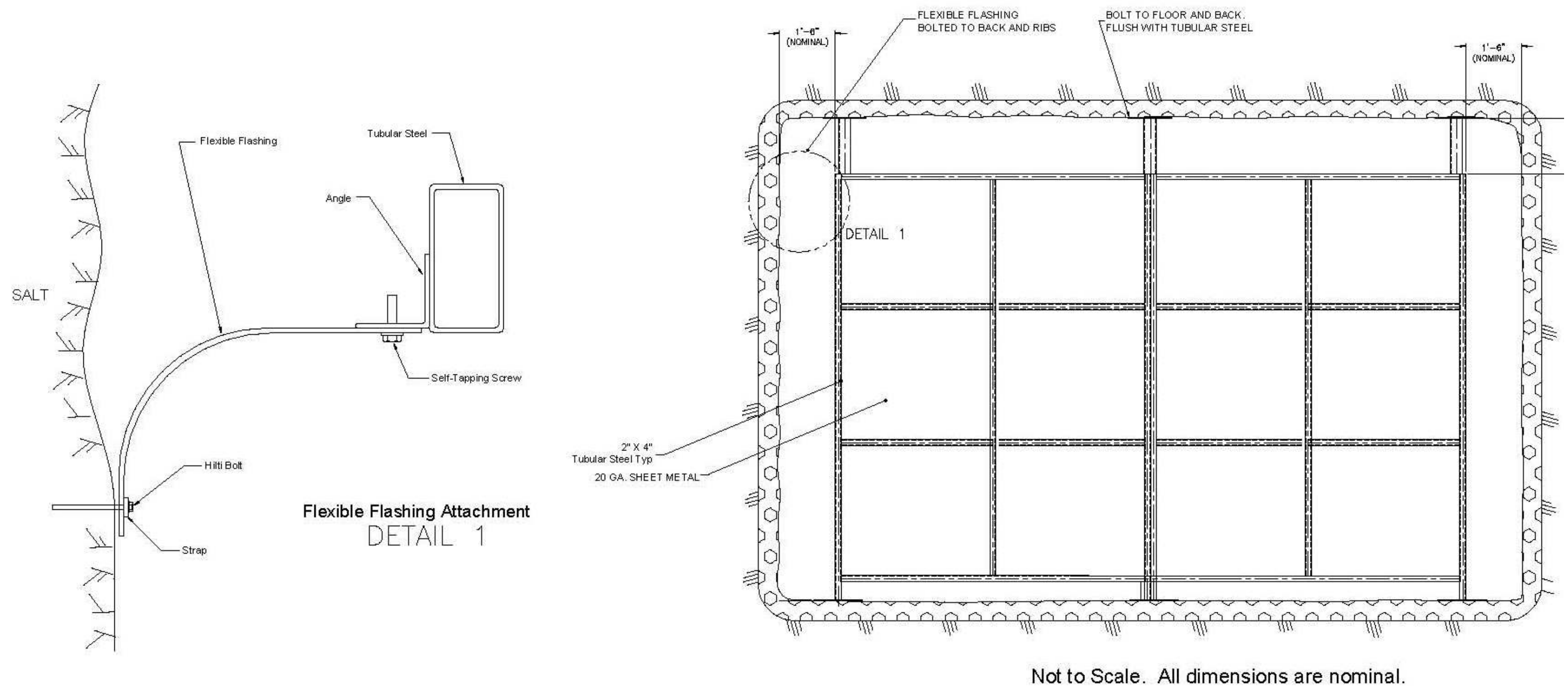
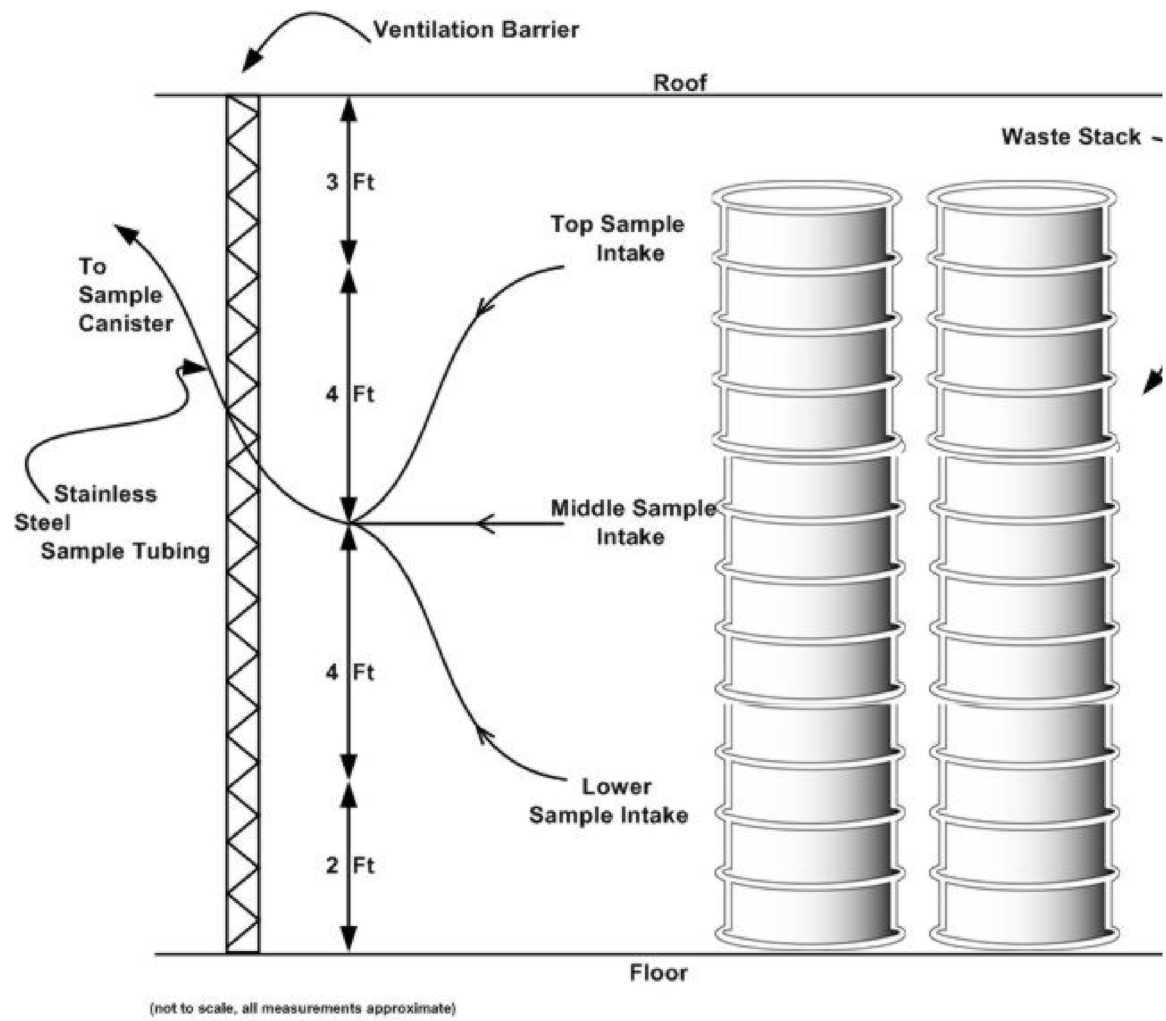


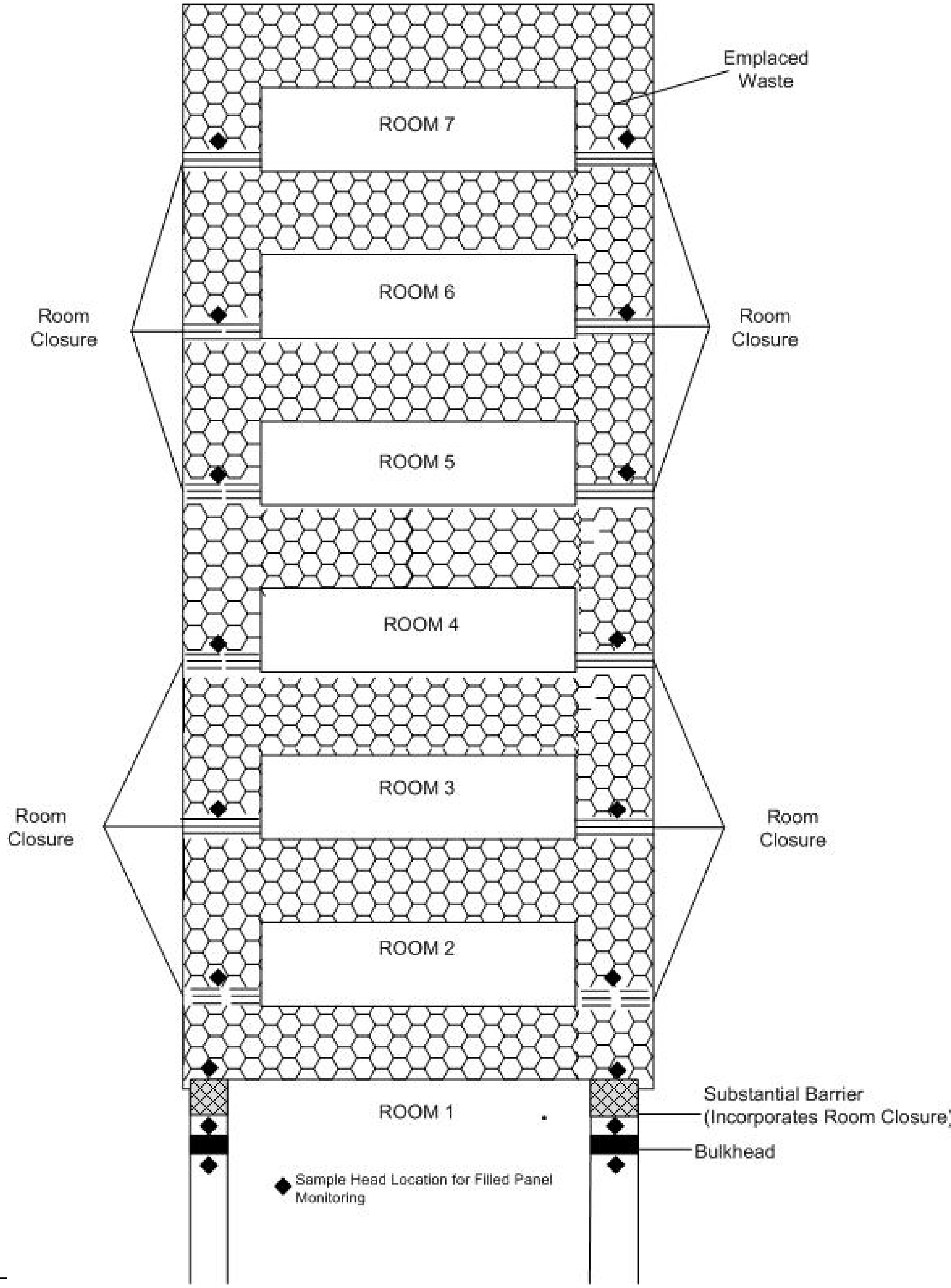
~~**Figure N1-1**~~
~~**Typical Substantial Barrier and Bulkhead**~~



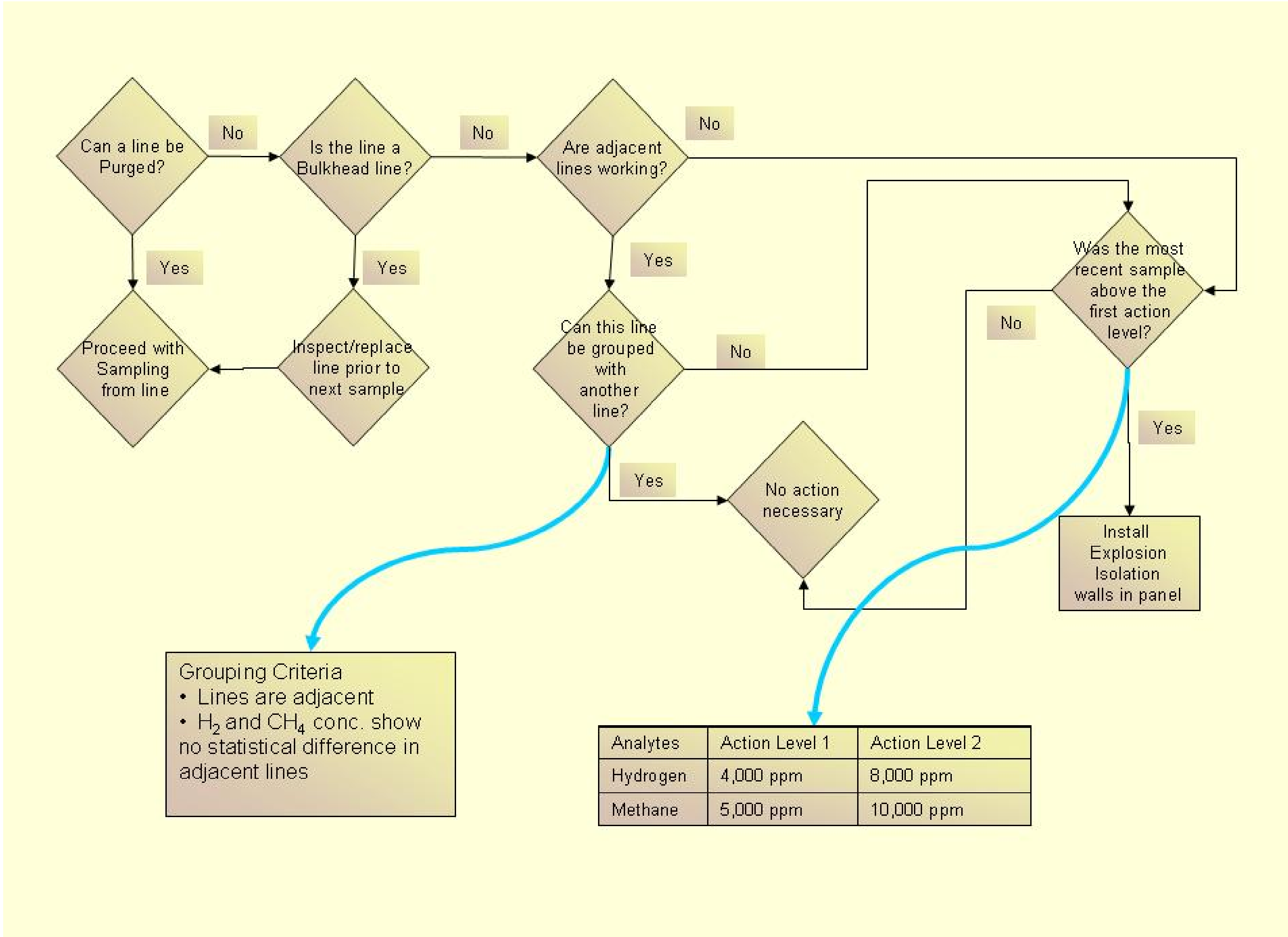
~~Figure N1-2~~
~~Typical Bulkhead~~



~~**Figure N1-3**~~
~~**Typical Hydrogen and Methane Monitoring System**~~



~~Figure N1-4~~
~~Typical Hydrogen and Methane Sampling Locations~~



Analytes	Action Level 1	Action Level 2
Hydrogen	4,000 ppm	8,000 ppm
Methane	5,000 ppm	10,000 ppm

~~**Figure N1-5**~~
~~**Logic Diagram for Evaluating Sample Line Loss**~~

Appendix C
Design Report for a Waste Panel Closure System at the Waste Isolation Pilot Plant

DESIGN REPORT FOR A
PANEL CLOSURE SYSTEM
AT THE WASTE ISOLATION PILOT PLANT

October 2012

Prepared for

Nuclear Waste Partnership LLC
P.O. Box 2078
Carlsbad, New Mexico 88221

Prepared by

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Certification

I certify that this document was prepared under my supervision for Nuclear Waste Partnership LLC, under WP13-1 Nuclear Waste Partnership LLC Quality Assurance Program Description. Based on my inquiry of the persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete.

ORIGINAL SIGNED BY:

Saeid Saeb, Ph.D., P.E.
New Mexico
Certification No. 11777
Expires December 31, 2013

John B. Case, P.E.
New Mexico
Certification No. 8049
Expires December 31, 2013

11/27/12

Executive Summary

Scope. This report describes the design and evaluation of a Waste Isolation Pilot Plant (WIPP) Panel Closure (WPC) system consisting of run-of-mine (ROM) salt and steel bulkheads.

Purpose. The purpose of the WPC is to comply with the closure performance standard in Permit Attachment G, Section G-1a pursuant to 20.4.1.500 NMAC (incorporating 40 CFR 264 Subpart X).

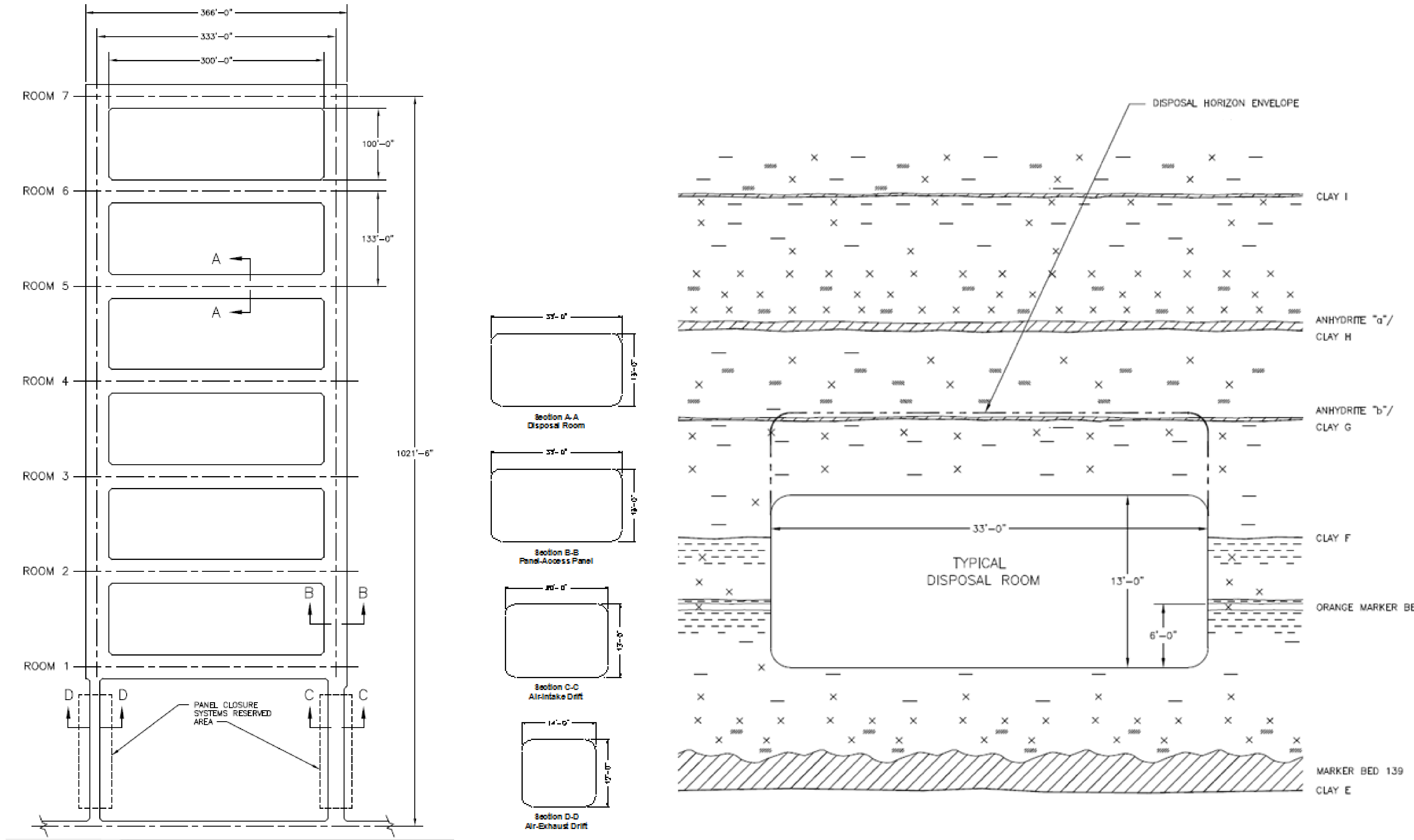
The WPC will be located in the panel air-intake and panel air-exhaust drifts of each waste-filled panel as shown in Figure ES-1. Two steel bulkheads will be placed at the ends of the ROM salt. This report also presents an alternate design for filled Panels 1, 2 and 5 where explosion isolation walls have been installed. The alternate design consists of one steel bulkhead and a block wall placed at the ends of the ROM salt.

Volatile Organic Compounds (VOCs) flow analyses through the WPC and then from the repository show that VOC concentrations will not exceed VOC Health Based Levels (HBLs) at the WIPP site boundary. In addition, the WPC will comply with the applicable requirements of the Mine Safety and Health Administration (MSHA). Finally the WPC will use common construction practices according to existing standards to the extent practicable.

Background. In 1996, a report entitled "Detailed Design Report for an Operational Phase Panel-Closure System" was prepared. This design was submitted as part of the original Hazardous Waste Facility Permit (Permit) application to the New Mexico Environment Department (NMED). The NMED subsequently selected portions of the report and included them in the issued permit.

Section 4.6.2 of the current Permit establishes limits and actions for VOCs of concern. The VOCs of concern in the Permit include carbon tetrachloride (CCl_4), chlorobenzene, chloroform, 1,1-dichloroethene, 1,2-dichloroethane, methylene chloride, 1,1,2,2-tetrachloroethane, toluene and 1,1,1-trichloroethane. Additional VOCs that contribute lesser risks are considered in this report. New VOCs and HBLs for the VOCs have been identified for the WIPP site boundary and are used in the report (Kehrman, 2012, Table 11).

Revised performance requirements are presented in this report. The WPC is evaluated against these revised performance requirements.



The figure shows the plan view of a waste panel (left), vertical cross sections (middle), and a stratigraphic cross section at the repository horizon (right). The disposal horizon may be selected within the envelope shown based on geomechanical, operational and safety considerations (Westinghouse, 1995).

Figure ES-1 Typical Panel Layout with Drift Cross Sections

Design. The WPC consists of two steel bulkheads and ROM salt. An alternate WPC for Panels 1, 2, and 5 consists of one steel bulkhead, ROM salt and one block wall. The construction methods and materials used in the design represent available technologies from previous mining projects (Fernandez et al., 1994, pp. 5-11 to 5-20) and as demonstrated by recent insitu testing of ROM salt (Zimmerly and Zavicar, 2012). No special requirements are identified for these components during the operational period of the repository. The fabrication, installation and maintenance of ventilation bulkheads are standard practice. Salt can be pushed reasonably tight to the underground surfaces of the drifts. A variety of techniques are available for placing the salt. These construction methods are simple and allow flexibility in construction scheduling and construction materials transportation.

Evaluation of WPC Performance. The evaluation of the WPC presented in this report included a review of current information on repository ventilation, VOC source terms and expected concentrations of VOCs in the mine exhaust air stream. Based upon a review of this information, a design performance specification was developed to emplace salt over a minimum length of 100 ft.

The ROM salt may be emplaced in a series of layers. The emplacement density is expressed in terms of fractional density which is represented as a percentage of the intact density (135 lbf/ft^3 [2,160 kg/m^3]). The ROM salt is emplaced at an assumed fractional density of 65% (88 lbf/ft^3 [1,400 kg/m^3]).

Steel bulkheads with flexible flashing to accommodate salt creep are used in the WPC design. Farnsworth (2011) indicated that smaller drifts with bulkheads near the Exhaust Shaft in the WIPP underground have resistances as high as 2,200 Practical Units [2,200 (milli-in wg)/$kcfm^2$]. The smaller drifts with bulkheads near the Exhaust Shaft are the closest in size to the Panel intake and exhaust drifts.

Structural analyses of the ROM salt in a single zone were performed using a FLAC3D computer code. FLAC3D is used by the WIPP site for geotechnical analyses and was used for the previous WPC design analyses. The FLAC3D analyses showed that an air gap between panel entry ceilings and the top of the run-of mine salt forms and increases over a period of several years. The air gap forms because initially the rate of settlement of the ROM salt exceeds the rate of panel-entry creep closure. Two years after WPC installation, the air gap starts to close. The air gap reaches a maximum value of 19 inches (47 cm). After approximately 23 years, the air gap is eliminated. Also, the fractional density of ROM salt increases with time. These calculations are input into the VOCs Flow Model.

VOCs Flow Model. The VOC flow analyses evaluate the flow of VOCs of concern through the WPC. The VOCs Flow Model considers VOCs emissions from open rooms (Kehrman, 2012, Table 12) up until the time that air gaps close within individual WPCs. When air gaps are present, air flow resistance is predominately due to steel bulkhead resistances for individual panels. After approximately 23 years, the air gap closes and the air flow resistance is predominately due to the consolidated ROM salt. VOCs flow equals the product of the air flow rate and the average headspace concentration for individual panels at this time. The VOCs flow model is based upon inventory average headspace concentrations (Kehrman, 2012, Table 1). The analysis compares the predicted results to measured results. The model is then used to evaluate future VOCs emissions considering ventilation air flow effects, other source terms for air flow (panel creep closure and gas generation) and average headspace concentrations of individual VOCs. Air flow due to ventilation through the air gap and ROM salt zone of the WPC is evaluated considering the air conductivity of ROM salt and the surrounding disturbed rock zone (DRZ), and the air flow resistance of steel bulkheads. The air conductivity values for all components are discussed in Section 3.

The results show a reduction in the air gap and air conductivity with time from panel intake drift and exhaust drift creep closure that isolates the waste from the underground ventilation air stream starting approximately 2 years after WPC installation with complete air gap closure after 23 years. The results indicate that for a period of about 23 years after WPC installation (28 years after panel excavation), the air flow induced from ventilation effects is dominant and that after this period of time, gas generation and panel creep closure would become dominant.

The analysis accounts for the reduction of VOC concentrations at the Exhaust Shaft of the WIPP due to underground repository ventilation, and then due to atmospheric dispersion to the WIPP site boundary (Kehrman, 2012, Table 6). The analyses consider only this receptor boundary, and do not provide calculations at other intermediate surface and underground receptor points.

The analysis uses HBLs that have been identified by the WIPP Project (Kehrman, 2012, Table 11). The projected concentrations from the VOC flow model are compared to the HBLs at the site boundary through calculation of risk fractions. These evaluations include the case for peak emissions from the WIPP repository.

The predicted mass flow rates for VOCs through the WPC (including flow through the air gap; the ROM salt; DRZ and the steel bulkheads) from ventilation, panel creep closure and gas generation are estimated to result in concentrations that are below the HBLs (Kehrman, 2012, Table 11) for the receptor point at the WIPP site boundary. Concentrations at other surface and underground receptor locations were not analyzed as part of this scope of work.

While no specific requirements exist for closing disposal areas under MSHA regulations, the intent of the regulations is to safely isolate abandoned areas from active workings using barricades of substantial construction.

This report presents the WPC system description with supporting calculations (Appendices A to B), Specifications (Appendix C), and Engineering Drawings (Appendix D) that comply with the design requirements for the WPC. Structural and air flow analyses are used to select the design features and are based upon data acquired from the WIPP underground. The Drawings illustrate the construction and details for the WPC. The Specifications cover the general requirements of the system, quality assurance and quality control, site work, and ROM salt emplaced in the panel entries. The WPC can be built to generally accepted national design and construction standards.

The design complies with the revised design requirements established for the WPC. The design can be constructed in the underground environment with no special requirements at the WIPP facility.

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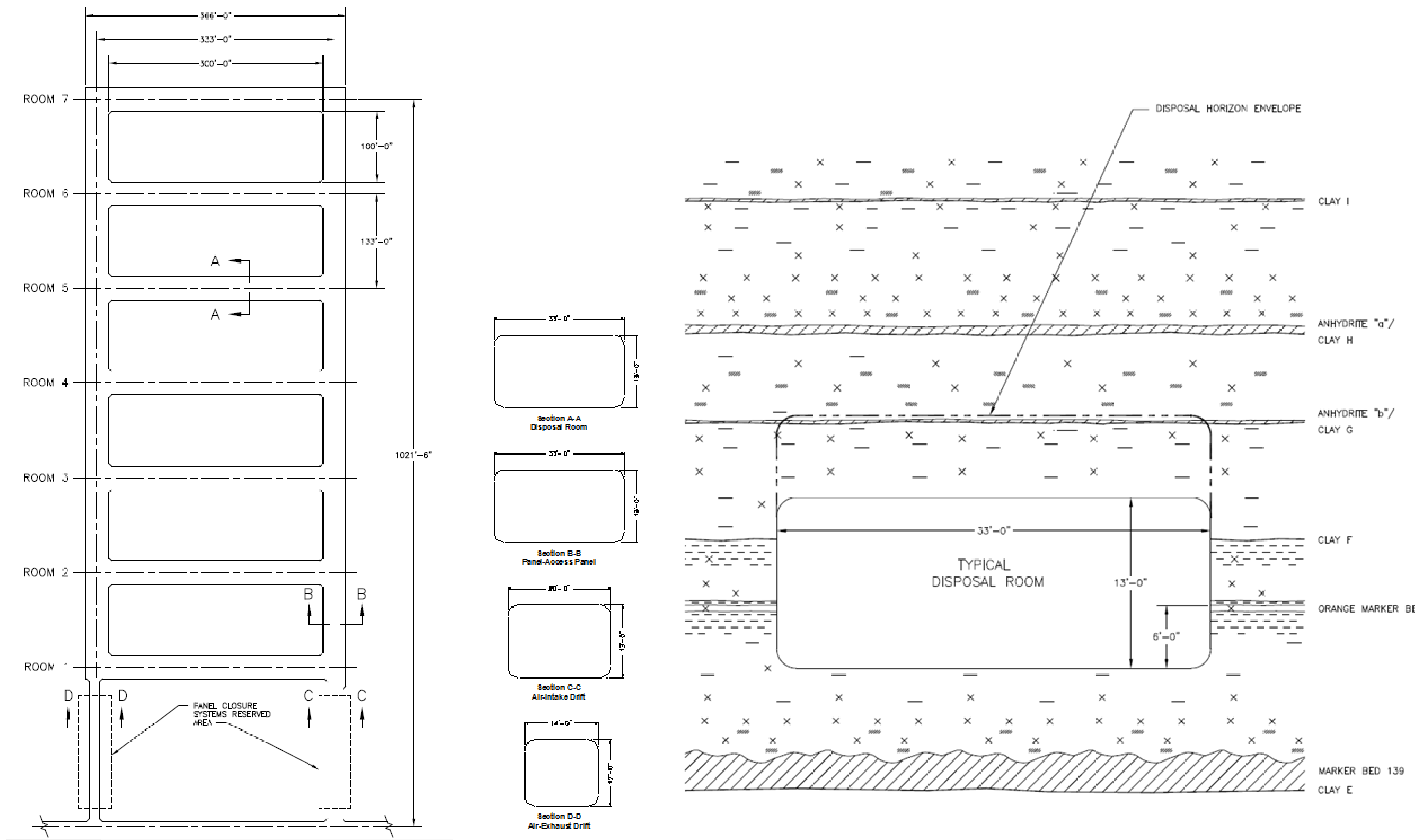
1.0 Introduction

The Waste Isolation Pilot Plant (**WIPP**) facility is a U.S. Department of Energy (**DOE**) facility located near Carlsbad, New Mexico, established for the safe disposal of defense-generated transuranic (**TRU**) waste. The WIPP repository is 2,150 feet (ft) (655 meters [m]) below the surface, in the Salado Formation.

One important aspect of repository operations at the WIPP facility is the activity associated with closure of waste disposal panels. Each panel consists of a panel air-intake drift, a panel air-exhaust drift, and seven rooms (Figure 1-1). After completion of waste disposal activities in a panel, it must be closed. The closure of individual panels during the operational period is conducted in compliance with the WIPP Hazardous Waste Facility Permit (**Permit**).

In 1996, a report entitled "Detailed Design Report for an Operational Phase Panel-Closure System" (DOE, 1996) was prepared. That design was submitted as part of the original Permit application to the New Mexico Environment Department (**NMED**). The NMED subsequently selected portions of the 1996 report and included them in the Permit.

This report builds on data collection and presents a design consisting of a run-of-mine (**ROM**) salt and steel bulkheads as are currently used in the WIPP repository. ROM salt is defined as a porous salt in the loose state derived from underground mining operations.



The figure shows the plan view of a waste panel (left), vertical cross sections (middle), and a stratigraphic cross section at the repository horizon (right). The disposal horizon may be selected within the envelope shown based on geomechanical, operational and safety considerations (Westinghouse, 1995).

Figure 1-1 Typical Panel Layout with Drift Cross Sections

1.1 Scope

This report describes the design of the WIPP Panel Closure (**WPC**), presents WPC analyses relating to structural response and VOCs flow, and provides an evaluation of the WPC against revised design requirements presented in Chapter 2. The WPC consists of ROM salt and steel bulkheads for 10 panels. The WPC relies on air flow resistance of ventilation bulkheads to control VOCs emissions at the WIPP site receptor boundary for 23 years following each individual panel closure installation. The work scope does not include other intermediate receptor points.

The design complies with the revised design requirements established for the WPC. The proposed design is of substantial construction and complies with applicable requirements promulgated by the U. S. Department of Labor, Mine Safety and Health Administration (**MSHA**).

1.2 Regulatory Requirements

The following subsections discuss the regulatory requirements specified in the Resource Conservation and Recovery Act (**RCRA**) and MSHA that apply to closure.

1.2.1 Resource Conservation and Recovery Act (40 CFR 264 and 270)

The Closure Plan in the WIPP Permit (NMED, 2012) was prepared in accordance with the requirements of 20.4.1.500 New Mexico Administrative Code (incorporating Title 40, Code of Federal Regulations [CFR], Part 264, Subparts G, I and X). The WPC design incorporates measures to mitigate VOC migration for compliance with environmental performance standards.

1.2.2 Mine Safety and Health Administration

Under 30 CFR 57 (MSHA, 2012), "seals and stoppings" must be constructed of noncombustible materials appropriate for the specific mine category and must be of "substantial construction." "Substantial construction" implies construction of such strength, material and workmanship that the barrier could withstand conditions expected in the mining environment. As discussed subsequently in this report, the WPC complies with relevant requirements.

1.3 Report Organization

This report presents the engineering analysis of the WPC in each panel entry consisting of two steel bulkheads and ROM salt emplaced to a minimum length of 100 feet. Chapter 2 presents the Permit Design Requirements and a description of the final design in terms of WPC design components. Chapter 3 presents the design evaluations addressing the structural adequacy and the VOC flow of the WPC. Chapter 4 presents a list of the technical specifications for the design. Chapter 5 presents a list of the design drawings. Chapter 6 presents conclusions. Chapter 7 presents supporting references.

2.0 Design Descriptions

This chapter presents the WPC evaluated in this report, including its design requirements and design components.

2.1 Permit Design Requirements

Original design requirements were presented in Table 7-1 of DOE, 1996, and were accepted in the Permit. Since then, the Permittees have collected gas emission and mined opening performance data that has greatly increased the understanding of current and future conditions in the repository. This increased understanding has led to a reassessment of the design requirements for a panel closure system. The WPC was evaluated against the following revised design requirements:

- The panel closure system shall contribute to meeting the environmental performance standards in Permit Part 4 Section 4.6.2 by mitigating the migration of VOCs from closed panels.
- The panel closure system shall consider potential flow of VOCs through the disturbed rock zone (**DRZ**) in addition to flow through closure components.
- The panel closure system shall perform its intended functions under loads generated by creep closure of the tunnels.
- The nominal operational life of the closure system is 35 years.
- The panel closure system may require minimal maintenance per 20.4.1.500 NMAC (incorporating 40 CFR 264.111).
- The panel closure system shall address the expected ground conditions in the waste disposal areas.
- The panel closure system shall be built of substantial construction and non-combustible material except for flexible flashing used to accommodate salt movement.

- The design and construction shall follow conventional mining practices.
- Structural analysis shall use data acquired from the WIPP underground.
- Materials shall be compatible with their emplacement environment and function.
- Treatment of surfaces in the closure areas shall be considered in the design.
- A Quality Assurance/Quality Control (**QA/QC**) program shall verify material properties and construction.
- Construction of the panel closure system shall consider shaft and underground access and services for materials handling.

Chapter 6 presents the expected compliance of the WPC with these requirements and identifies the sections of this report where each requirement is addressed.

Figure 2-1 and Figure 2-2 illustrate the design that is evaluated in this report. Figure 2-1 applies to drifts without existing block walls. Figure 2-2 shows the configuration for drifts with existing block walls.

Conventional mining practices will be used in construction of the WPC. After completion of waste emplacement operations in future active panels, in-by steel bulkheads will be installed in the intake and exhaust panel entries as illustrated in Figure 2-1. Work packages prepared for the fabrication and installation of bulkheads will list the materials used, the equipment used, special precautions and limitations. Each work package will address prerequisites for installing the WPC and the required performance and documentation of such performance.

The ROM salt can be emplaced using conventional mining equipment in such a manner as to maintain a slope of 2 horizontal to 1 vertical at the ends. The ROM salt can be emplaced as is from the mining operations at an assumed fractional density of 65% (Zimmerly and Zavicar, 2012). After salt emplacement, the outer steel bulkhead is installed.

Three panels have block walls[1] installed and an alternate design is presented for these panels. The installation of the WPC in these panels shall follow preapproved work packages as outlined previously. In these cases (Figure 2-2), the ROM salt is emplaced up to the block wall. After salt emplacement, the outer steel bulkhead is installed.

2.2 Design Components

The following subsection presents system and component design features. Appendices C and D present specifications and drawings for the WPC, respectively. Individual specifications address shaft and underground access and materials handling, construction quality control, treatment of surfaces in the closure areas, and applicable design and construction standards.

2.2.1 Steel Bulkhead

The steel bulkhead (Figure 2-3) serves to block ventilation at the intake and exhaust of the panel and prevents personnel access. This use of a bulkhead is a standard practice and will be constructed as a typical WIPP bulkhead with no access (NMED, 2012, Figure N1-2). The bulkhead will consist of a noncombustible steel member frame covered with sheet metal. Telescoping tubular steel is used to bolt the bulkhead to the floor and roof. Flexible flashing material such as a rubber conveyor belt (or other appropriate material) will be attached to the steel frame and the salt as a gasket, thereby providing an effective yet flexible blockage to ventilation air. The steel bulkheads need maintenance for air flow resistance and the accommodation of panel entry salt creep during a 23-year period following each individual panel closure installation. The out-by bulkhead will be repaired, renovated or replaced as required. The WPC relies upon bulkheads for approximately 23 years to control VOCs flow. During this period steel bulkheads may need to be maintained or replaced and the surrounding Disturbed Rock Zone (DRZ) may need to be treated or removed to provide air flow resistance as intended.

[1] The block wall was originally designed to resist underground methane deflagration due to a hypothetical buildup of methane gas after panel closure.

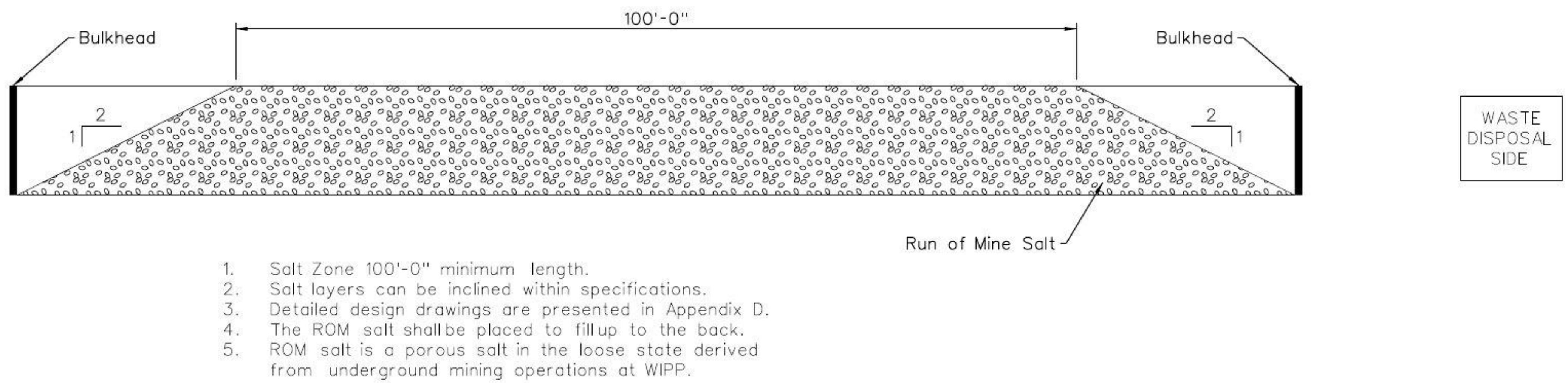


Figure 2-1 Typical WPC for Drifts without Block Walls

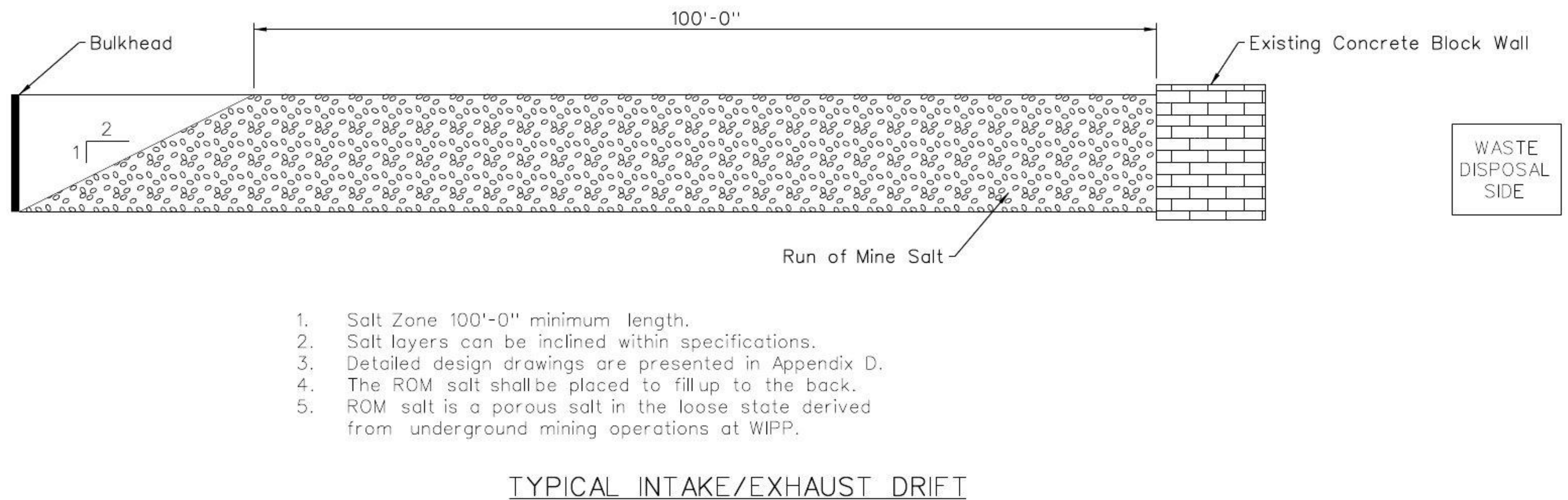


Figure 2-2 Typical WPC for Drifts with Existing Block Walls

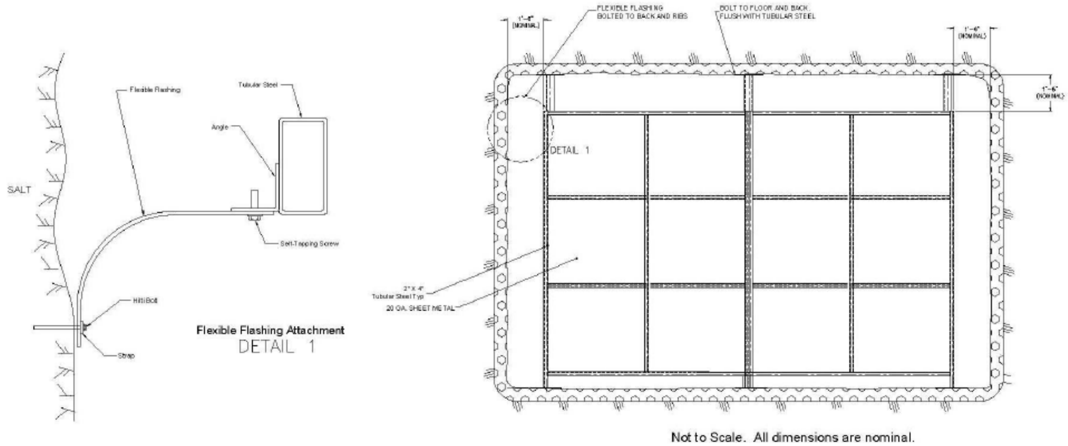


Figure 2-3 Typical Bulkhead for the WPC

2.2.2 ROM Salt

ROM salt material from mining operations is as delivered by haul truck or LHD units to the panel closure area in a loose state. As such, it is a noncombustible natural material that is completely compatible with the repository environment. The ROM salt is emplaced over a minimum length of 100 feet. The ROM salt at the ends would be emplaced at a slope of approximately 2 horizontal 1 vertical.

The air flow and structural modeling analyses (Chapter 3) use the basic design for the WPC. Air flow resistance through a panel closure is proportional to flow path length and inversely proportional to the product of the air conductivity and the flow path cross sectional area.

Figures 2-1 and 2-2 illustrate the design for typical cases with and without block walls. Variations in entry height are expected for individual WPCs. For WPCs emplaced in panel entries with block walls, the end slope for the ROM salt can be steepened to 1.4 horizontal to 1.0 vertical to accommodate the full length of ROM salt. The emplacement of ROM salt will avoid putting significant lateral pressure on bulkheads.

The bulk density of the ROM salt is not prescribed in this report. A fractional density of 64% to

65% for ROM salt is nearly universal for WIPP and other salt mining operations throughout the world (Hansen, et. al, 1998 and Rothfuchs and Wieczorek, 2010). It is assumed that any additional salt compaction that occurs during construction will improve the performance by reducing the air gap that forms above and lowering permeability within the ROM salt.

2.3 Constructability, Environmental and Worker Safety, Operational Considerations, and Longevity

This section presents information on the constructability, environmental and worker safety, operational considerations, and longevity. More detailed information is presented in the supporting Appendices C and D that present specifications and engineering drawings.

2.3.1 Constructability

The WPC can be constructed using available technologies for the construction of steel bulkheads and placement of salt. The construction methods and materials used in the design represent available technologies from previous mining projects (Fernandez et al., 1994, pp. 5-11 to 5-20) and as demonstrated by recent insitu testing of ROM salt at WIPP (Zimmerly and Zavicar, 2012). Field tests and construction experience at the WIPP facility will guide the emplacement and construction methods used to construct these barriers. Construction quality control and quality assurance requirements will be based on the construction method employed. The steel bulkheads are commonly used and ROM salt is available in sufficient quantities at minimum cost.

2.3.2 Environmental and Worker Safety

The proposed WPC is not expected to adversely impact environmental safety. The construction materials are primarily natural material removed from the mine, with the exception of the bulkheads, which are already used throughout the underground. The construction methods use equipment identical or similar to day-to-day mining operations or in construction.

Note that the analysis presented in this report does not address specific compliance with HBLs for worker exposure at WIPP during installation and operation of the WPC. Such analyses are beyond the scope of this report.

The following qualitative discussion addresses the complexity and risks in the current design as compared to those in the previous design. Two factors are involved in qualitatively estimating the increase in worker safety and risk reduction associated with installation of the proposed

WPC. One factor involves the complexity of the construction project. The other related factor is the number of workers and the time that they spend transporting, handling, and installing the WPC. The exposure of workers to VOCs relates to exposure times during the construction and emplacement of individual WPCs.

The Permittees reviewed the complexity of the construction project associated with Option D versus the construction of the current WPC. The previous design (DOE, 1996) used complex steel formwork and concrete with removal of portions of the DRZ and closure of the interface zones. The current design is easier to construct as there is no need for complex formwork or the production and placement of Salado Mass Concrete.

As part of a previous redesign process, the Permittees prepared installation schedules for the Option D PCS and WPC (NMED, 2002). The underground construction activities for Option D were estimated to require approximately 14 months. The comparable period for construction of the WPC is estimated at six months or less (40 CFR 264.113 (b)). The WPC construction project uses more common materials for the steel bulkheads and salt than Salado Mass Concrete, thus reducing the number of workers required and the time required for workers to be in the construction area. Less complex construction translates into less time for transportation, handling, and emplacement of materials. Shorter construction time translates to an increase in worker safety and lower risk to workers.

2.3.3 Operational Considerations

The construction of the current WPC can be stopped and re-started as necessary to accommodate operational concerns and reduce or eliminate impact on waste handling. Temporarily stopping construction will not affect the performance of the WPC. The equipment used to construct the WPC can be quickly mobilized and demobilized to accommodate waste handling and other operational needs. Shaft schedules would not be impacted as the majority of the construction materials are already underground.

2.3.4 Longevity

As discussed in Chapter 3, the WPC closures derive their air flow resistances primarily from steel bulkheads for a period of 23 years and from ROM salt thereafter. During the 23 year period of time that steel bulkheads are relied on for air flow resistance, the steel bulkheads will be maintained in the underground environment. The panel entry creep closure with time reduces the air gap at the interface of the ROM salt and entry roof as well as the porosity of the ROM salt, which in turn reduces the air conductivity due to the plastic deformation of the ROM salt.

ROM salt is completely compatible with the underground environment. This results in improved performance with time or longevity. Eventually, the ROM salt will become structurally indistinguishable from the surrounding intact salt.

3.0 Analysis

This chapter presents evaluations of the engineered WPC: (1) structural analyses; (2) projected VOC emissions from air flow analysis and advection analysis; and (3) a material compatibility evaluation.

3.1 Analyses Addressing Operational Requirements

To evaluate the effectiveness of the panel closure system, structural analyses were performed to examine the geomechanical performance of the WPC over the operational period of the repository. Air flow analyses were then performed to evaluate the change in WPC air flow resistance, and then evaluate VOCs flow through the WPC. Structural analyses predict a gap forms between the roof and top of the ROM and reduction of the fractional density due to creep of intact rock salt of the surrounding panel entry surfaces. Air flow analyses are then conducted to predict the release of VOCs through the panel closure system due to gas generation, panel creep closure and the effects of underground ventilation. These analyses support the WPC design for the protection of human health and the environment at the WIPP site boundary. Explosion effects on the WPC were not analyzed because monitoring of methane and hydrogen concentrations indicates that they will not reach minimum explosive concentrations during the operational period (Myers, 2012 and Nelson, 2011).

3.2 Structural Analyses of ROM Salt Emplacements

Three dimensional geomechanical models of a 100-foot long section of ROM salt were analyzed using FLAC3D. The following discussion presents the properties of the ROM salt, the structural modeling method, a crushed salt benchmark calculation, model geometry, modeling sequence, and modeling results.

3.2.1 ROM Salt Properties

The FLAC3D requires the initial densities and material properties of the ROM salt. As discussed previously, the ROM salt initial density is assumed to be 65% of the intact density of salt. The intact density used in this study is 2,160 kg/m^3 (Callahan, 1999).

3.2.2 Structural Modeling Method

The settlement and change in density with time (and implicitly intrinsic permeability) of the

ROM salt was calculated using the three-dimensional geomechanical modeling program Fast Lagrangian Analysis of Continua in Three Dimensions (FLAC3D) (Itasca Consulting Group, 2006). The predecessor program Fast Lagrangian Analysis of Continua (FLAC) and FLAC3D have been used for 20 years for the WIPP project, including structural analyses for the previous panel closure design. FLAC3D implements the Callahan and DeVries (1991) crushed salt creep constitutive model. This model is based on Sjaardema and Krieg (1987) and was verified by Callahan (1999) through comparisons of numerical analysis predictions with laboratory test results. Material properties for the other materials in the surrounding salt are from Krieg (1984).

3.2.3 Crushed Salt Benchmark Calculation

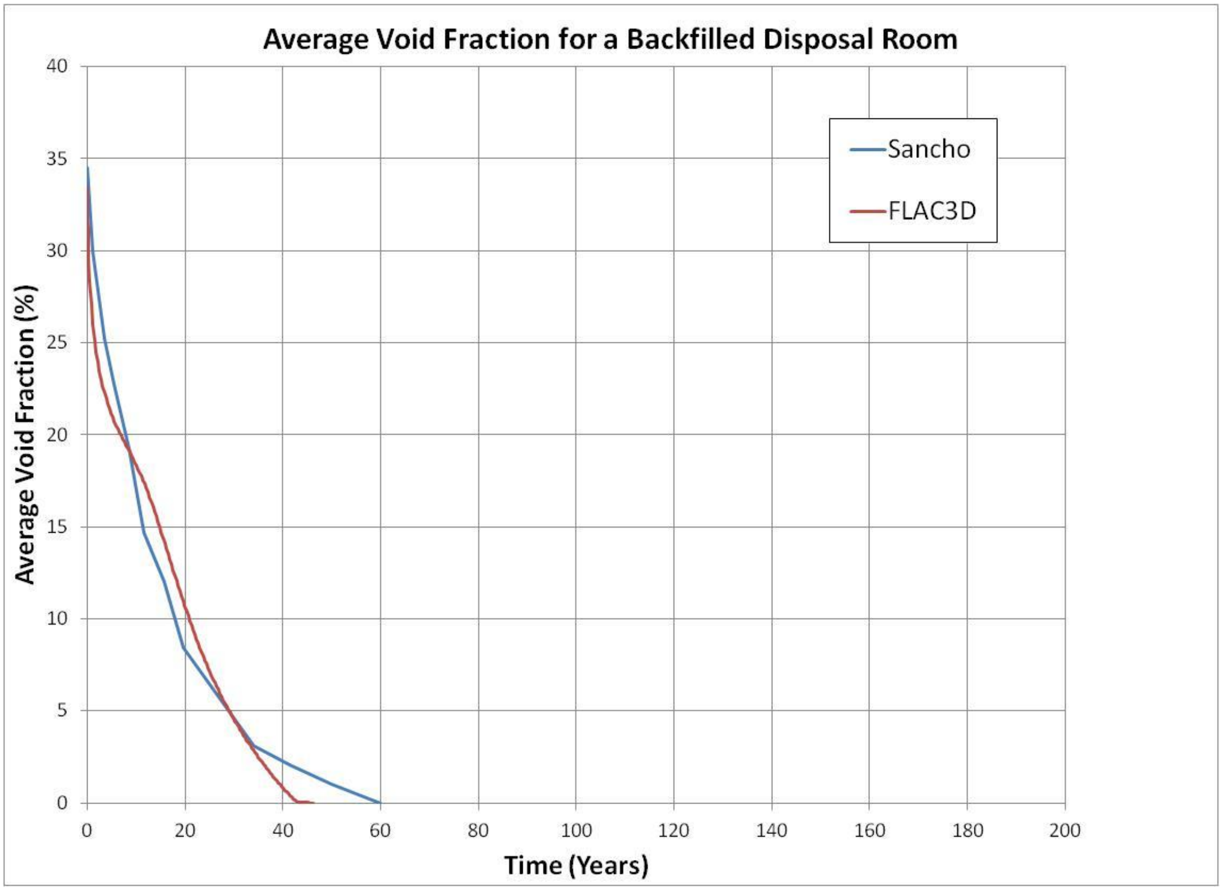
A benchmark calculation (Wagner et al., 1990) was performed to provide comparisons of the predicted consolidation of salt from several models. These included the SANCHO model developed by SNL. A FLAC3D model was developed for comparison to Wagner's results. The FLAC3D three-dimensional model consisted of a backfilled disposal room at the repository horizon that is subjected to a lithostatic stress of 2070 psi (14.3 MPa). In order to simulate the two-dimensional model in FLAC3D, the lateral displacements were set to zero for the plane strain condition. The FLAC3D model used the material properties and crushed salt constitutive model in the room-scale model developed by RE/SPEC for Sandia National Laboratories (SNL).

Figure 3-1 compares the FLAC3D results to the SNL SANCHO results from a previous calculation. The FLAC3D results were reasonably close to the SANCHO results because both use the same constitutive model and backfill type as implemented in FLAC3D.

3.2.4 Model Geometry

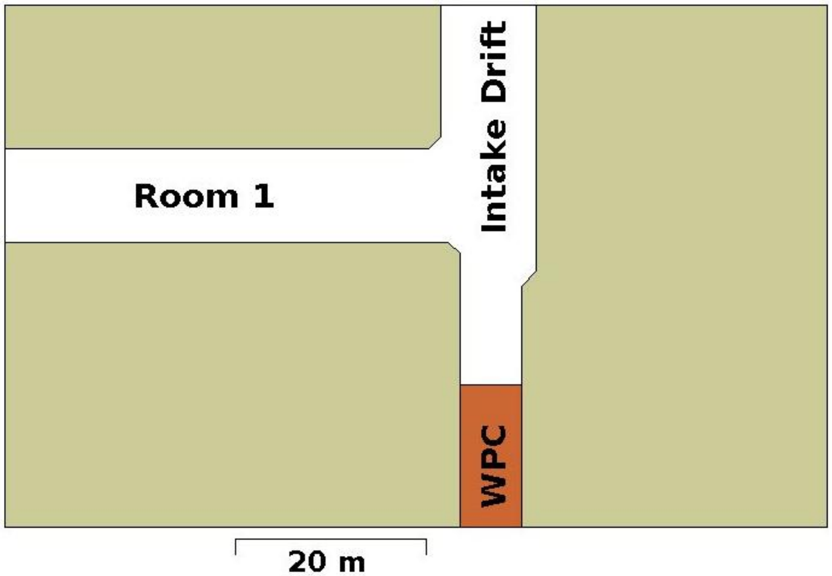
The horizontal extents of the intake and exhaust models are shown in Figure 3-2 and Figure 3-3 respectively. Separate models were developed for the panel intake and exhaust drifts. These figures show the model extents for each case below the roof of the room. The model includes half of Room 1 of a generic panel and the access drift from a line halfway between the rib of Room 1 and the ventilation drift (E-300 or W-170, depending on the panel). The north-south extents go from halfway between panels to an east-west line bisecting the panel. The salt fill is modeled in half-symmetry so only the half nearest Room 1 is modeled. The vertical extents run from about 250 ft (75 m) above and below the floor of the openings.

The crushed salt is modeled in half-symmetry along its length to reduce the run-time of the model, which in turn allows a more refined discretization, producing more accurate



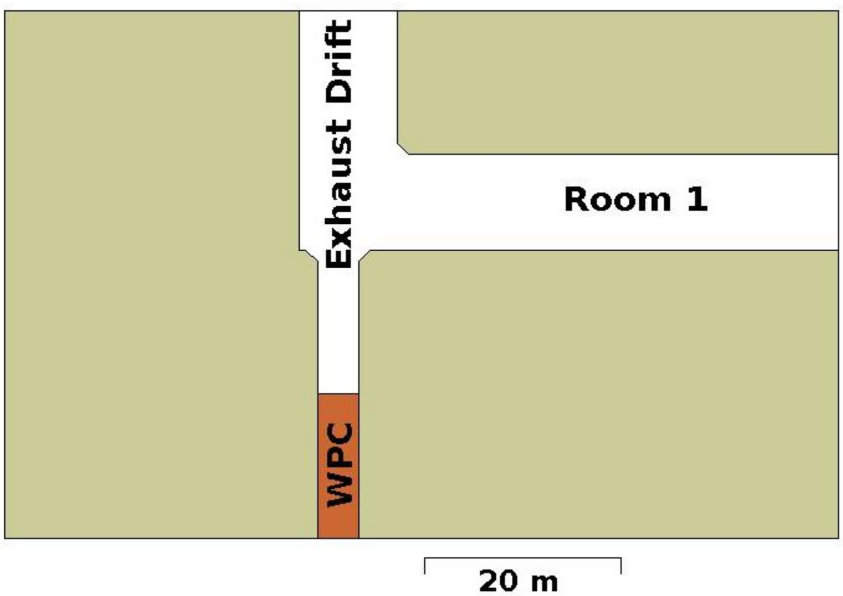
The average void fraction equals 1 minus the porosity.

Figure 3-1 Comparison of FLAC3D and Previous SANCHO Results for the Crushed Salt Benchmark Problem



The lower edge shown is the center of the emplaced fill. All edges are considered planes of symmetry in the analysis.

Figure 3-2 Horizontal Extents for Intake Drift Model



The lower edge shown is the center of the emplaced fill. All edges are considered planes of symmetry in the analysis.

Figure 3-3 Horizontal Extents for Panel Exhaust Drift Model

results. The behavior of the out-by end of the emplaced salt is not expected to be significantly different than the in-by end. This is because the closure rates that would affect the void or pore space of the WPC do not vary significantly along the length of the WPC. Additionally, the end effects are assumed to be essentially identical at each end.

The stratigraphy consists of rock salt with the inclusion of the anhydrite Marker Bed 139 located below the floor of the repository horizon and thin clay seams E, G and H. The roof of the entry corresponds to Clay G. The model grid is made up of over 313,000 three-dimensional zones. The model uses interface elements at the boundary between the emplaced salt and the surrounding drift. These interface elements provide a sliding boundary condition along this surface.

The ROM salt is emplaced at an assumed initial density of 65 % of intact density (88 lbf/ft^3 [1,404 kg/m^3]). This is the natural fractional density of ROM salt.

3.2.5 Modeling Sequence

The openings in the model are excavated instantaneously to reduce model run time. The model is then run without the ROM salt to five years after excavation to simulate the waste emplacement period in the active panel. This time was chosen based on estimates for the time between excavation and closure of Panel 5. In the models, the creep rates that control salt compaction reach steady state within the first two years, so the timing of ROM salt emplacement only affects the volume of the ROM salt, not the consolidation or permeability. Figure 3-4 shows the model-calculated vertical (roof-to-floor) and horizontal (wall-to-wall) closure rate histories at the center of the panel intake drift where the ROM salt will be located. Elapsed time in the FLAC3D analysis is from the time of excavation with the completion of waste emplacement activities in five years.

Figure 3-5 shows the same calculations for the panel exhaust drift. The horizontal measurements were only recorded after the ROM salt was emplaced. Oscillations in the curves occur at Year 28 when the top of the salt fill re-contacts the excavation roof (see Figures 3-7 and 3-8).

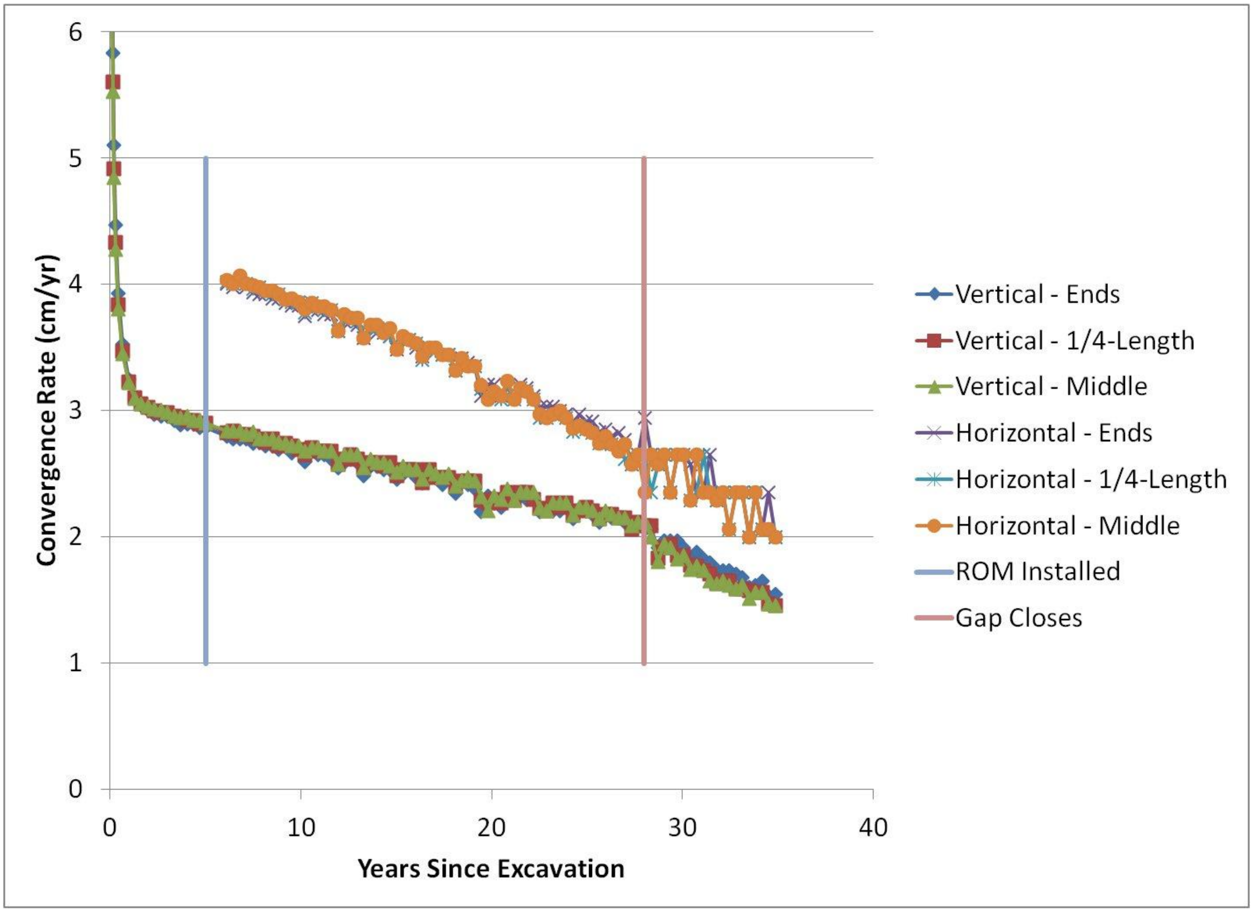


Figure 3-4 Calculated Vertical and Horizontal Panel Intake Entry Convergence Rates Before and After ROM Salt Emplacement

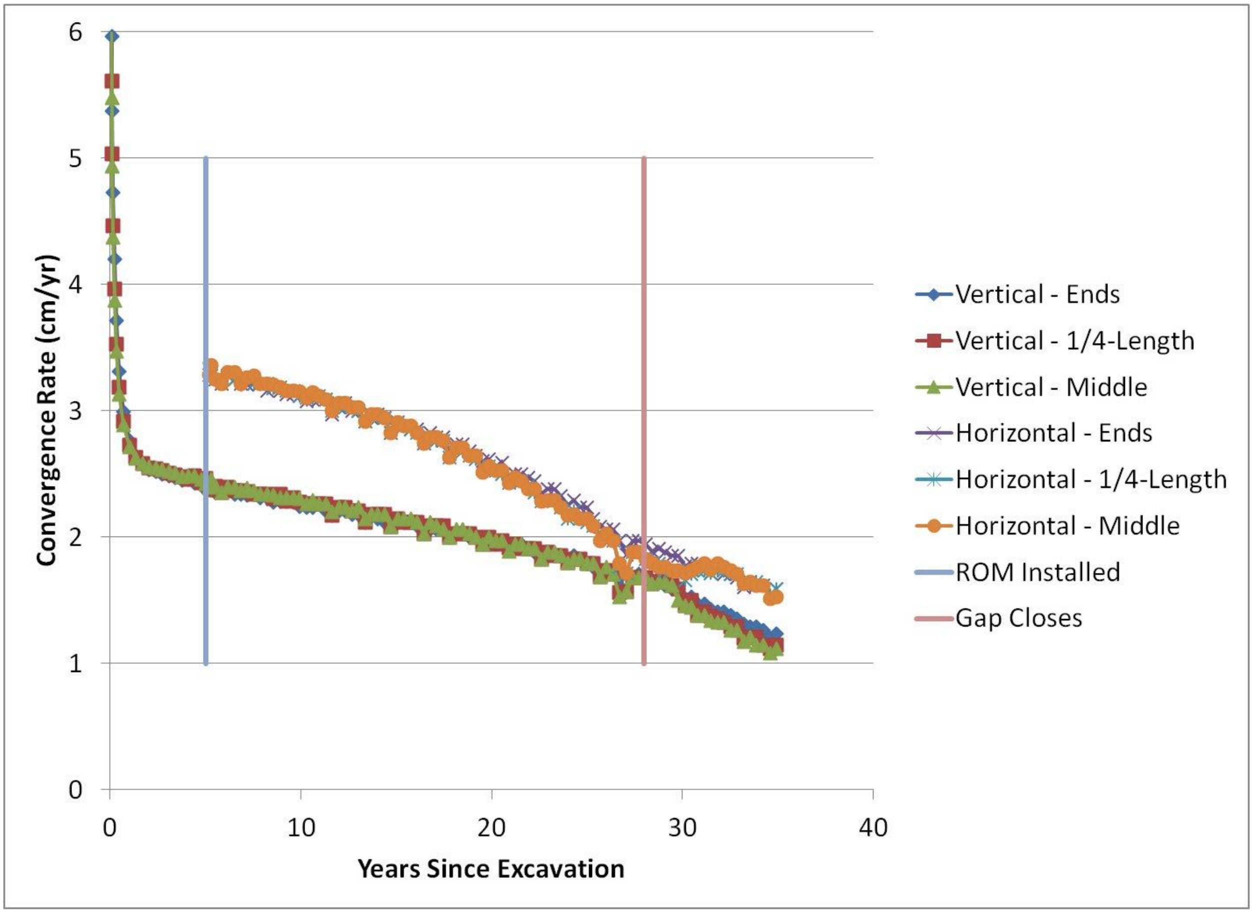


Figure 3-5 Calculated Vertical and Horizontal Panel Exhaust Entry Convergence Rates Before and After ROM Salt Emplacement

3.2.6 Structural Modeling Results

The variation with time of the fractional density of the emplaced salt in each drift is shown in Figure 3-6. These calculations are input into the air flow calculations. The values in Figure 3-6 were calculated by taking a volumetric average of the fractional density of all zones (model elements) in the compacted salt. The fractional density values for the panel intake and exhaust drifts are nearly identical. The intake drift is about 30% wider than the exhaust drift. The larger span results in larger intact rock displacement rates, but it also leads to a larger volume of fill under consolidation. In this case, the effect of the higher displacement rates in the intake drift is nearly balanced by the larger volume of material undergoing compaction. In other words, the

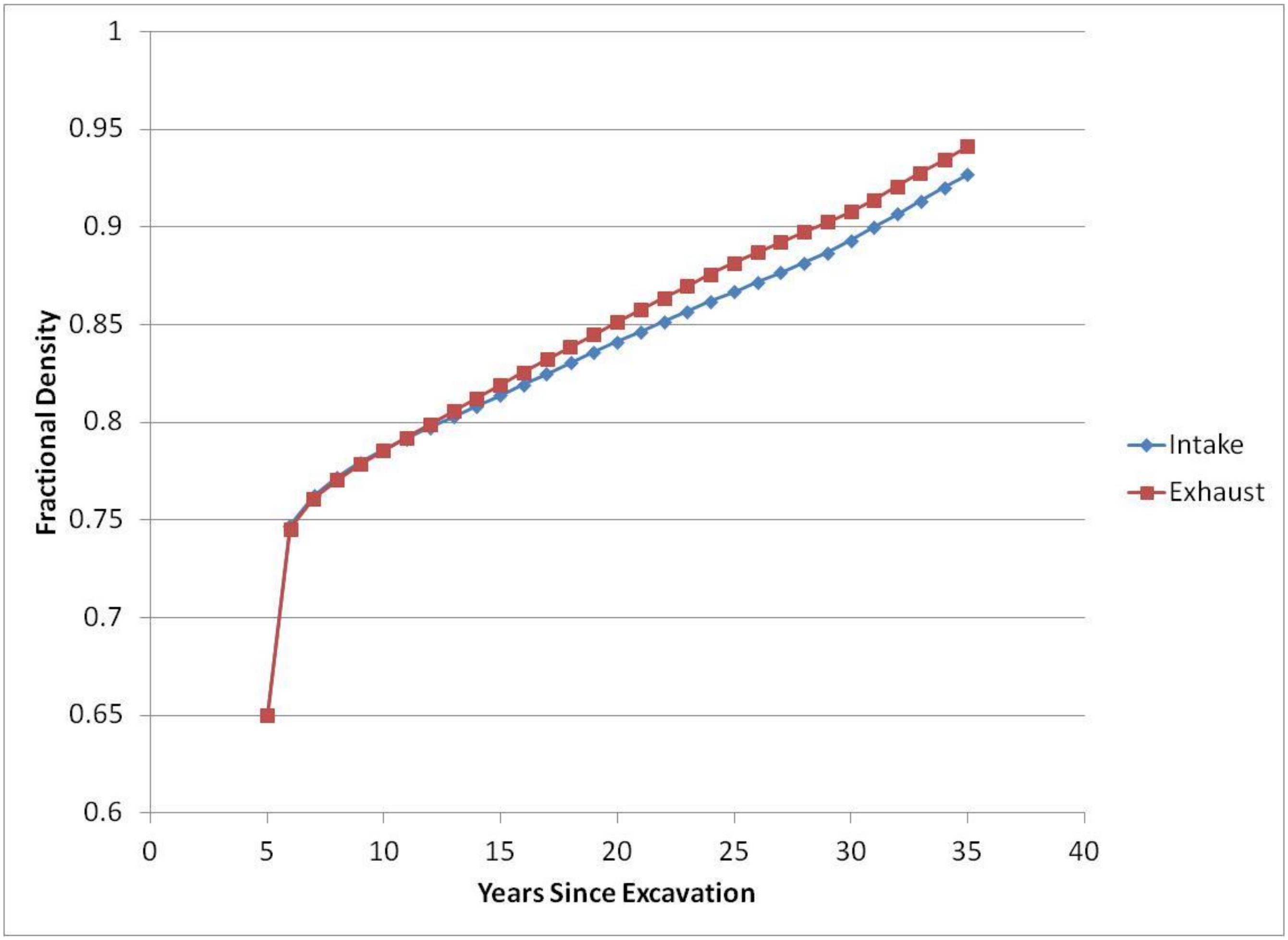


Figure 3-6 Fractional Density of ROM Salt vs. Time for Both Drifts

larger volume in the intake drift requires larger displacements to reach the same level of compaction (volumetric strain) as seen in the exhaust drift.

As a result of the self-settlement of the ROM salt, the post-installation consolidation rate is faster in this case than the roof-to-floor convergence rate. This results in an air gap forming between the roof of the excavation and the top of the emplaced salt. Figure 3-7 shows the gap magnitude versus time for points at the center and ends of the fill in the intake drift. Figure 3-8 shows the gap magnitude versus time in the exhaust drift. The gap reaches a maximum of 18.5 inches (47 cm) in the intake drift and 16.5 inches (42 cm) in the exhaust drift. The maximum gap occurs 2.5 years after installation in the intake drift and 1.8 years after installation in the exhaust drift. The gap magnitude reduces when the consolidation rate slows to less than the excavation closure rate. The gap closes in approximately 23 years after installation in both drifts. Gap magnitude and duration is slightly lower at the ends of the fill.

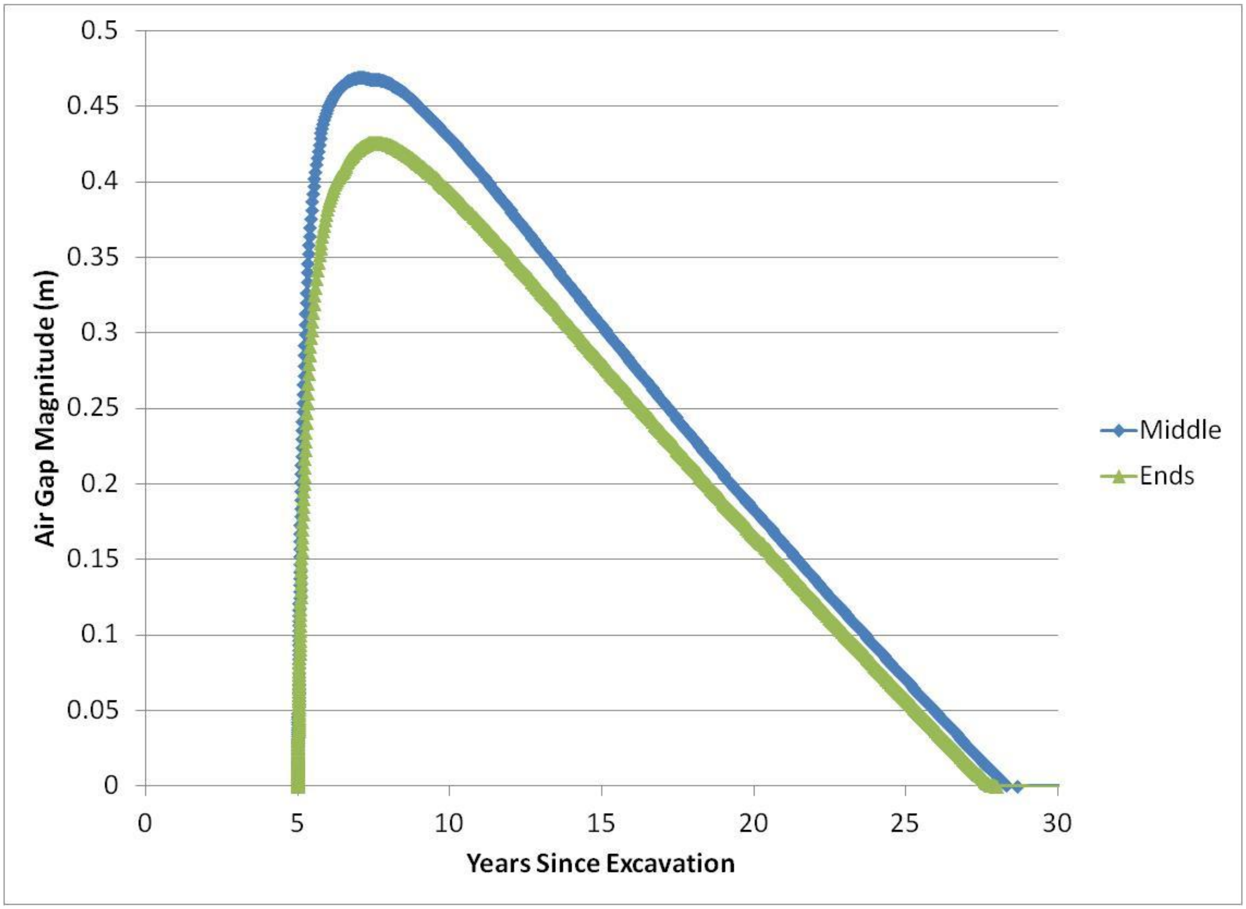


Figure 3-7 Air Gap Magnitude in Intake Drift

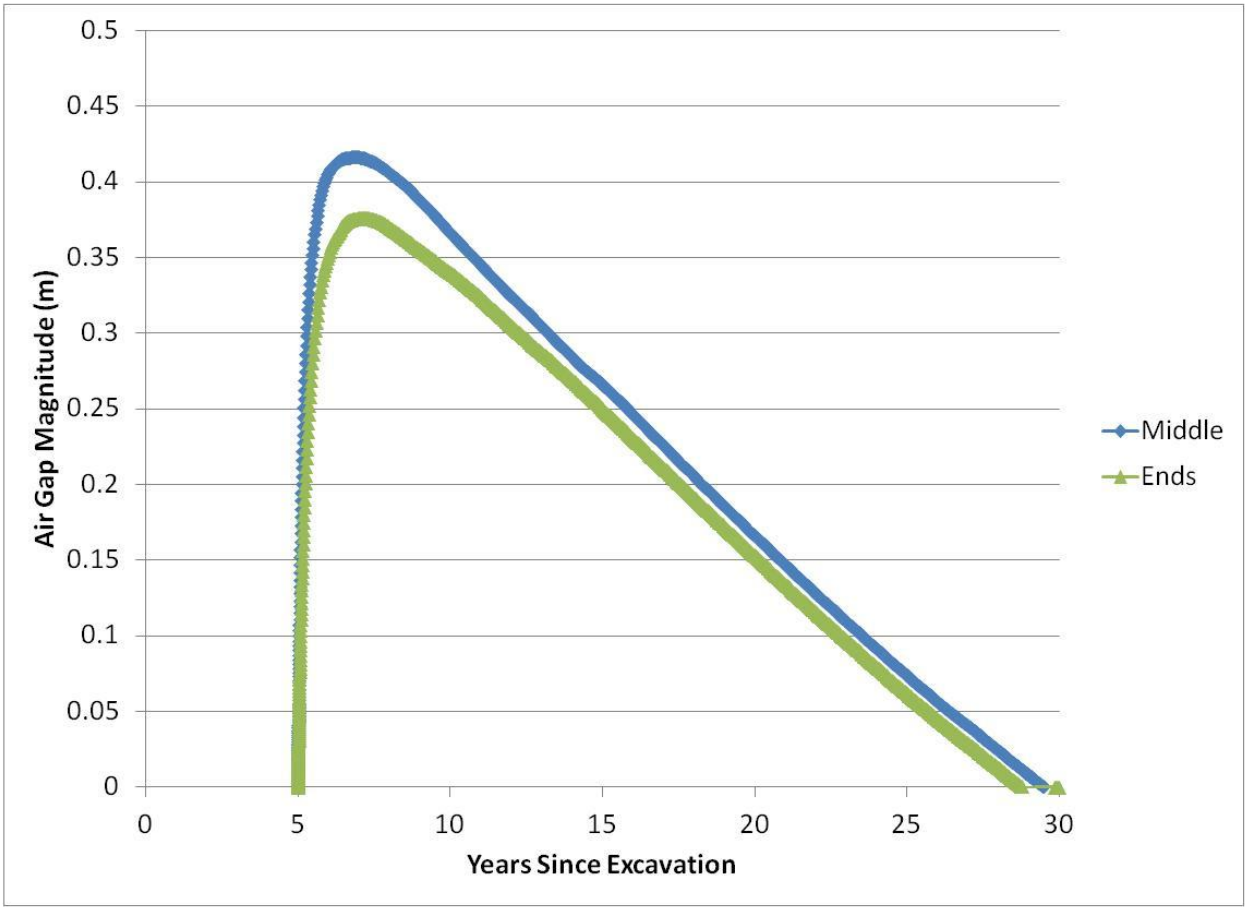


Figure 3-8 Air Gap Magnitude in Exhaust Drift

3.3 VOCs Flow Analyses

The VOCs flow analyses evaluate the flow of VOCs of concern through the WPC to the time of completion of waste emplacement operations at the WIPP facility. These analyses address the VOCs of concern; the VOC concentration data; the current emission rate of VOCs of concern; the schedule for closure of panels; and the future projected VOC emission rates. Also, the effective air conductivity of the panel closure system is evaluated and used as input to the air flow model (DOE, 1996) to assess VOCs flow performance.

Three sources for air flow are considered in projecting future emission rates. These include: (1) an average gas generation rate due to microbial degradation (Kehrman, 2012, Table 2); (2) a volumetric closure rate due to salt creep; and (3) an underground ventilation rate.

3.3.1 WPC VOCs Evaluation Procedure

The WPC VOCs evaluation procedure includes the analysis of air flow rates from a single panel. A detailed evaluation is then made of VOC concentrations for carbon tetrachloride (CCl_4) based upon open room emissions prior to closure of the air gap, and average headspace CCl_4 concentrations after closure of the air gap. A schedule is considered for individual WPC closure assuming approval of a Class 3 Permit Modification to include the WPC in the Permit in December 2013. The contributions from individual panels are superimposed to obtain the repository CCl_4 emissions. The risk fractions at the WIPP site boundary receptor point are then evaluated for CCl_4. The risk fractions for other VOCs are then calculated at the time of peak VOC emissions.

The WPC VOC analysis for a single panel closure includes: (1) evaluation of air flow rates after placement of a single layer of salt (65% fractional density) and the construction of steel bulkheads; (2) the period of time when a gap exists and air flow resistance is provided by steel bulkheads; (3) a period of time when the air gap is closed and air flow resistance is increased; and (4) a final period of time when air flows through consolidating ROM salt. The VOC concentrations are evaluated as the CCl_4 emission rate for open rooms (Kehrman, 2012, Table 12) during time periods when the air gap exists. After the gap is closed in 23 years, the dominant air flow resistance is through the pore space of the ROM salt. VOC emission then equals the product of the air flow rate and the average headspace concentration. These analyses compare predicted VOC concentrations from the model with existing VOC emissions measurements for Panels 1 through 5 and part of 6 to July 2012. Other assumptions used in the analysis are:

- Air flow occurs under quasi-steady state conditions. Air flows from gas generation and panel creep closure are source terms from each panel while air flow from underground ventilation occurs under Darcy's Law between the panel entries.
- The gas generation rate is 4,020 moles per panel per year (0.1 moles per drum per year) (Kehrman, 2012).
- Volumetric reduction of a panel due to creep closure reduces the void space at a rate of 28,680 ft^3 per year (812 m^3 per year) (DOE 1996, Appendix B).

- Underground ventilation in the adjacent main exhaust drift[2] results in a pressure drop between the panel air-intake and panel air-exhaust drifts for each panel (See Appendix A). The ventilation air flow entering each panel air-intake drift equals the air flow leaving the panel air-exhaust drift for each waste panel under a pressure drop of 170 milli-inches (4.3 mm) of water gage. The ventilation network analysis results in an average flow rate of several hundred cfm prior to closure of the air gap. The air flow rate is then reduced to less than 0.1 cfm.

- Steel bulkheads (Section 2.2.1) with flexible flashing to accommodate salt creep are used in the WPC design. Farnsworth (2011) indicated that smaller drifts with bulkheads near the Exhaust Shaft in the WIPP underground have air flow resistances as high as 2,200 Practical Units. The smaller drifts with bulkheads near the Exhaust Shaft are the closest in size to the Panel intake and exhaust drifts. Steel bulkheads will be maintained to accommodate panel entry salt creep to achieve a minimum air flow resistance of 2,200 Practical Units for as long as the bulkheads are needed to provide flow resistance.

- VOC transport occurs by advection. Hydrodynamic dispersion through the WPC is neglected. The VOC releases are determined for individual panels and then are superimposed in time.

The WPC VOC flow analyses are considered bounding because: (1) the pressure drop of 170 milli-inches (4 mm) of water gage is considered a maximum value; (2) a permeability vs. porosity relationship provides a maximum envelope for measured data (See Figure 3-9); and (3) the analysis models panel creep closure and gas generation as point-source at the panel air exhaust drift. These bounds are discussed in the following subsections.

3.3.2 Existing VOCs Emissions Measurements for Panels 1 through 5

The WIPP collected measurements on VOC concentration data and ventilation rates at the E-300

[2] The E-300 drift is the adjacent main exhaust drift for Panels 1 through 4, while W-170 is the adjacent main exhaust drift for Panels 5 through 8.

point of compliance were collected during the period from January 2008 to July 2012 for the VOCs of concern. The E-300 point is located at the intersection of the E-300 main exhaust drift, and S-1300 cross drift. The existing measurements reflect VOC emissions from Panels 1 through 6, with Panel 6 being the active panel during the measurement time period.

3.3.3 Estimation of Air flow Rates

Three sources for air flow are considered in projecting future emission rates. These include: (1) a gas generation rate due to microbial degradation; (2) a volumetric closure rate due to salt creep; and (3) an air flow rate due to underground ventilation in the adjacent exhaust drift. The air flow rate due to ventilation in the adjacent exhaust drift includes estimates of the potential air flow boundary condition for the WPC, the air flow resistances for components of the WPC and how these resistances change with time due to closure of the air gap, and consolidation of the salt.

Underground ventilation measurements and the analysis of these measurements are provided by the operating staff (Appendix B). This information is used to assess VOC emissions rates for the underground repository.

Figure A-1 shows the configuration for evaluating ventilation effects. A comparison of the analyses presented in Appendix A and DOE (1996, Appendix B) indicates that ventilation effects in the adjacent main exhaust drift are more significant than gas generation and panel creep closure. Since the flow in the adjacent exhaust drift is the path of least resistance for air flow, the pressure drop or potential is set by the head loss down the adjacent main exhaust drift. The potential difference then provides the pressure or head differential for flow through the WPC. It is much smaller than flow through the adjacent exhaust drift. However, it is much larger than flow generated by gas generation and panel creep closure used in previous studies (DOE, 1996).

Appendix B presents information on ventilation rates in thousands of cubic feet per minute (kcfm) and pressure drops in milli-inches of water gage for the WIPP underground ventilation network. The measurements include pressure drop measurements in the main exhaust drift adjacent to each WPC as shown in Figure A-1.

The normal and full operating modes provide measurements during testing and balancing that are representative of underground ventilation conditions. Appendix B describes the normal and full operating modes. For the normal operating mode, the average value for the pressure drop was 163 milli-inches of water gage. The range of pressure drops was from 12 to 350 milli-inches

(0.3 to 9 mm) of water gage. For the full operating mode, the average value was 165 milli-inches of water gage with a range of values from 0 to 394 milli-inches (0 to 10 mm) of water gage.

The FLAC3D analysis provides the settlement time histories of ROM salt that results in the reduction of the air gap and increase in fractional density or reduction in porosity of the ROM salt.

The FLAC3D analysis indicates closure of the air gap at different locations within the ROM salt over time. The analyses of both the WPC Intake and Exhaust drift show an increase in air gap occurs for two years followed by a reduction in the air gap after this time. The air gap closes first near the ends, and then followed by the middle of the ROM salt. These times are approximately 23 years after panel closure. Prior to the time of closure of the air gap, air flow resistance through the WPC is predominately due to the steel bulkhead resistance. After approximately 20 years, the air gap closes to a point at which the air flow resistance offered by the consolidating salt equals the air flow resistance through steel bulkheads. Flow rates through the WPC are calculated using methods presented in Appendix A Section A5.0. The estimated flow rates are of the order of several hundred cfm.

After closure of the air gap, the dominant air flow resistance is through the consolidating salt. Air flow is reduced to a small percentage of the air flow through the gap. The air conductivities were then calculated based upon the intrinsic permeability relationship that accounts for both the relative density and the average particle size of the ROM salt backfill (Kelsall et al., 1983, Equation A-4). This relationship is illustrated in Figure 3-9 and is based upon the investigations made by Shor, et al. (1981) and bounds the intrinsic permeability relationship derived from laboratory investigations of crushed salt (Case et al., 1987, Figure 1, and from Mellegard, 1999, Figure 4-15). The analysis is bounding in that measured intrinsic permeabilities of ROM salt from measured relationships (Case et al., 1987, Figure 1 and Mellegard, 1999, Figure 4-15) are lower than those predicted on the basis of the Shor relationship for a particle size of 0.13 inches (0.34 cm). Figure 3-10 and Figure 3-11 present the air conductivities based upon the relative density vs. intrinsic permeability relationship for a single panel. The reduction in fractional density is anticipated to result in a reduction in air conductivity through the ROM salt over a 30-year period.

Small amounts of moisture exist in the ROM salt. Also small amounts of brine will flow from the surrounding entries into the ROM salt (Deal and Case, 1987). Moisture within the salt is conservatively neglected in the analysis. The technical basis for this assumption is that moisture existing or being introduced in the pore space will reduce the intrinsic air permeability to the gas phase, and thus reduce the flow of VOCs.

Bear (1972, p. 712) provides an air flow network resistance method. Appendix A presents derivations for the air flow model. Air flow is governed by Darcy's Law under quasi steady state conditions.

The air flow analysis considers flow through other components as presented in Table 3-1 . Flow through the disturbed rock zone (referred to as fractured and dilated salt in Table 3-1), clay seams and Marker Bed 139 occur in parallel to air flow through the WPC.

Case and Kelsall (1987) evaluated permeability measurements performed by Peterson et al. (1985). These data showed a zone of increased permeability (10^{-18} ft^2 to 10^{-20} ft^2 [10^{-19} m^2 to 10^{-21} m^2]) from 3 ft to 42 ft (1 to 14 m) from the opening. Based on this observation, the calculations assumed that the cross-sectional area for flow through the DRZ and the panel closure system will equal nine times the panel intake or panel exhaust drift area or that the DRZ extends out three radii from the center (DOE 1996, Section 2.1.1.1).

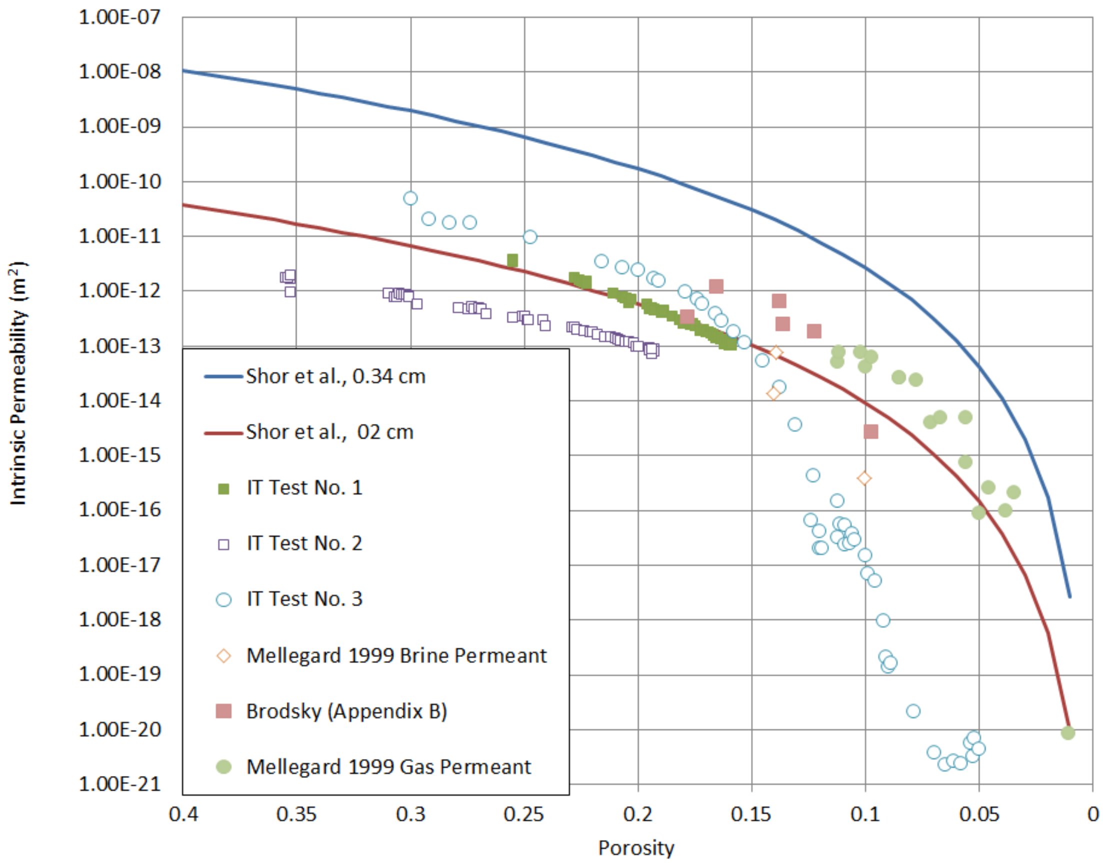


Figure 3-9 Relationship of Intrinsic Permeability to Porosity

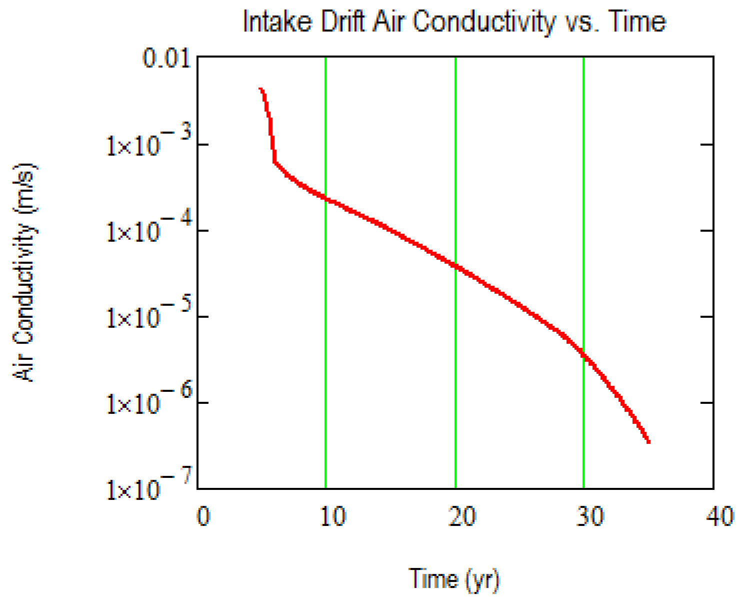


Figure 3-10 Panel Intake Drift Air Conductivity Through ROM Salt vs. Time

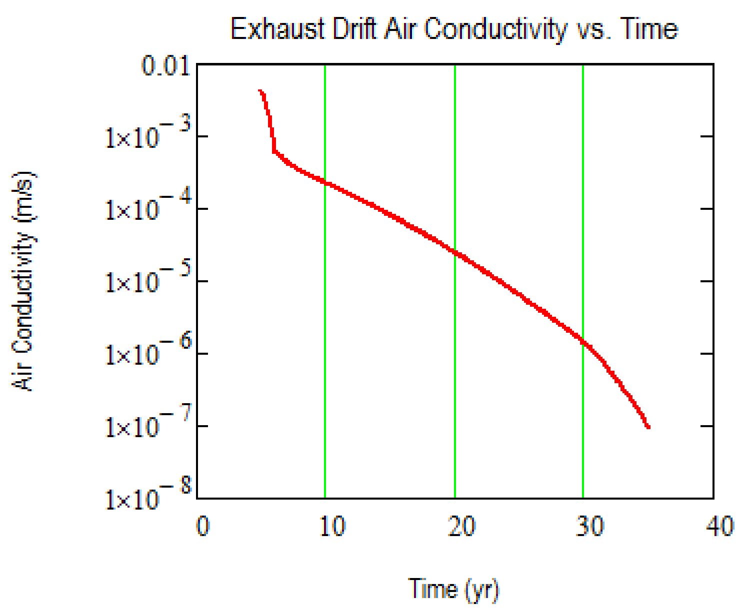


Figure 3-11 Panel Exhaust Drift Air Conductivity Through ROM Salt vs. Time

A distinction is made between "dilated rock salt" and "fractured rock salt." Dilated rock salt exhibits a higher permeability than intact rock salt due to stress relief from the lithostatic state of stress and this corresponds to the increased permeability zone observed by Case and Kelsall (1987). The value used here for the intrinsic permeability of dilated rock salt (10^{-18} ft^2 (10^{-19} m^2)) is more conservative than measurements using the guarded packer straddle system (Case and Kelsall, 1987, Figure 5). The fractured rock salt refers to the highly fractured zone in the immediate vicinity of the openings.

A comparison is made of the air conductance of the ROM salt emplaced in the drift to the air conductance in the surrounding DRZ. The flow resistance through the DRZ and the adjacent 100 ft (30.5 m) of ROM salt can be compared by considering the sum of the product of the air conductivities times the cross sectional areas of each DRZ component to the product of the air conductivity times the cross sectional area of the ROM salt. The estimated flow is several orders of magnitude lower through the DRZ. The analysis predicts the dominant flow path is through the ROM salt and flows through components of the DRZ are small.

Comparisons were made between the flow resistance of the ROM salt with a minimum length of 100 ft (30.5 m) with steel bulkheads. Using the fundamental relationship relating head loss to air flow and considering 170 milli-inches (4 mm) of water gage with bulkhead resistance of 2,200 Practical Units[3] (0.070 $mm/(m^3/min)^2$), the estimated air flow resistance through a gap above the ROM salt was about two orders of magnitude smaller than the resistance of bulkheads. After 23 years following WPC emplacement, the air gaps are closed and the resistance of the salt is much higher than that of steel bulkheads. Flow resistance through 100 ft (30.5 m) of ROM salt is dominant after 23 years. See Appendix A for details. Steel bulkheads will be maintained to provide a minimum air flow resistance of 2,200 Practical Units during the 23 year period following WPC construction.

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[3] A Practical Unit equals 1 milli-inch of water gage divided by (1 kcfm [1000 cubic feet per minute)^2 (Mine Ventilation Services (2003, p. 10). 1 kcfm = 1000 ft^3/min (28.3 m^3/min). The Practical Unit is equivalent to 3.17 x 10^{-5} $mm/(m^3/min)^2$ in the metric system. The Practical Unit is derived from the Square Law used in underground ventilation analysis.

Table 3-1 Air Conductivity of Other Flow Components

Component	Air Conductivity		References
	ft/s	m/s	
Dilated salt	2.03×10^{-13}	6.2×10^{-14}	DOE, 1996
Fractured salt	2.03×10^{-9}	6.2×10^{-10}	DOE, 1996
Clay seams	2.03×10^{-11}	6.2×10^{-12}	DOE, 1996
Marker Bed 139	2.03×10^{-10}	6.2×10^{-11}	DOE, 1996

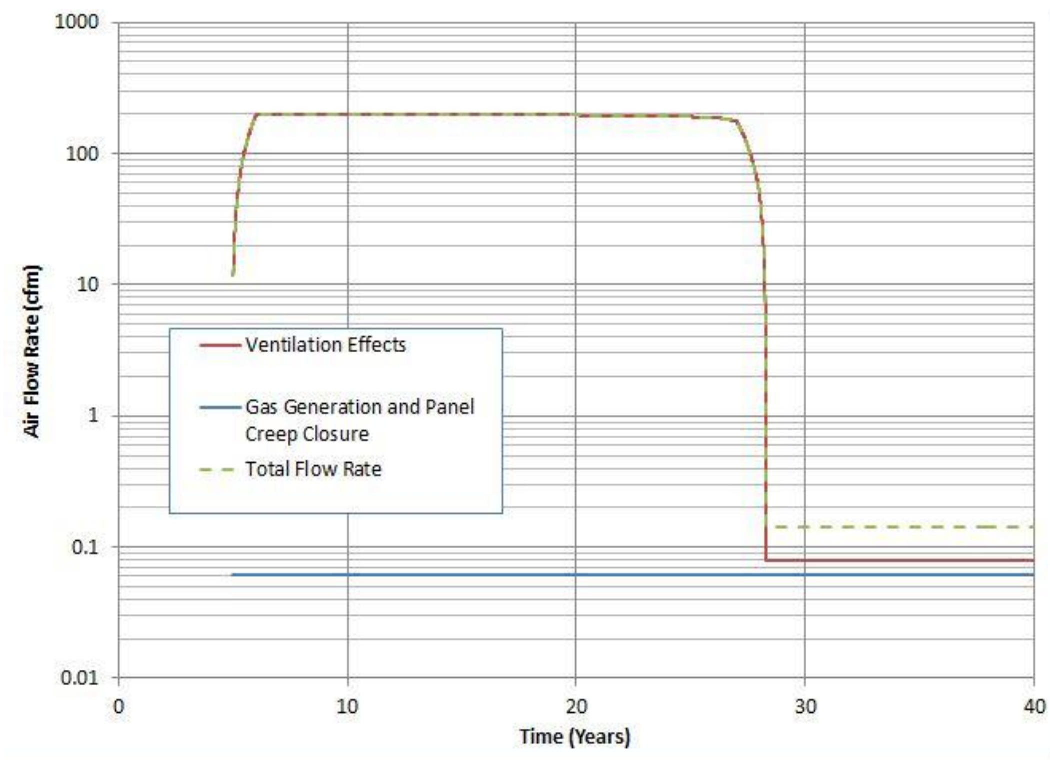

Figure 3-12 Air flow Rate for a Single Panel

Time shown is after panel excavation with panel closure occurring after 5 years.

Figure 3-12 presents the results of the single panel air flow analysis and compares air flow from air-ventilation effects of the adjacent main exhaust drift with the other point source terms for gas generation and panel creep closure. The analysis assumes that gas generation and panel creep closure are point source terms for air flow out of the WPC and that the total air flow is the sum of the air flow from ventilation effects of the adjacent main exhaust drift and the other source terms.

After ROM salt emplacement and installation of steel bulkheads, the analysis predicts that air flow through the WPC is initially of the order of 10 cubic feet per minute (cfm). Soon after emplacement, the air gap aperture quickly grows and air flow increases until flow is limited by the bulkheads to about 200 cfm. After about 20 years, the air flow resistance through closing air gap and the steel bulkheads are nearly equal. After about 23 years, closure of the air gaps above the consolidating salt is complete, and air flow resistance is dominantly through the pore space of the consolidating salt. The estimated flow through the WPC is of the order of 1cfm (0.028 m^3/min) and air flows from ventilation effects are twice the flow from gas generation and panel creep closure.

3.3.4 Transport of VOCs by Advection

Transport of VOCs occurs either from the open room emissions (Kehrman, 2012, Table 12) prior to closure of the air gap in each WPC, and then by advection with the projected emission rate determined as the product of the air flow rate times the average head space concentration for each VOC. When the air gap is closed, it is assumed for the air flow model that the average headspace concentrations serve as a constant source of VOCs. This assumption is conservative because some containers may only have trace quantities of VOCs, either trapped in the headspace or on the surfaces of the various waste components. The analysis uses the weighted average headspace concentration for VOCs (Kehrman, 2012, Table 1) and no VOC source depletion is assumed.

Previous analysis (DOE, 1996) evaluated the effects of hydrodynamic dispersion on VOC transport through the WPC, using a one-dimensional dispersion model (Freeze and Cherry, 1979). Analysis was performed to evaluate the breakthrough or travel time of a concentration front considering the average linear velocity of the air flow. The analysis shows that breakthrough times increase with time as the salt compacts to higher fractional densities. The analysis shows that breakthrough times range from 7 to 70 days over 10 years. Hydrodynamic effects can be neglected for this rapid breakthrough time.

Comparisons of the model predictions with existing VOCs running average measurements at E-300 provide model validation. Figure 3-13 presents the analysis of CCl_4 and compares predictions with existing CCl_4 measurements from January 2008 to July 2012. The measurements include the emission rates during the time period when Panels 1 through 3 were closed and Panels 4 through 6 were active. The analysis initially predicts a higher rate of VOC emissions than what has been measured. This is because Panels 1 and 2 received smaller inventories of Type IV solidified organic wastes. At the time that Panel 6 is in operation, the VOCs model is in agreement with measurements of the running annual average (RAA) for CCl_4 at the E-300 location. The analysis predicts that the estimated CCl_4 emissions reach a value of about 300 ppbv at year 20, and then reduce with time as individual WPCs are constructed followed by closure of the air gap 23 years after each closure. The field measurements include a variety of factors that are not considered in the emissions model. These include changes in ventilation, temperature, barometric pressure, etc. This results in the oscillations in the field measurements that are not seen in the model predictions.

3.3.5 VOCS Analysis Results

The evaluation includes the case when all but one panel is closed using the WPC at the time of repository closure, and the single open active panel consists of six filled and closed rooms and one open room at current existing emissions rates. The case being evaluated is equivalent to the evaluations performed for other panel closures with the updated source term information.

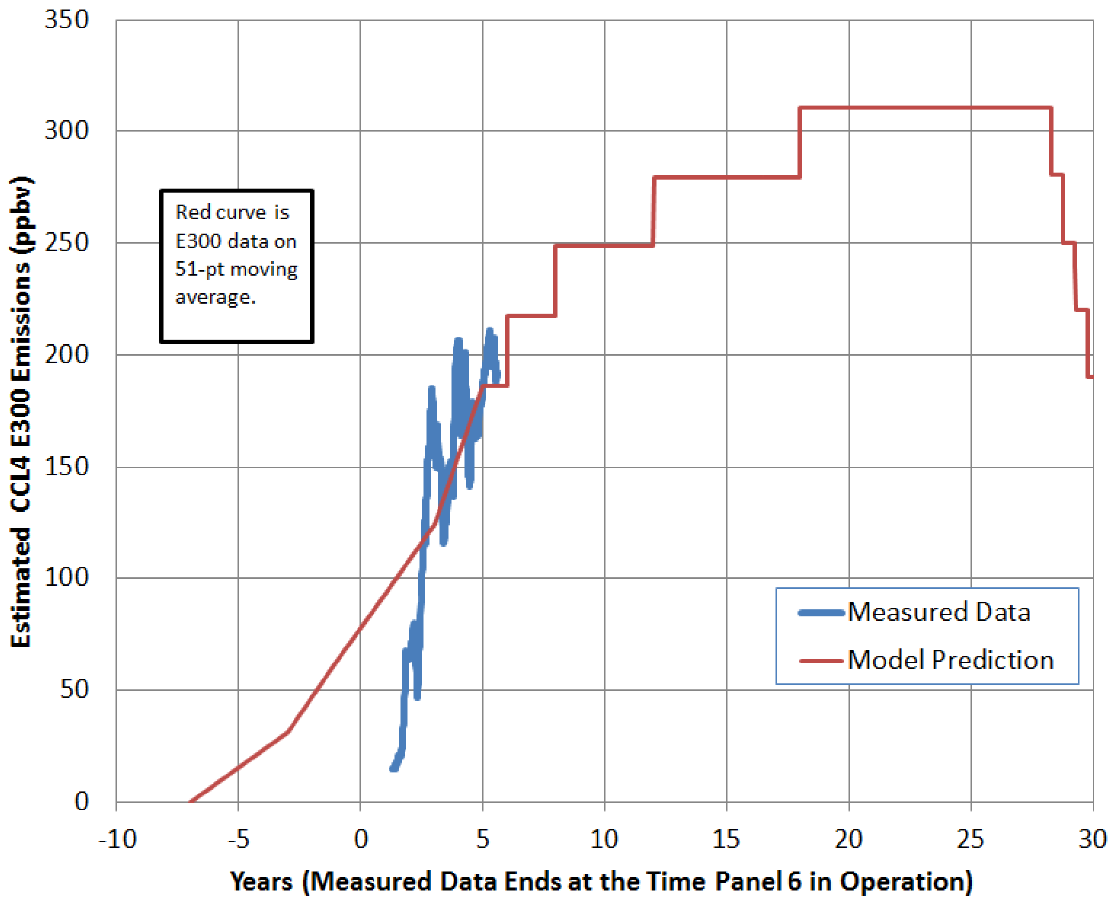

Figure 3-13 Comparison of Predicted and Measured Concentrations for CCl_4 at E-300.

The current Permit Application considers compliance with HBLs (Kehrman, 2012, Table 11) at the WIPP site boundary. Kehrman (2012, Table 6) provides the air dispersion factor for evaluating concentrations at this point. Kehrman (2012, Table 11) provides HBLs for these WIPP boundary receptor points for CCl_4 for carcinogenic risk and noncarcinogenic risk scenarios.

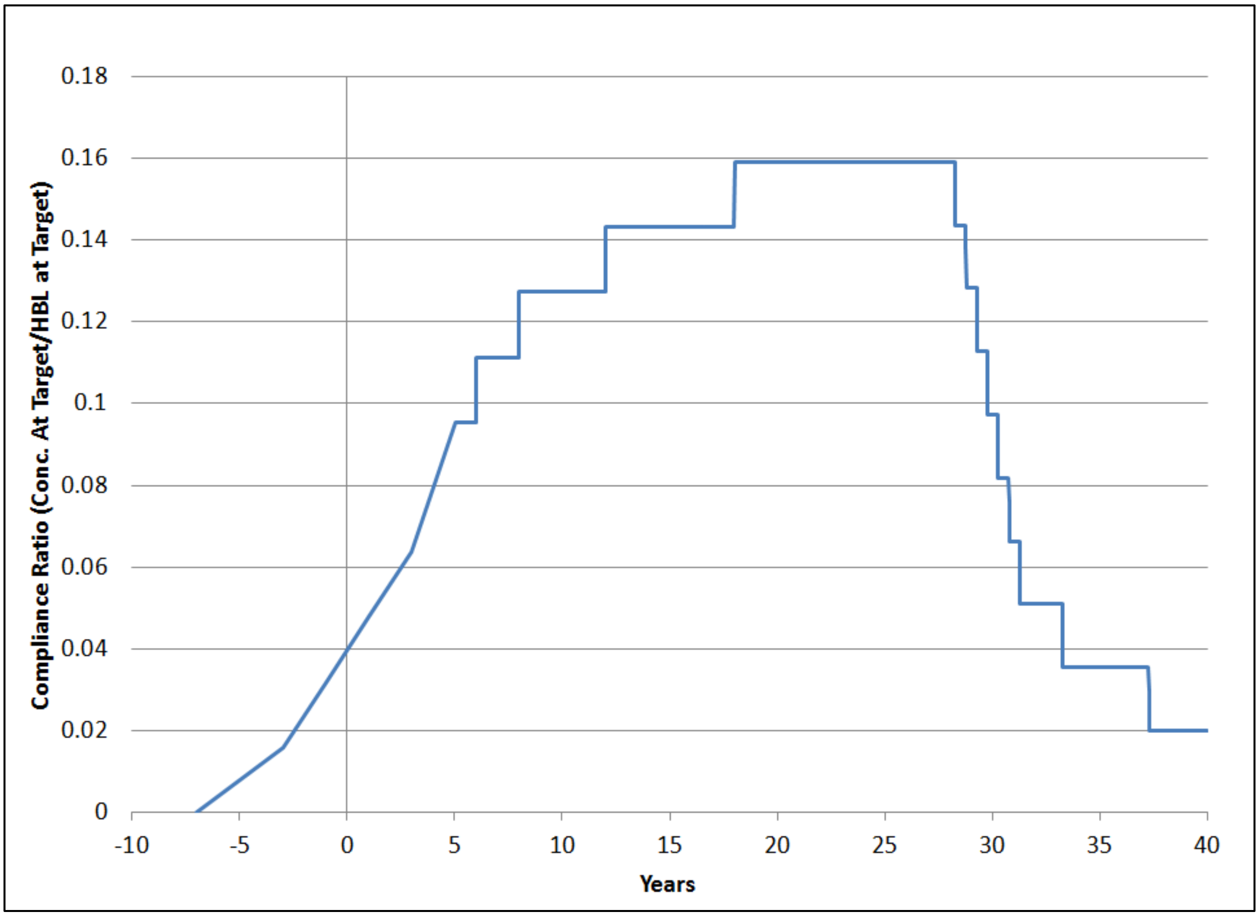

Figure 3-14 Risk Fractions For CCl4 At WIPP Boundary Receptor Points

Figure 3-14 presents the risk fractions for the carcinogenic scenario for CCl_4 at the WIPP site boundary. Noncarcinogenic scenarios result in lower risk fractions than for carcinogenic scenarios (see Table 3-2). The figure also shows the average risk fractions for CCl_4 at the WIPP boundary receptor location are about 0.16 or less.

The predicted mass flow rates for CCl_4 through the WPC due to open room emissions prior to closure of the interface gap and then through the WPC after interface gap closure (including flow through the DRZ, the steel bulkheads and ROM salt) from gas generation, panel creep closure and ventilation effects of the adjacent main exhaust drift are predicted to result in concentrations that are below the limits established at the WIPP receptor boundary. The risk fractions are in compliance at the time of completion of waste emplacement operations in which nine WPCs have been installed, and there are six closed rooms with one open room in a single panel. The evaluation of risk fractions at intermediate locations has not been performed, and is not part of the scope of work.

3.3.6 Other VOCs

Table 3-2 presents an evaluation of risk fractions for all VOCs in the waste inventory at the time of maximum release. Risk fractions are the ratio of the predicted emissions to the HBLs. The analysis shows that the release fractions are less than one and that releases from the WIPP repository results in VOCs concentrations that are less than HBLs for VOCs of interest (Kehrman, 2012, Table 11) at the WIPP site boundary. Concentrations at other surface and underground locations were not analyzed as part of this scope of work.

Table 3-2 Maximum Risk Fractions for VOCS at WIPP Site Boundary

VOC	Carcinogen Site Boundary Ratio	Non-carcinogen Site Boundary Ratio
Carbon Tetrachloride	1.59E-01	5.26E-04
Chloroform	1.13E-02	1.04E-05
Trichloroethylene	6.13E-03	1.50E-03
1,1,2,2-Tetrachloroethane	5.24E-03	N/A
1,2-Dichloroethane	2.95E-03	3.37E-05
Benzene	1.02E-03	8.85E-06
1,1-Dichloroethane	5.11E-04	N/A
Ethyl Benzene	2.35E-04	1.88E-07
Bromoform	4.81E-05	N/A
Tetrachloroethylene	4.59E-05	8.82E-06
Methylene Chloride	1.25E-05	4.18E-06
1,2,4-Trimethlybenzene	N/A	1.81E-05
Butanol	N/A	1.41E-05
Methyl Chloride	N/A	1.31E-05
1,1,1-Trichloroethane	N/A	8.46E-06
trans-1,2-Dichloroethylene	N/A	4.52E-06
1,1-Dichloroethylene	N/A	4.26E-06
m,p-Xylene	N/A	3.34E-06
Chlorobenzene	N/A	2.93E-06
o-Xylene	N/A	1.95E-06
Methanol	N/A	1.61E-06
Carbon Disulfide	N/A	1.11E-06
1,1,2-Trichloro-1,2,2-Trifluoroethane	N/A	4.43E-07
Methyl Isobutyl Ketone	N/A	2.15E-07
Methyl Ethyl Ketone	N/A	1.71E-07
Toluene	N/A	1.37E-07
Acetone	N/A	1.17E-07
Cyclohexane	N/A	1.05E-07
Total	**1.87E-01**	**2.17E-03**

Note: N/A indicates there is no regulatory limit for the VOC.

3.4 ROM Salt Material Compatibility Evaluation

The WPC consists of bulkheads and ROM salt. Additional steel from bulkheads used in the WPC for individual panels is not expected to affect repository modeling and analysis. Since only the outer steel bulkheads are subject to repository ventilation, only trace amounts of brine would contact the steel bulkheads over the operational period. This is due to the low moisture content of the halite. The outer steel bulkheads can be replaced or repaired if needed. ROM salt is entirely compatible with the underground environment.

4.0 Technical Specifications

The specifications are in the engineering file room at the WIPP facility. These specifications are included as an attachment in Appendix C and are summarized in Table 4-1.

Table 4-1 Technical Specifications for the WIPP Panel Closure System

Division 1 - General Requirements	
Section 01010	Summary of Work
Section 01090	Reference Standards
Section 01400	Contractor Quality Control
Section 01600	Material and Equipment
Division 2 - Site Work	
Section 02010	Mobilization and Demobilization
Section 02222	Excavation
Division 4 - Salt	
Section 04100	Run-of-Mine Salt

5.0 Drawings

The Drawings (Appendix D) are in the engineering file room at the WIPP facility and are summarized in Table 5-1.

Table 5-1 WIPP Panel Closure System Drawings

Drawing Number	Title
262-001	WIPP Panel Closure System Title Sheet
262-002	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (3,4,6,7,8)
262-003	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (1,2,5)
262-004	WIPP Panel Closure System, Construction Details

6.0 Conclusions

This chapter presents the conclusions for the design activities for the WPC. Table 6-1 shows the Permit design requirements for the WPC and the compliance of the design with these requirements. The design configuration and essential features for the WPC include ROM salt, and two barriers. The barriers consist of two steel bulkheads placed at the ends of the ROM salt or alternatively, one steel bulkhead and a block wall. The design includes a minimum length of 100 ft of ROM salt.

This report presents the design as a series of calculations and Engineering Drawings and Specifications that comply with the design requirements for the WPC. Structural and air flow analyses are used to select the design features and are based upon data acquired from the WIPP underground. The Drawings illustrate and describe the construction and details for the WPC. The Specifications cover the general requirements of the system, quality assurance and quality control, site work, and ROM salt emplaced in the panel entries. The WPC can be built to generally accepted national design and construction standards. Bulkheads are not included in the Specifications (Section 2.1) since they are routinely constructed and used at the WIPP facility. There is no construction or materials specification for bulkheads, only a performance requirement (2,200 P.U. air flow resistance).

The design complies with all aspects of the design basis established for the WPC. The design can be constructed in the underground environment with no special requirements at the WIPP facility. To investigate several key aspects of the design and to implement the design, design evaluations were performed. The conclusions reached from the evaluations are as follows:

- An air gap forms between the excavation roof and the top of the fill due to the settlement of the ROM salt. Structural modeling results using the three dimensional finite difference code FLAC3D predict the change in gap height and density of the salt with time. The salt compacts from its initial placement density to approximately 90% of the intact salt density under its own weight 23 years after panel closure.

- A VOC Flow Model accounts for gas generation, panel-creep closure, and the effects of underground ventilation of the adjacent main exhaust drift. The VOC Flow Model evaluates the reduction in air conductivity that occurs with the increase in salt density, reduction in gap size and reduction in porosity. The low air flow through the WPC is initially caused by the effects of ventilation of the adjacent main exhaust drift. About 23 years after closure, the air gap above the ROM salt is eliminated. The ROM salt consolidates due to panel-entry closure and air conductivity is significantly reduced. This results in low air flow rates.

- The passive design components of the WPC require minimal routine maintenance during the nominal operational life. Out-by bulkheads must be maintained to provide 2,200 P.U. resistance for 23 years after installation.
- The WPC provides for flexibility over the remaining operational life in construction scheduling and construction material transportation and therefore minimizes the effect on waste receipt.

In addition to the design requirements presented above, the design includes a construction QA/QC program to verify material properties and construction practices.

The predicted mass flow rates for CCl_4 and other VOCs through the WPC (including flow through the DRZ, the steel bulkheads and the ROM salt) will result in concentrations that are below the HBLs established at the WIPP site boundary. Concentrations at other surface and underground locations were not analyzed. Modeling results of the WPC did not produce VOC concentrations from combined effects that would exceed limits for the repository. If the HBLs, air dispersion factors, or the average headspace values change, the calculations should be re-evaluated to ensure that compliance is maintained.

It is also concluded that:

- The WPC provides for flexibility over the remaining operational life in construction scheduling and construction material transportation effects on facility operations.
- The existing shafts and underground access can accommodate the construction of the WPC.

While no specific requirements exist for closing disposal areas under MSHA regulations, the intent of the regulations is to safely isolate abandoned areas from active workings using barricades of substantial construction. The ROM salt is considered substantial construction.

Table 6-1 Expected Compliance with Performance Specifications

No.	Current Design Requirement	Expected Compliance with Requirement	Section in Report	Notes on Compliance
1	The panel closure system shall contribute to meeting the environmental performance standards in Permit Part 4 Section 4.6.2 by mitigating the migration of VOCs from closed panels.	Complies	3.3.5, Appendix A	Complies with the use of ventilation bulkheads with flexible flashing to accommodate salt creep and ROM salt a minimum of 100 ft in length.
2	The panel closure system shall consider potential flow of VOCs through the disturbed rock zone (DRZ) in addition to flow through closure components.	Complies	3.3.3	VOCs flow model considers flow through the DRZ.
3	The panel closure system shall perform its intended functions under loads generated by creep closure of the tunnels.	Complies	3.2.7	The flexible flashing and maintenance of the steel bulkhead accommodates panel entry creep closure. The plastic deformation of the ROM salt will result in a reduction in porosity and permeability with time.
4	The nominal operational life of the closure system is thirty-five (35) years.	Complies	3.2.7, 3.3.5	The combination of maintaining the outer bulkheads with ROM salt can accommodate a design life of 35 years.
5	The panel closure system may require minimal maintenance per 20.4.1.500 NMAC (incorporating 40 CFR 264.111)	Complies	2.2.1	The ROM salt requires no future maintenance. The outbye bulkhead can be maintained or replaced with minimal maintenance.

No.	Current Design Requirement	Expected Compliance with Requirement	Section in Report	Notes on Compliance
6	The panel closure system addresses the expected ground conditions in the waste disposal areas.	Complies	2.2, 3.2.6	Design is based upon structural analyses and flow for the most severe ground conditions.
7	The panel closure system shall be built of substantial construction and non-combustible material except for flexible flashing used to accommodate salt movement.	Complies	Appendix C Section 04100	The panel closure system uses ROM salt which is of substantial construction. The materials are noncombustible except for the flexible flashing.
8	The design and construction shall follow conventional mining practices.	Complies	2.3	The future construction sequence for the design will follow conventional civil and mining practices.
9	Structural analysis shall use data acquired from the WIPP underground.	Complies	3.2, 3.3	Available geomechanical, air flow and gas generation measurements were used in the analysis.
10	Materials shall be compatible with their emplacement environment and function.	Complies	3.4	ROM salt is compatible with the surrounding environment. The out bye steel bulkheads can be replaced when the design life is exceeded.
11	Treatment of surfaces in the closure areas shall be considered in the design.	Complies	2.1, Appendix C Section 02222	Surface scaling of loose material surrounding the WPC is included in the design specifications.
12	A QA/QC program shall verify material properties and construction.	Complies	2.1, Appendix C Section 01400	Future submittals according to the design specifications will utilize materials testing to verify material properties and future construction practices as necessary.
13	The construction of the panel closure system shall consider shaft and underground access and services for materials handling.	Complies	2.1, Appendix C, Section 01010	The specification allows future construction within the capacities of the underground access.

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APPENDIX A
DERIVATION OF RELATIONSHIPS FOR THE AIR-FLOW MODELS

APPENDIX A
DERIVATION OF RELATIONSHIPS FOR THE AIR-FLOW MODELS

A1.0 Introduction

This appendix presents the derivation of the air-flow model used to determine the performance of the WIPP Panel Closure (**WPC**). These derivations were used in the analyses in Section 3 to determine air flow from a single panel. These analyses provide an estimate of the volatile organic compound (**VOC**) flow for the Waste Isolation Pilot Plant (**WIPP**).

A2.0 Air Flow Model

The waste-emplacement capacity of a panel includes the seven rooms and the panel-access drifts from Rooms 1 to 7. Field data from geotechnical engineering measurements was used to determine closure rates for 35 years as presented in DOE (1996, Appendix B). Appendix B provides review and analysis of existing information with the conclusion that the underground ventilation effects of the adjacent exhaust drift are significant for **VOC** transport.

Consider a simple resistance model from Figure A-1. The rooms of the waste emplacement panel are interconnected with air gaps along the sides and the tops of the waste stack. Assuming air flow through a resistance network, Bear (1972, p. 712) and Chapman (1974, pp. 171 -174) provides a heat flow network resistance model for heat transfer that is analogous to an air flow model for VOCs transport. Air flow is governed by Darcy's Law under quasi steady state conditions:

$$Q = -K \cdot i \cdot A$$

Equation A-1

Where

Q Flow rate (ft^3/s [m^3/s]),

i Air flow gradient,

A Flow Area (ft^2 [m^2]), and

K Air conductivity (ft/s [m/s])

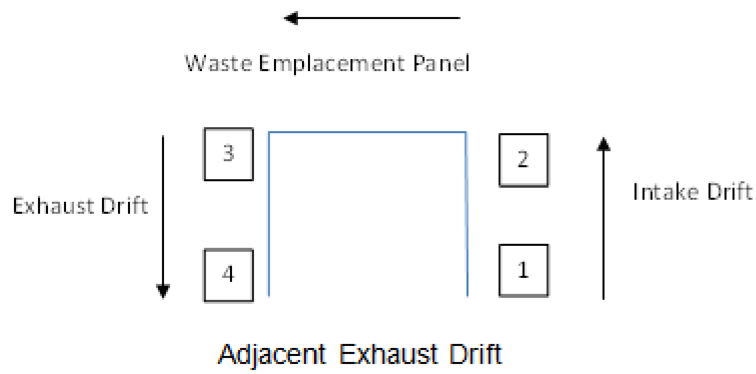

Figure A-1 Network for WPC Analysis

The effective air conductivity (K) can be further expressed in terms of the effective intrinsic permeability of the panel closure system and the fluid properties of air as (Freeze and Cherry, 1979, p. 27):

$$K_S = \frac{k_S \cdot \rho \cdot g}{\mu}$$

Equation A-2

where

K_s Effective air conductivity of panel closure system (ft/s [m/s]),

k_s Effective intrinsic permeability of panel closure system (ft^2 [m^2]),

ρ Air mass density (lb/ft^3 [kg/m^3]),

g Acceleration due to gravity (ft/s^2 [m/s^2]), and

μ Absolute air viscosity (lb/(ft s) [kg/(m·s)]).

A3.0 Effective Intrinsic Permeability of a Parallel System

Air conductance is defined as the product of the air conductivity and cross sectional area divided by the flow path length. The effective flow conductance for a parallel system consisting of n flow components can be obtained in terms of the conductances of its flow components as follows (Freeze and Cherry, 1979):

$$C_t = \sum_{i=1}^{n} C_i$$

Equation A-3

where

C_t Total flow conductance of the system, and

C_i Flow conductance of the i^{th} component.

Based on the definition of flow conductance, this can be rewritten as:

$$K_t \frac{A_t}{L} = \sum_{i=1}^{n} K_i \frac{A_i}{L}$$

Equation A-4

or

$$K_t = \frac{\sum_{i=1}^{n} K_i A_i}{A_t}$$

Equation A-5

where

K_t Effective conductivity of the system (ft/s [m/s]),

A_i Cross-sectional area of the i^{th} component (ft^2 [m^2]),

A_t Total cross-sectional area of the system ($\sum_{i=1}^{n} A_i$)(ft^2 [m^2]), and

L Length of flow path (ft [m]).

A4.0 Effective Intrinsic Permeability of a Series System

The effective flow conductance for a series system consisting of n flow components can be obtained in terms of the conductances of its flow components as follows (Freeze and Cherry, 1979):

$$\frac{1}{C_t} = \sum_{i=1}^{n} \frac{1}{C_i}$$

Equation A-6

where

C_t Total flow conductance of the system (ft^2/s) [m^2/s]), and

C_i Flow conductance of the i^{th} component (ft^2/s) [m^2/s]).

Based on the definition of flow conductance (Equation A-3), Equation A-6 can be rewritten as follows:

$$\frac{L_t}{K_t\ A} = \sum_{i=1}^{n} \frac{L_i}{K_i\ A}$$

Equation A-7

or

$$K_t = \frac{L_t}{\sum_{i=1}^{n} \frac{L_i}{K_i}}$$

Equation A-8

where

K_t Effective conductivity of the system (ft/s [m/s])

L_i Length of flow path for i^{th} component (ft [m])

L_t Total length of flow path ($\sum_{i=1}^{n} L_i$) (ft [m]), and

A Cross-sectional area of the flow path (ft^2 [m^2])

Now write expressions for the flow rate $Q_{12}(t)$, and $Q_{34}(t)$. Assume the resistance to flow in branch 23 of Figure A-1 is small since there might exist an air gap at the top and on the sides of the waste stack. However, there are source terms for gas generation, and panel creep closure. The flow rates are written as functions of time to account for consolidation of the emplaced salt. Express the total head in terms of water gage:

$$Q_{12}(t) = -\left[\sum_{i=1}^{4} \left(\frac{K_i \cdot A_i}{L}\right) + \frac{\rho_a \cdot g}{\mu} \cdot \frac{k_{ID}(t) \cdot A_{ID}}{L}\right] \cdot \left(h_1 \cdot \frac{\rho_w}{\rho_a} - h_2 \cdot \frac{\rho_w}{\rho_a}\right)$$

Equation A-9

$$Q_{34}(t) = -\left[\sum_{i=1}^{4} \left(\frac{K_i \cdot A'_i}{L}\right) + \frac{\rho_a \cdot g}{\mu} \cdot \frac{k_{ED}(t) \cdot A_{ED}}{L}\right] \cdot \left(h_3 \cdot \frac{\rho_w}{\rho_a} - h_4 \cdot \frac{\rho_w}{\rho_a}\right)$$

Equation A-10

Where

$Q_{12}(t)$ Air flow rate through the intake drift (ft^3 /s [m^3/s]) as a function of t,

$Q_{34}(t)$ Air flow rate through the exhaust drift (ft^3/s [m^3/s]) as a function of t,

K_i Air conductivity of the *i*th component of the DRZ (ft/s [m/s]),

$k_{ID}(t)$ Average intrinsic permeability (ft^2 [m^2])for the run-of-mine (ROM) salt in the intake drift as a function of t (s),

$k_{ED}(t)$	Average intrinsic permeability (ft^2 [m^2]) for the three layers of compacted salt in the exhaust drift as a function of *t*,
A_{ID}	Area of the intake drift (ft^2 [m^2]),
A_{ED}	Area of the exhaust drift (ft^2 [m^2]),
A_i	Area of the *i*th component of the DRZ for the intake drift (ft^2 [m^2]),
A'_i	Area of the *i*th component of the DRZ for the exhaust drift (ft^2 [m^2]),
L	Length of the compacted salt (ft [m]),
ρ_a	Mass density of air (lb/ft^3 [kg/m^3]),
ρ_w	Mass density of water(lb/ft^3 [kg/m^3]),
μ	Absolute viscosity (lb/(ft s) [kg/(m s)]),
g	Acceleration due gravity (ft/s^2 [m/s^2]),
h_1	Water gage at point 1(ft [m]),
h_2	Water gage at point 2(ft [m]),
h_3	Water gage at point 3(ft [m]),
h_4	Water gage at point 4(ft [m]), and
t	Time(s)

Noting that h_3 equals h_2 based upon the low air flow resistance in Branch 23, and equating the air flow rates:

$$-\left[\sum_{i=1}^{4}\left(\frac{K_i \cdot A_i}{L}\right)+\frac{\rho_a \cdot g}{\mu}\cdot\frac{k_{ID}(t)\cdot A_{ID}}{L}\right]\cdot\left(h_1\cdot\frac{\rho_w}{\rho_a}-h_2\cdot\frac{\rho_w}{\rho_a}\right)=-\left[\sum_{i=1}^{4}\left(\frac{K_i \cdot A'_i}{L}\right)+\frac{\rho_a \cdot g}{\mu}\cdot\frac{k_{ED}(t)\cdot A_{ED}}{L}\right]\cdot\left(h_2\cdot\frac{\rho_w}{\rho_a}-h_4\cdot\frac{\rho_w}{\rho_a}\right)$$

Equation A-11

Define time dependent functions for the conductances of the air intake and air exhaust panels:

$$A(t) = \sum_{i=1}^{4} \left(\frac{K_i \cdot A_i}{L} \right) + \frac{\rho_a \cdot g}{\mu} \cdot \frac{k_{ID}(t) \cdot A_{ID}}{L}$$

Equation A-12

$$B(t) = \sum_{i=1}^{4} \left(\frac{K_i \cdot A'_i}{L} \right) + \frac{\rho_a \cdot g}{\mu} \cdot \frac{k_{ED}(t) \cdot A_{ED}}{L}$$

Equation A-13

$$A(t) \cdot h_2 \cdot \frac{\rho_w}{\rho_a} - A(t) \cdot \left(h_1 \cdot \frac{\rho_w}{\rho_a} \right) = -\left(B(t) \cdot h_2 \cdot \frac{\rho_w}{\rho_a} \right) + B(t) \cdot h_4 \cdot \frac{\rho_w}{\rho_a}$$

Equation A-14

Solving for the potential at node h_2 and noting that potential is a function of time:

$$h_2(t) = \frac{h_1 \cdot A(t) + h_4 \cdot B(t)}{A(t) + B(t)}$$

Equation A-15

The function for $h_2(t)$ is then substituted into the relationships for $Q_{12}(t)$, and $Q_{34}(t)$ in Equations A-9 and A-10. The function $Q_{34}(t)$ is then used to produce the relationship of air flow through the WPC as discussed subsequently.

A5.0 Flow Through Ventilation Bulkheads and an Air Gap

The analysis presented above applies to panel closures in which the air gap has been closed. Consider an air gap forms at the top of the ROM salt backfill. For laminar flow in a narrow slit, the flow rate is given by (Bird et al., 1960, p. 62):

$$Q = \frac{2}{3} \cdot \frac{(P_U - P_L) \cdot B^3 \cdot W}{\mu \cdot L}$$

Equation A-16

Where

Q Flow rate (ft^3 /s [m^3/s]),

P_U Upstream pressure (psi [Pa]) ,

P_L Downstream pressure (psi [Pa]),

B One half width of the aperture (ft [m]),

L Length over which the pressure drop takes place (ft [m]),

μ Absolute viscosity (lb/(ft s) [kg/(m s)]), and

W Flow width (ft [m]).

An equivalent conductivity can be derived by considering Darcy's Law:

$$Q = K \cdot i \cdot A$$

Equation A-17

Where

K Air conductivity (ft/s [m/s],

i Air gradient, and

A Flow Area (ft^2 [m^2])

Substituting in Equation A-16 into Equation. A-17:

$$Q = \frac{1}{3} \cdot \frac{B^2}{\mu} \cdot \gamma \cdot \frac{(H_U - H_L)}{L} \cdot W \cdot 2B$$

Equation A-18

In the above relationship, the pressure equals the head times the weight density (γ). Substituting in the mass density:

$$Q = \frac{1}{3} \cdot \frac{B^2}{\mu} \cdot \rho \cdot g \cdot \frac{(H_U - H_L)}{L} \cdot W \cdot 2B$$

Equation A-19

The expression for the air conductivity becomes:

$$K = \frac{1}{3} \cdot B^2 \cdot \frac{\rho \cdot g}{\mu}$$

Equation A-20

$$k = \frac{1}{3} \cdot B^2$$

Equation A-21

Expressing the intrinsic permeability in terms of the full aperture width (B=b/2):

$$k = \frac{b^2}{12}$$

Equation A-22

The flow through a single bulkhead in the ventilation circuit shown in Figure A-1 is expressed as:

$$h_{12} = R_{12} \cdot Q_{12}{}^2$$

Equation A-23

Where

h_{12} Head loss through a single bulkhead (milli inches water gage),

R_{12} Bulkhead resistance (Practical Units), and

Q_{12} Flow rate through the bulkhead (kcfm).

For this ventilation analysis, the flow path 12 and 24 represents flow through bulkheads while the flow path 23 represents the flow through air gap above the crushed salt.

Solve for the flow rate Q_{12} in terms of h_{12}:

$$Q_{12} = \sqrt{\frac{h_{12}}{R_{12}}}$$

Equation A-24

Equating the flow rate to the flow rate through the air gap:

$$Q_{12} = Q_{23}$$

Equation A-25

$$\sqrt{\frac{h_{12}}{R_{12}}} = \frac{K_s \cdot A_{Gap}}{L_{Path}} \cdot H_{23}$$

Equation A-26

Invoking symmetry ($h_{12} = h_{24}$) and that the total head loss is given by:

$$h_{Total} = 2 \cdot h_{12} + h_{23}$$

Equation A-27

Solving for h_{23}:

$$H_{23} = H_{Total} - 2H_{12}$$

Equation A-28

Substituting this equation into Equation A-26 and expressing the head loss in terms of water gage:

$$\sqrt{\frac{h_{12}}{R_{12}}} = \frac{K_s \cdot A_{Gap}}{L_{Path}} \cdot (h_{Total} - 2 \cdot h_{12} \cdot) \cdot \frac{\gamma_h}{\gamma_a}$$

Equation A-28

This equation is solved graphically for the h_{12}.

A5.0 Current Closure Plan and Projected Panel Closure Schedule

The current Resource Conservation and Recovery Act (**RCRA**) Closure Plan for the WIPP includes monitoring for compliance with individual VOCs limits for the WIPP repository. The repository VOCs concentration limits are listed in Table A-1 and are applied at the E-300 Point of Compliance. The E-300 point of compliance is located at the intersection of the E-300 exhaust drift, and S-1300 cross drift as illustrated in Figure N-1 of the Permit. Panel closures, in conjunction with operational practices in the active panel are used to meet limits on these concentrations of concern. The following discussion presents the schedule for panel closures.

The WIPP Permit currently includes the original design for Option D. Following completion of the design report for the WPC, an updated RCRA Permit submittal is planned by December 2012. The updated WIPP Permit would be evaluated for a period of one year with approval of the new WIPP permit modification by December 2013. At that time, the panel closures would be implemented in Panels 1 through 6 by January 31, 2016. Panel 7 would be closed six months after this time by July 2016. Table A-1 shows the estimated schedule for future panel closures.

Table A-1 Estimated Schedule for Future Panel Closure Activities

Closure Activity	Date
Submit WPC Permit Modification	12/31/2011
Complete Ventilation Barriers to Panel 6	3/16/2013
Receive WPC Permit Approval	12/30/2013
Close Panel 6	6/1/2014
Close Panel 4	7/1/2014
Close Panel 3	1/1/2015
Close Panel 2	1/1/2015
Close Panel 1	7/1/2015
Close Panel 5	1/31/2016
Close Panel 7	2/1/2018
Close Panel 8	10/1/2021
Close Panel 9	6/1/2025
Close Panel 10	2/1/2029

Source: Washington, TRU (2011)

A5.0 References

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APPENDIX B
Analysis and Review of Existing Information

B1 Existing Panel Operations

Since March 1999, contact-handled TRU (**CH TRU**) waste has been emplaced in the WIPP underground repository starting with Panel 1, and continuing to the present with active operations in Panel 6. Block walls have been installed for Panels 1, 2, and 5. Currently the project has installed steel bulkheads for Panels 3 and 4. VOCs, hydrogen, and methane are monitored at various locations within these panels.

The current active CH TRU waste panel is Panel 6 with waste emplacement activities commencing in July 2011 upon retreat according to the waste emplacement plan. Completion of waste emplacement activities in the active Panel 6 is anticipated to occur during 2013.

B2 Ventilation Information

Consistent with Permit requirements, the WIPP facility operating staff maintains a minimum repository ventilation exhaust rate of 260,000 standard ft^3/min (7,360 m^3/min) and a minimum ventilation rate of 35,000 standard ft^3/min (990 m^3/min) in the active room when workers are present. Ventilation barricades are used in active underground hazardous waste disposal units (**HWDUs**) to prevent the flow of mine ventilation air through full disposal rooms, as specified in Attachment A2 of the Permit.

The WIPP operations provide ventilation in four underground circuits. These include the Waste Disposal Circuit; the Construction Ventilation Circuit; the Waste Shaft Station Circuit, and the North Area Circuit. Ventilation analysis has been performed for the WIPP repository during various stages of operation and underground repository development. Appendix B presents pressure drops in the exhaust drifts adjacent to closed or inactive panels for the normal operating and full flow operating modes. Normal Mode is comprised of operating two of the three 700 fans at an exhaust ventilation rate of 460 kacfm[1] (13,030 m^3/min). Regulators are configured to obtain flows in the four underground ventilation circuits as described as follows:

[1] kacfm = 1000 actual cubic feet per minute

Circuit	Ventilation Rate (kacfm)
Waste Disposal Ventilation Circuit	170
Construction Ventilation Circuit	140
Waste Shaft Station Circuit	70
Northern Area Circuit	80

Full Flow is comprised of two of three main 700 area fans running (approximately 460 kacfm (13,030 m^3/min) of exhaust) with regulators opened to "reasonable" settings based on underground ventilation experience. The regulators are not adjusted to achieve particular flows in the different circuits. Measurements are taken to determine resistance throughout the underground and to quantify the air flow distribution with as little regulation as possible. This initial data gathering guides the regulation of air to achieve the desired distribution when testing and balancing under Normal Mode operations. Full Flow and Normal Mode provide representative flow in the active and inactive waste emplacement areas.

The WIPP project performed ventilation analysis for the repository during various stages of operation and underground development. Table B-1 presents pressure drop measurements in the exhaust drifts adjacent to closed or inactive panels for the normal operating mode. Table B-2 presents pressure drop measurements for the full flow operating mode. For the normal operating mode, the average value for the pressure drop was 163 milli inches (4.14 mm) of water gage. The range of pressure drops was from 12 to 350 milli inches (0.31 to 8.90 mm) water gage. For the full operating mode, the average value was 165 milli inches (4.19 mm) of water gage with a range of values from 0 to 394 milli inches (0 to 10 mm) of water gage.

Table B-1 Ventilation Analysis for the Normal Operating Mode

Date	Mar-08		Aug-09	
Panel	Panel Status	Pressure Drop (milli inches Water Gage)	Panel Status	Pressure Drop (milli inches Water Gage)
1	Closed	356	Closed	133
2	Closed	118	Closed	74
3	Closed	12	Closed	96
4	Active	NA	Inactive	350
5	Under Construction	NA	Active	NA
6	NA	NA	Under Construction	NA
7	NA	NA	NA	NA
8	NA	NA	NA	NA
9	NA	NA	NA	NA
10	NA	NA	NA	NA

Average	163	(milli inches Water Gage)
Minimum Value	12	(milli inches Water Gage)
Maximum Value	350	(milli inches Water Gage)

Source: Mine Ventilation Services (2008, 2009)

Table B-2 Ventilation Analysis for the Full Flow Operating Mode

Date	Mar-04		Aug-05		Oct-06		Aug-09		Oct-10	
Panel	Panel Status	Pressure Drop (milli inches Water Gage)	Panel Status	Pressure Drop (milli inches Water Gage)	Panel Status	Pressure Drop (milli inches Water Gage)	Panel Status	Pressure Drop (milli inches Water Gage)	Panel Status	Pressure Drop (milli inches Water Gage)
1	Closed	25	Closed	394	Closed	236	Closed	113	Closed	263
2	Active	NA	Inactive	204	Closed	128	Closed	62	Closed	202
3	Under Construction	NA	Active	NA	Inactive	101	Inactive	78	Inactive	68
4	NA	NA	Under Construction	NA	Active	NA	Inactive	456	Inactive	0
5	NA	NA	NA		Under Construction	NA	Active	NA	Active	NA
6	NA	NA	NA		NA	NA	Under Construction	NA	Active	NA
7	NA	NA	NA		NA	NA	NA	NA	Under Construction	NA
8	NA	NA	NA		NA	NA	NA	NA	NA	NA
9	NA	NA	NA		NA	NA	NA	NA	NA	NA
10	NA	NA	NA		NA	NA	NA	NA	NA	NA

Average Value	166	(milli inches Water Gage)
Minimum Value	0	(milli inches Water Gage)
Maximum Value	394	(milli inches Water Gage)

Source: Mine Ventilation Services (2004), 2005, 2006, 2009, 2010)

During future WIPP repository operations and development, overall WIPP repository air flow resistance could increase. For example if Panels 9 and 10 are developed to the south of Panels 4 and 5, air exhaust lengths might increase. For purposes of analysis, it is assumed that the pressure drop for air flow between the panel intake drift and the panel exhaust drift is 170 milli inches of water gage.

B3 References

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APPENDIX C

TECHNICAL SPECIFICATIONS

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.1 Scope

This section includes:

- Scope of Work
- Definitions and Abbreviations
- List of Drawings
- Work by Others
- Contractor's Use of Site
- Contractor's Use of Facilities
- Work Sequence
- Work Plan
- Health and Safety Plan (HASP)
- Contractor Quality Control Plan (CQCP)
- Submittals

1.2 Scope of Work

The Contractor shall furnish all labor, materials, equipment and tools to construct two (2) WIPP panel closure systems for Panels 1 through 10. Each WIPP Panel closure system consists of two steel bulkheads and ROM salt, one of each to be installed in the air-intake drift and the air-exhaust drift of a waste disposal panel, as shown on the Drawings and described in these Specifications. Unless otherwise agreed by Nuclear Waste Partnership, the Contractor shall use Nuclear Waste Partnership supplied equipment underground. Such use shall be coordinated with Nuclear Waste Partnership and may include the use of Nuclear Waste Partnership qualified operators.

The scope of work shall include but not necessarily be limited to the following units of work:

- Develop work plan, health and safety plan (HASP) and contractors quality control plan (CQCP) and submit it for approval
- Prepare and submit all plans requiring approval
- Mobilize to site

- Coordinate construction with WIPP operations
- Perform the following operations for the air-intake entry and the air-exhaust entries that do not contain block walls:
    1. Construct the inner steel bulkhead
    2. Prepare the surfaces for the ROM salt.
    3. Construct the inner steel bulkhead
    4. Place ROM salt material in multiple layers
    5. Construct the outer steel bulkhead
    6. Clean up construction areas in underground and above ground
    7. Submit all required record documents
    8. Demobilize from site

Perform the following operations for the air-intake entry and the air exhaust entries that do contain existing block walls

1. Prepare the surfaces for the ROM salt
2. Place ROM salt material in multiple layers
3. Construct the outer steel bulkhead
4. Clean up construction areas in underground and above ground
5. Submit all required record documents
6. Demobilize from site

1.3 Definitions and Abbreviations

Definitions

Creep—Viscoplastic deformation of salt under deviatoric stress.

Block Wall— Existing mortared concrete brick wall adjacent to the panel waste disposal area as shown in the drawings.

Methane explosion—A postulated deflagration caused by methane gas at an explosive level.

Partial closure—The process of rendering a part of the hazardous waste management unit in the underground repository inactive and closed according to approved facility closure plans.

Run of Mine Salt (ROM) — A salt obtained from mining operations emplaced in an uncompacted state.

Volatile Organic Compound (VOC) —Any VOC with Hazardous Waste Facility Permit emission limits.

Nuclear Waste Partnership—Nuclear Waste Partnership, LLC as the construction management authority.

Abbreviations/Acronyms

ACI	American Concrete Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CFR	Code of Federal Regulations
CQCP	Contractor Quality Control Plan
DOE	U.S. Department of Energy
DWG	Drawing
EPA	U.S. Environmental Protection Agency
HASP	Health And Safety Plan
JHA	Job Hazard Analysis
LHD	Load Haul Dump
LLC	Limited Liability Corporation
MSHA	U.S. Mine Safety and Health Administration
RCRA	Resource Conservation and Recovery Act
USACE	U.S. Army Corps of Engineers
VOC	Volatile Organic Compound
WIPP	Waste Isolation Pilot Plant

1.4 List of Drawings

The following Drawings are made apart of this Specification:

Drawing No.	Title
DWG 262-001	WIPP Panel Closure System Title Sheet
DWG 262-002	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (3,4,6,7,8)
DWG 262-003	WIPP Panel Closure System, Underground Waste Disposal Panel Configurations (1,2,5)
DWG 262-004	Construction Details

1.5 Work by Others

Survey

All survey work to locate, control, confirm, and complete the work will be performed by Nuclear Waste Partnership. All survey work for record purposes will be performed by Nuclear Waste Partnership. The Contractor shall be responsible for developing the salt backfill to fit the excavation.

Nuclear Waste Partnership may elect to perform certain portions, or all, of the work. The work performed by the Nuclear Waste Partnership will be defined prior to the contract. Unless otherwise agreed by Nuclear Waste Partnership, the Contractor shall use underground equipment furnished by Nuclear Waste Partnership for construction of the steel bulkheads and placement of ROM salt. Underground mining personnel who are qualified for the operation of such underground construction equipment may be made available to the Contractor. The use of Nuclear Waste Partnership equipment shall be coordinated with Nuclear Waste Partnership.

1.6 Contractor's Use of Site

Site Conditions

The WIPP site is located near Carlsbad in southeastern New Mexico, as shown on the Drawings. The underground arrangements and location of the WIPP waste disposal panels are shown on the Drawings. The work is to construct steel bulkheads and place ROM salt in the air-intake and air-exhaust drifts of one of the panels upon completion of the disposal phase of that panel. The waste disposal panels are located approximately 2,150 ft. (655 m) below the ground surface. The Contractor shall visit the site and become familiar with the site and site conditions prior to preparing his bid proposal.

Contractor's Use of Site

Areas at the ground surface will be designated for the Contractor's use in assembling and storing his equipment and materials. The Contractor shall utilize only those areas so designated.

Limited space within the underground area will be designated for the Contractor's use for storage of material and setup of equipment.

Coordination of Contractor's Work

The Contractor is advised that on-going waste emplacement and excavation operations will be conducted throughout the period of construction of the panel closure system. These operations have priority over the Contractor's work. The Contractor shall coordinate his construction operations with that of the waste emplacement and mining operations. All coordination shall be through Nuclear Waste Partnership.

1.7 Contractor's Use of Facilities

Existing facilities at the site available for use by the Contractor are:

- Waste shaft conveyance
- Salt skip hoist
- 460 volt AC, 3 phase power
- Water (underground, at waste shaft only) (above ground, at location designated by Nuclear Waste Partnership)

Additional information on mobilization and demobilization to these facilities is presented in Section 02010.

1.8 Work Sequence

Work Sequence shall be as shown on the Drawings and as directed by Nuclear Waste Partnership.

1.9 Work Plans

The Contractor shall prepare Work Plans fully describing the proposed fabrication, installation and construction for each WIPP Panel Closure System. The work plan shall define all proposed materials, equipment and construction methods. The Work Plan shall state all supporting processes, procedures, materials safety data sheets, and regulations by reference. The work plans shall address precautions related to the Job Hazards Check List. The Work Plan shall address limitations such as hold and witness points. The Work Plans shall address all prerequisites for work. Nuclear Waste Partnership shall approve the Work Plan and no work shall be performed prior to approval of the Work Plan.

1.10 Health and Safety Plan (HASP)

The Contractor shall obtain, review, and agree to applicable portions of the existing WIPP Safety Manual, WP 12-1. The Contractor shall prepare a project-specific HASP taking into account all applicable sections of the WIPP Safety Manual. All personnel shall be qualified to work underground. All personnel operating heavy construction equipment shall be qualified to operate such equipment. The Contractor shall also perform a Job Hazard Analysis (JHA) in accordance with WP 12-111. Nuclear Waste Partnership shall approve the HASP and JHA and no work shall be performed prior to approval of the HASP and JHA.

1.11 Contractor Quality Control Plan (CQCP)

The Contractor shall prepare a CQCP identifying all personnel and procedures necessary to produce an end product, which complies with the contract requirements. The CQCP shall comply with all Nuclear Waste Partnership requirements, including operator training and qualification; and Section 01400, Contractor Quality Control, of this Specification. Nuclear Waste Partnership shall approve the CQCP and no work shall be performed prior to approval of the CQCP.

1.12 Submittals

Submittals shall be in accordance with Nuclear Waste Partnership Submittal Procedures and as required by the individual Specifications.

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

Not used

End of section

SECTION 01090

REFERENCE STANDARDS

PART 1 - GENERAL

1.1 Scope

This section includes:

- Provision of Reference Standards at Site
- Acronyms used in Contract Documents for Reference Standards

1.2 Quality Assurance

For products or workmanship specified by association, trade, or Federal Standards, the Contractor shall comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

Conform to reference by date of issue current on the date of the owner-contractor agreement.

The Contractor shall obtain, at his own expense; a copy of the standards referenced in the individual Specification sections and shall maintain that copy at the jobsite until completion and acceptance of the work.

Should specified Reference Standards conflict with the contract documents, the Contractor shall request clarification from Nuclear Waste Partnership before proceeding.

1.3 Schedule of References

Various publications referenced in other sections of the Specifications establish requirements for the work. These references are identified by document number and title. The addresses of the organizations responsible for these publications are listed below.

ANSI	American National Standards Institute 25 West 43rd St. New York NY 10036 Ph: 212-642-4900 Fax: 212-398-0023
ASTM	ASTM International 100 Barr Harbor Drive P.O. Box C700, West Conshohocken, Pennsylvania 19428-2959 Ph: 610-832-9585 Fax: 610-832-9555
CFR	Code of Federal Regulations Government Printing Office 732 N. Capital Street, NW Washington D. C. Ph: 202-512-1530 Fax: 202 512-1262
EPA	Environmental Protection Agency 1445 Ross Avenue Suite 1200 Dallas Texas 75202-2733 Ph: 214-665-2200 Fax: 800-887-6063
FTM-STD	Federal Test Method Standards Standardization Documents Order Desk Bldg. 4D 700 Robbins Ave. Philadelphia, PA 19111-5094 Ph: 215-697-2179 Fax: 215-697-2978

NIST	National Institute of Standards and Technology 100 Bureau Drive, Stop 1000 Gaithersburg, MD 20899-1000 Ph: 301-975-6478 Fax: 301-975-8295
NTIS	National Technical Information Service U.S. Department of Commerce 5301 Shawnee Rd Alexandria, Virginia 22312 Ph: 703- 605-6000 Fax: 703-321-8547

End of section

SECTION 01400

CONTRACTOR QUALITY CONTROL

PART 1 - GENERAL

1.1 Scope

This section includes:

- Contractor Quality Control Plan (CQCP)
- Reference Standards
- Quality Assurance
- Tolerances
- Testing Services
- Inspection Services
- Submittals

1.2 Related Sections

- 01090 - Reference Standards
- 01600 - Material and Equipment
- 02222 - Excavation
- 04100 – Run-of-Mine Salt

1.3 Contractor Quality Control Plan (CQCP)

The Contractor shall prepare a Contractor Quality Control Plan (CQCP describing the methods to be used to verify the performance of the engineered components of the Panel Closure System. The quality control plan for the run-of-mine (ROM) salt shall detail the methods the Contractor proposes to meet the minimum requirements, and the standard quality control test methods to be used to verify that minimum requirements have been complied with. All equipment methods employed shall be traceable to standard quality control tests as approved in the CQCP. No work shall be performed prior to Nuclear Waste Partnership approval of the CQCP.

1.4 Reference Standards

Refer to individual Specification sections for standards referenced therein, and to Section 01090, Reference Standards, for general listing. Additional standards will be identified in the CQCP.

Standards referenced in this section are as follows:

ASTM E 329-01b	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
ASTM E 543-02	Standard Practice for Agencies Performing Nondestructive Testing

1.5 Quality Assurance

The Contractor shall:

- Monitor suppliers, manufacturers, products, services, site conditions, and workmanship to produce work of specified quality
- Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship
- Perform work with qualified persons to produce required and specified quality

1.6 Tolerances

The Contractor shall:

- Monitor excavation, fabrication, and tolerances in order to produce acceptable work. The Contractor shall not permit tolerances to accumulate.

1.7 Testing Services

Unless otherwise agreed by Nuclear Waste Partnership, the Contractor shall employ an independent firm qualified to perform the testing services and other services specified in the individual Specification sections, and as may otherwise be required by Nuclear Waste Partnership. Testing and source quality control may occur on or off the project site.

The testing laboratory shall comply with applicable sections of the Reference Standards and shall be authorized to operate in the State of New Mexico.

Testing equipment shall be calibrated at reasonable intervals traceable to either the National Institute of Standards and Technology or accepted values of natural physical constants.

1.8 Inspection Services

The Contractor may employ an independent firm to perform inspection services as a supplement to the Contractor's quality control as specified in the individual Specification sections, and as may be required by Nuclear Waste Partnership. Inspection may occur on or off the project site.

The inspection firm shall comply with applicable sections of the Reference Standards.

1.9 Submittals

The Contractor shall submit a CQCP as described herein.

Prior to start of work, the Contractor shall submit for approval, the testing laboratory name, address, telephone number and name of responsible officer of the firm as well as a copy of the testing laboratory compliance with the reference ASTM standards and a copy of report of laboratory facilities inspection made by Materials Reference Laboratory of National Institute of Standards and Technology with memorandum of remedies of any deficiencies reported by the inspection.

The Contractor shall submit the names and qualifications of personnel proposed to perform the required inspections, along with their individual qualifications and certifications. Once approved by Nuclear Waste Partnership these personnel shall be available as may be required to promptly and efficiently complete the work.

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

3.1 General

The Contractor is responsible for quality control and shall establish and maintain an effective quality control system. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product which complies with the contract requirements. The system shall cover all construction operations, both on site and off site, and shall be keyed to the proposed construction sequence. The project superintendent will be held responsible for the quality of work on the job. The project superintendent in this context is the individual with the responsibility for the overall management of the project including quality and production.

3.2 Contractor Quality Control Plan

3.2.1 General

The Contractor shall supply, not later than 30 days after receipt of notice to proceed, the Contractor Quality Control Plan (CQCP) which implements the requirements of the Contract. The CQCP shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. Construction shall not begin until the CQCP is approved by Nuclear Waste Partnership.

3.2.2 Content of the CQCP

The CQCP shall cover all construction operations, both on site and off site, including work by subcontractors, fabricators, suppliers, and purchasing agents and shall include, as a minimum, the following items:

- A description of the quality control organization, including a chart showing lines of authority and acknowledgment that the Contractor Quality Control (CQC) staff shall implement the control system for all aspects of the work specified.
- The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.
- A description of CQCP responsibilities and a delegation of authority to adequately perform the functions described in the CQCP, including authority to stop work.
- Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, off site fabricators, suppliers, and purchasing agents. These procedures shall be in accordance with Nuclear Waste Partnership Submittal Procedures.
- Control, verification, and acceptance testing procedures as may be necessary to ensure that the work is completed to the requirements of the Drawings and Specifications.
- Procedures for tracking deficiencies from identification, through acceptable corrective action, to verification that identified deficiencies have been corrected.
- Reporting procedures, including proposed reporting formulas.

3.2.3 Acceptance of Plan

Acceptance of the Contractor's plan is conditional. Nuclear Waste Partnership reserves the right to require the Contractor to make changes in his CQCP and operations, including removal of personnel, if necessary, to obtain the quality specified.

3.2.4 Notification of Changes

After acceptance of the CQCP, the Contractor shall notify Nuclear Waste Partnership in writing of any proposed change. Proposed changes are subject to acceptance by Nuclear Waste Partnership.

3.3. Tests

3.3.1 Testing Procedure

The Contractor shall perform specified or required tests to verify that control measures are adequate to complete the work to contract requirements. Upon request, the Contractor shall furnish, at his own expense, duplicate samples of test specimens for testing by Nuclear Waste Partnership. The Contractor shall perform, as necessary, the following activities and permanently record the results:

- Verify that testing procedures comply with contract requirements.
- Verify that facilities and testing equipment are available and comply with testing standards.
- Check test instrument calibration data against certified standards.
- Verify that recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
- Record the results of all tests taken, both passing and failing. Specification paragraph reference, location where tests were taken, and the sequential control number identifying the test will be given. If approved by Nuclear Waste Partnership, actual test reports may be submitted later with a reference to the test number and date taken. An information copy of tests performed by an offsite or commercial test facility will be provided directly to Nuclear Waste Partnership.
- The contractor may elect to develop an equipment specification with construction parameters based upon test results of a test section of compacted salt. The equipment specification based upon construction parameters shall be traceable to standard test results identified in the CQCP. Specification paragraph reference, location where construction parameters were taken, and the sequential control number identifying the construction

parameters will be given. If approved by Nuclear Waste Partnership, actual construction parameter reports may be submitted later with a reference to the recording of construction parameters, location, time and date taken.

3.4 Testing Laboratory

The testing laboratory shall provide qualified personnel to perform specified sampling and testing of products in accordance with specified standards, and the requirements of Contract Documents.

Reports indicating results of tests, and compliance or noncompliance with the contract documents will be submitted in accordance with Nuclear Waste Partnership submittal procedures. Testing by an independent firm does not relieve the Contractor of the responsibility to perform the work to the contract requirements.

3.5 Inspection Services

The inspection firm shall provide qualified personnel to perform specified inspection of products in accordance with specified standards.

Reports indicating results of the inspection and compliance or noncompliance with the contract documents will be submitted in accordance with Nuclear Waste Partnership submittal procedures.

Inspection by the independent firm does not relieve the Contractor of the responsibility to perform the work to the contract requirements.

3.6 Completion Inspection

3.6.1 Pre-Final Inspection

At appropriate times and at the completion of all work, the Contractor shall conduct an inspection of the work and develop a punch list of items which do not conform to the Drawings and Specifications. The Contractor shall then notify Nuclear Waste Partnership that the work is ready for inspection. Nuclear Waste Partnership will perform this inspection to verify that the work is satisfactory and appropriately complete. A final punch list will be developed as a result of this inspection. The Contractor shall ensure that all items on this list are corrected and notify Nuclear Waste Partnership so that a final inspection can be scheduled. Any items noted on the final inspection shall be corrected in a timely manner. These inspections and any deficiency corrections required by this paragraph will be accomplished within the time slated for completion of the entire work**.**

3.6.2 Final Acceptance Inspection

The final acceptance inspection will be formally scheduled by Nuclear Waste Partnership based upon notice from the Contractor. This notice will be given to Nuclear Waste Partnership at least 14 days prior to the final acceptance inspection. The Contractor shall assure that all specific items previously identified as unacceptable, along with all remaining work performed under the contract, will be complete and acceptable by the date scheduled for the final acceptance inspection.

3.7 Documentation

The Contractor shall maintain current records providing factual evidence that required quality control activities and/or tests have been performed. These records shall include the work of subcontractors and suppliers and shall be on an acceptable form approved by Nuclear Waste Partnership.

3.8 Notification of Noncompliance

Nuclear Waste Partnership will notify the Contractor of any noncompliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the worksite, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, Nuclear Waste Partnership may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to such stop orders shall be made the subject of claim for extension of time or for excess costs or damages by the Contractor.

End of section

SECTION 01600

MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.1 Scope

This section includes:

- Equipment
- Products
- Transportation and Handling
- Storage and Protection
- Substitutions

1.2 Related Sections

- 01010 - Summary of Work
- 01400 - Contractor Quality Control
- 02010 - Mobilization and Demobilization
- 02222 - Excavation
- 04100 Run of Mine Salt

1.3 Equipment

The Contractor shall specify his proposed equipment in the Work Plan. Power equipment for use underground shall be either electrical or diesel engine driven. All diesel engine equipment shall be certified for use underground at the WIPP site.

1.4 Products

The Contractor shall specify in the Work Plan, or in subsequently required submittals, the proposed products including, but not limited to steel bulkheads and ROM salt. The proposed products shall be supported by laboratory test results as required by the Specifications. All products shall be subject to approval by Nuclear Waste Partnership.

1.5 Transportation and Handling

The Contractor shall:

- Transport and handle products in accordance with manufacturer's instructions.
- Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.6 Storage and Protection

The Contractor shall:

- Store and protect products in accordance with manufacturers' instructions.
- Store with seals and labels intact and legible.
- Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- Provide ventilation to prevent condensation and degradation of products.
- Store loose granular materials on solid flat surfaces in a well-drained area and prevent mixing with foreign matter.
- Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- Arrange storage of products to permit access for inspection and periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.7 Substitutions

1.7.1 Equipment Substitutions

The Contractor may substitute equipment for that proposed in the Work Plan subject to Nuclear Waste Partnership approval.

1.7.2 Product Substitutions

The Contractor may not substitute products after the proposed products have been approved by Nuclear Waste Partnership unless he can demonstrate that the supplier/source of that product no longer exists in which case he shall submit alternate products with lab test results to Nuclear Waste Partnership for approval.

PART 2 – PRODUCTS

Not used

PART 3 - EXECUTION

Not used

End of section

SECTION 02010

MOBILIZATION AND DEMOBILIZATION

PART 1 - GENERAL

1.1 Scope

This section includes:

- Mobilization of Equipment and Facilities to Site
- Contractor Use of Site
- Use of Existing Facilities
- Demobilization of Equipment and Facilities
- Site Cleanup

1.2 Related Sections

- 01010 - Summary of Work
- 01600 - Material and Equipment

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

3.1 Mobilization of Equipment and Facilities to Site

Upon authorization to proceed, the Contractor shall mobilize his equipment and facilities to the jobsite. Equipment and facilities shall be as specified and as defined in the Contractor's Work Plan.

Nuclear Waste Partnership will provide utilities at designated locations. The Contractor shall be responsible for all hookups and tie-ins required for his operations.

The Contractor shall be responsible for providing his own office, storage, and sanitary facilities.

Areas will be designated for the Contractor's use in the underground area in the vicinity of the panel closure system installation. These areas are limited.

3.2 Contractor Use of Site

The Contractor shall use only those areas specifically designated for his use by Nuclear Waste Partnership. The Contractor shall limit his on-site travel to the specific routes required for performance of his work, and designated by Nuclear Waste Partnership.

3.3 Use of Existing Facilities

Existing facilities available for use by the Contractor are:

- Waste shaft conveyance
- Salt skip hoist
- 460 Volt AC, 3 phase power
- Water underground at waste shaft only
- Water on surface at location designated by Nuclear Waste Partnership

The Contractor shall arrange for use of the facilities with Nuclear Waste Partnership and coordinate his actions and requirements with ongoing Nuclear Waste Partnership operations.

Use of water in the underground will be restricted. No washout or cleanup will be permitted in the underground except as designated by Nuclear Waste Partnership. Above ground washout or cleanup of equipment will be allowed in the areas designated by Nuclear Waste Partnership.

The Contractor is cautioned to be aware of the physical dimensions of the waste conveyance and the air lock.

The Contractor shall be responsible for any damage incurred by the existing site facilities as a result of his operations. Any damage shall be reported immediately to Nuclear Waste Partnership and repaired at the Contractor's cost.

3.4 Demobilization of Equipment and Facilities

At completion of this work, the Contractor shall demobilize his equipment and facilities from the job site. All Contractor's equipment and materials shall be removed and all disturbed areas restored. Utilities shall be removed to their connection points unless otherwise directed by Nuclear Waste Partnership.

3.5 Site Cleanup

At conclusion of the work, the Contractor shall remove all trash, waste, debris, excess construction materials, and restore the affected areas to their prior condition, to the satisfaction of

Nuclear Waste Partnership. A final inspection will be conducted by Nuclear Waste Partnership and the Contractor before final payment is approved.

End of section

SECTION 02222

EXCAVATION

PART 1 - GENERAL

1.1 Scope

This section includes:

- Excavation for surface preparation and leveling of surrounding areas for compacted salt
- Disposition of excavated materials
- Field measurement and survey

1.2 Related Sections

- 01010 - Summary of Work
- 01600 - Material and Equipment

1.3 Reference Documents

Krieg, R. D., 1984, "Reference Stratigraphy and Rock Properties for the Waste Isolation Pilot Plant," SAND83-1908, Sandia National Laboratories, Albuquerque, New Mexico.

1.4 Field Measurements and Survey

All survey required for performance of the work will be provided by Nuclear Waste Partnership.

PART 2 - PRODUCTS

Not used

PART 3 - EXECUTION

3.1 Excavation for Surface Preparation and Leveling of Surrounding Areas for Salt

The Contractor shall inspect the panel entry excavations for loose material at locations where the panel closure system is emplaced. If loose material is found, the contractor shall excavate and prepare the surface for the panel closure system component.by removing all loose material, and cleaning all rock surfaces. The surface preparation of the floor shall produce a surface suitable for placing the first layer of ROM salt. Excavation may be performed by either mechanical or manual means. Use of explosives is prohibited.

3.2 Disposition of Excavated Materials

The Contractor shall dispose of all excavated materials as directed by Nuclear Waste Partnership.

3.3 Field Measurements and Survey

All survey required for performance of the work will be provided by Nuclear Waste Partnership. The Contractor shall protect all survey control points, benchmarks, etc., from damage by his operations. Nuclear Waste Partnership will verify that the Contractor has excavated to the required lines and grades. No salt shall be emplaced until approved by Nuclear Waste Partnership.

End of section

SECTION 04100

RUN OF MINE SALT

PART 1 - GENERAL

1.1 Scope

This section includes:

- Salt Placement

1.2 Related Sections

- 01010 Summary of Work
- 01400 Contractor Quality Control
- 01600 Material and Equipment

1.3 Submittals for Revision and Approval

The salt emplacement method, dust control plan and other safety related material shall be approved by Nuclear Waste Partnership.

1.4 Quality Assurance

The Contractor shall perform the work in accordance with the CQCP.

PART 2 - PRODUCTS

2.1 Salt Material

The salt is ROM salt and requires no grading or compaction. The salt shall be free of organic material.

PART 3 - EXECUTION

3.1 General

The Contractor shall furnish all labor, material, equipment and tools to handle and place the salt.

The Contractor shall use underground equipment and underground mine personnel as required in Part 1.5 Work by Others in Section 01010 Summary of Work. Nuclear Waste Partnership will supply ROM salt. The Contractor shall make suitable arrangements for transporting and placing the ROM salt.

3.2 Installation

ROM salt shall be transported to the panel closure area after the construction of the inner steel bulkhead. The ROM salt is not required to achieve a specified density. The salt shall be free of organic material.

Salt may be emplaced in layers to facilitate the construction. The ROM Salt is emplaced in layers with a 2:1 slope near the ends of the WIPP Panel Closure System. The inner and outer salt emplacements are designated on the drawings.

For the inner emplacement of the ROM Salt, the salt is emplaced at the angle of repose, of 1 (rise) to 2 (run) as designated on the drawings. There shall be no gap left between salt and roof or sidewalls. Hand placement or the use of push plates can be used to fill all the voids if necessary.

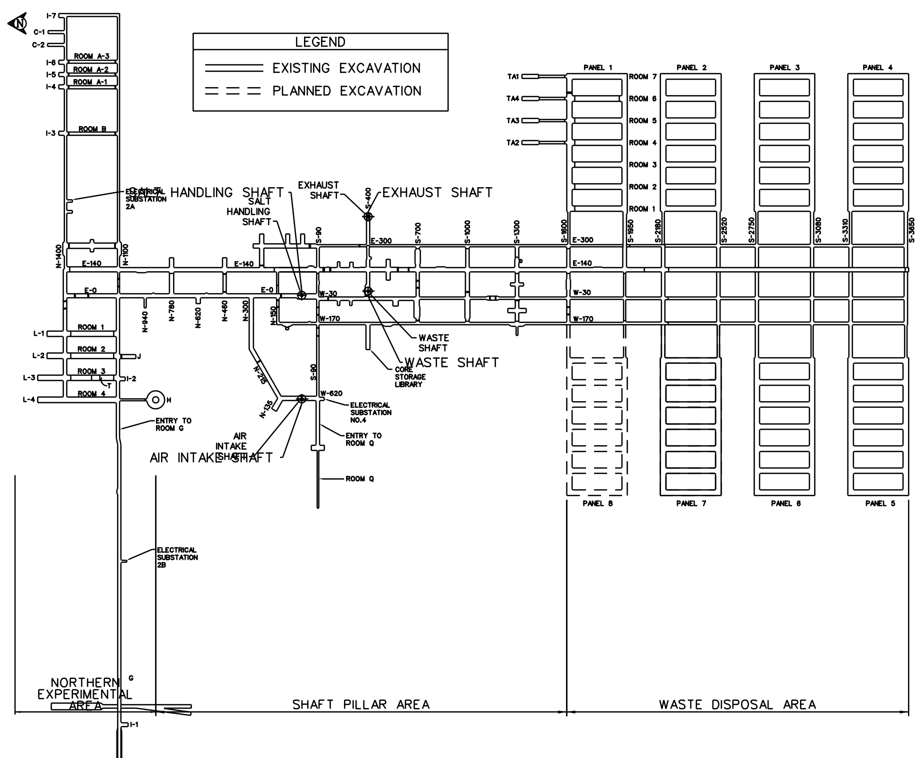
3.3 Field Quality Control

The Contractor shall provide a Quality Control Inspector to inspect the emplacement of salt.

APPENDIX D
DESIGN DRAWINGS

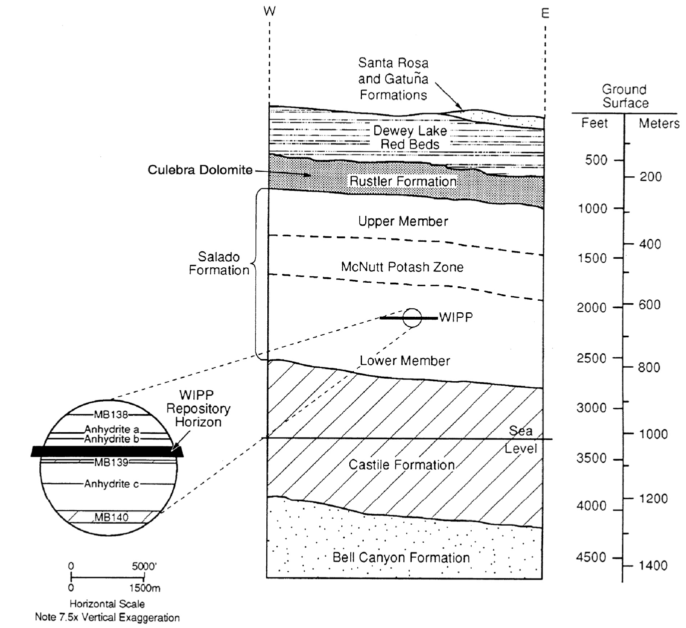
INDEX OF DRAWINGS

DRAWING NO.	TITLE
262-001	TITLE SHEET
262-002	UNDERGROUND WASTE DISPOSAL PANEL CONFIGURATIONS (3,4,6,7,8)
262-003	UNDERGROUND WASTE DISPOSAL PANEL CONFIGURATIONS (1,2,5)
262-004	PANEL CLOSURE SYSTEM CONSTRUCTION DETAILS



UNDERGROUND REPOSITORY LAYOUT PLAN

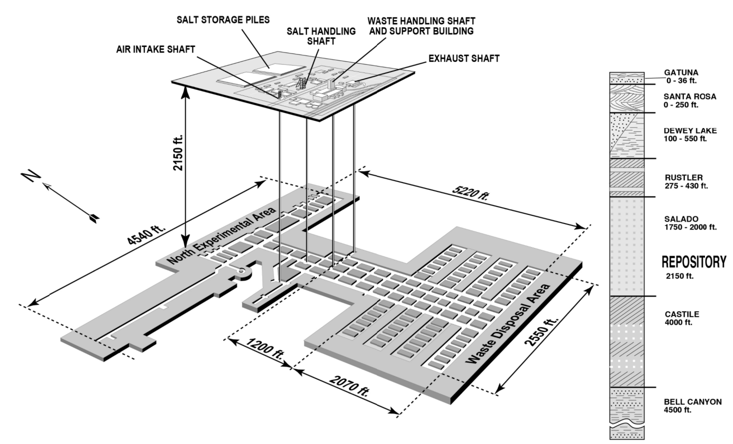
SCALE: NOT TO SCALE

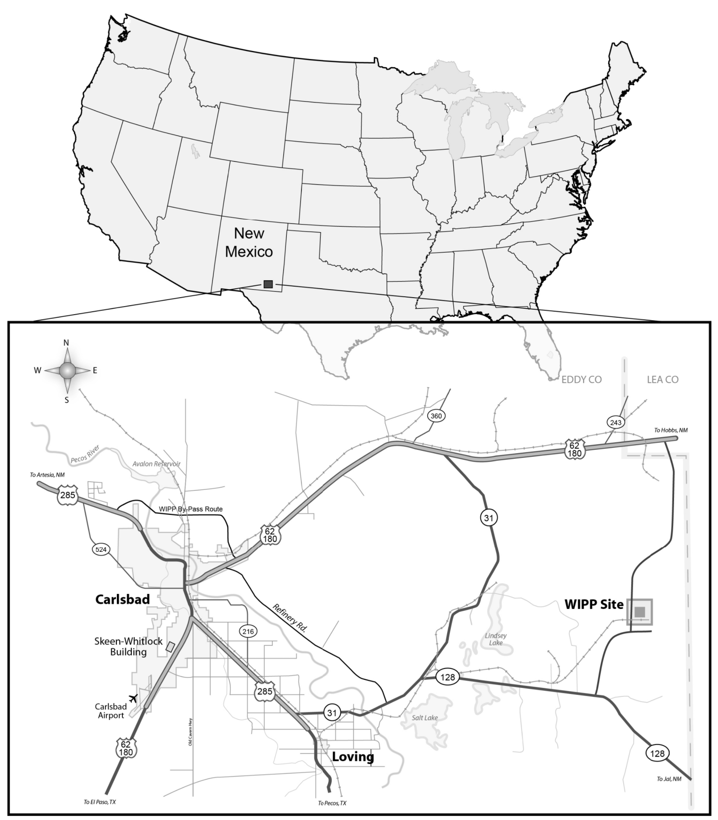


GENERAL STRATIGRAPHY AT THE REPOSITORY HORIZON

SCALE: NOT TO SCALE

WIPP Facility and Stratigraphic Sequence





GENERAL LOCATION OF THE WIPP FACILITY

WASTE ISOLATION PILOT PLANT PANEL CLOSURE SYSTEM CARLSBAD, NEW MEXICO

PREPARED BY
ROCKSOL CONSULTING GROUP INC.

REV	ISSUE DESCRIPTION	DFTR DATE	CHKR DATE	COG DATE	DFTG MGR DATE	ECO	PWR

THIS DRAWING CREATED BY ENGINEERING CHANGE ORDER (ECO): PWR:

DFTR: CHKR: COG: QA: CM: SFTY: APPD: APPD: DM: DOE:

U.S. DEPARTMENT OF ENERGY

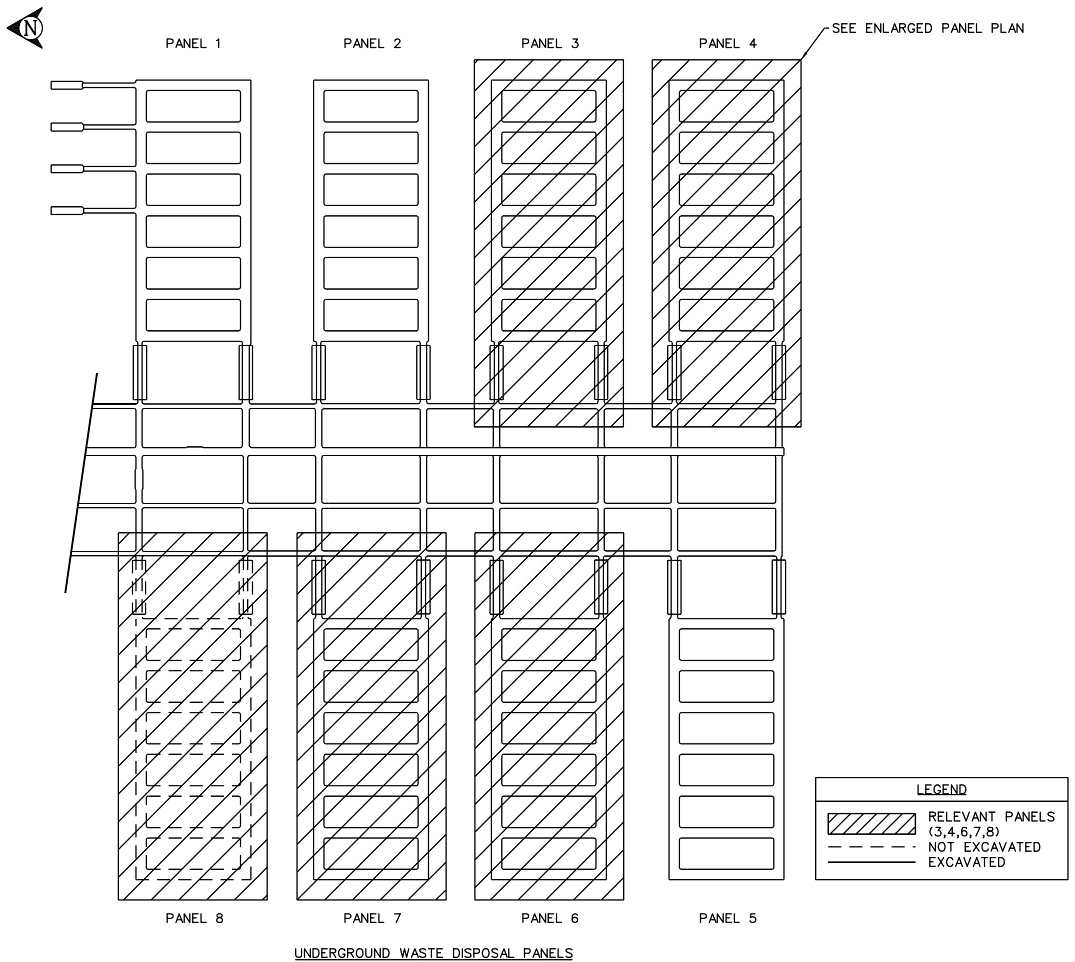
Nuclear Waste Partnership LLC — RockSol Consulting Group, Inc.

PANEL CLOSURE SYSTEM
TITLE SHEET

SIZE E | SYS AU00 | DWG NO 262-001 | REV

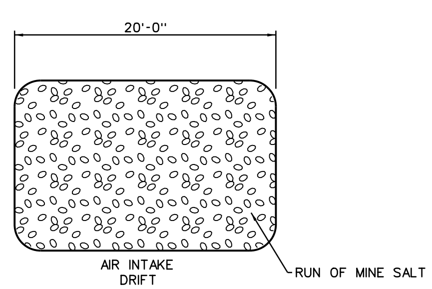
SCALE: NOTED | INTERPRET DWG PER ANSI Y14 | DWG: OF

THIS DRAWING TAKEN FROM: VENDOR:

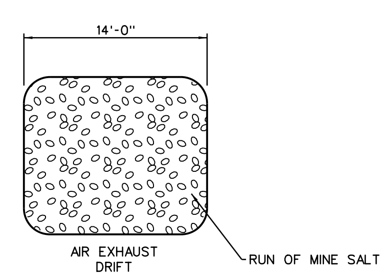


UNDERGROUND WASTE DISPOSAL PANELS

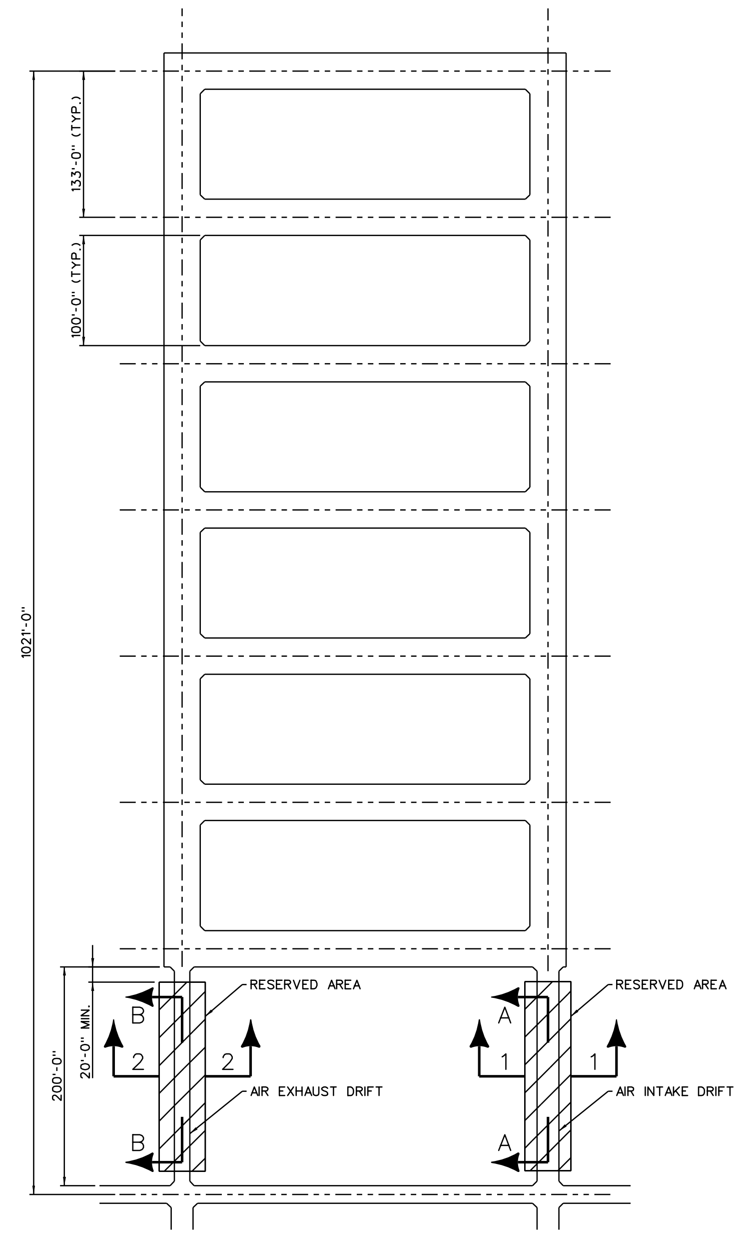
KEY PLAN



SECTION 1-1



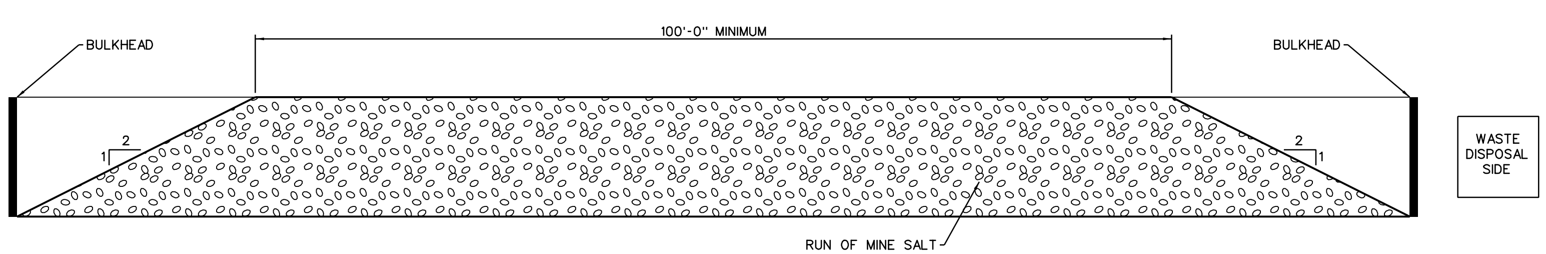
SECTION 2-2



TYPICAL ENLARGED WASTE DISPOSAL PANEL PLAN

GENERAL NOTES

1. GROUND CONTROL NOT SHOWN. INSTALL IN ACCORDANCE WITH APPROVED GROUND CONTROL PLANS.
2. VENTILATION CONTROLS NOT SHOWN. INSTALL IN ACCORDANCE WITH APPROVED VENTILATION PLANS.
3. ALL DIMENSIONS REPRESENT NOMINAL VALUES AND MAY VARY FROM LOCATION TO LOCATION. CONSTRUCTION TOLERANCE ON THE PLACEMENT OF THE SALT IS 1'-0".
4. THE PANEL CLOSURE SYSTEM WILL BE POSITIONED IN THE RESERVED AREA AT A LOCATION TO BE DETERMINED BY WASHINGTON TRU. THE POSITION DOES NOT EFFECT CLOSURE PERFORMANCE AND CAN BE BASED ON A GENERAL ASSESSMENT OF THE GROUND CONDITIONS IN THE RESERVED AREA.
5. RUN OF MINE SHALL BE EMPLACED A MINIMUM OF 100'0".
6. SALT ZONES CAN BE INCLINED AS LONG AS LENGTH IS MAINTAINED.
7. FOR PANEL ENTRIES THAT ARE HIGHER THAN THE DESIGN HEIGHT, THE RUN OF MINE SHALL BE INCREASED IN HEIGHT TO ACCOMODATE THE PANEL ENTRY HEIGHT.
8. OUTER SLOPES ON RUN OF MINE SALT CAN BE INCREASED TO 1.4 HORIZONTAL TO 1 VERTICAL IF NEEDED DUE TO SPACE LIMITATIONS IN THE DRIFTS.
9. PLACEMENT OF RUN OF MINE SALT SHALL FILL THE GAP TO THE BACK.



TYPICAL PANEL CLOSURE SYSTEM CROSS SECTION A-A & B-B

(PANELS 3,4,6,7,8)

REV	ISSUE DESCRIPTION	DFTR / DATE	CHKR / DATE	COG / DATE	DFTG MGR / DATE	ECO	PWR

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DFTR:
CHKR:
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DOE:

U.S. DEPARTMENT OF ENERGY

Nuclear Waste Partnership LLC

RockSol Consulting Group, Inc.

PANEL CLOSURE SYSTEM
UNDERGROUND WASTE DISPOSAL
PANEL CONFIGURATIONS (3,4,6,7,8)

SIZE E | SYS AU00 | DWG NO 262-002 | REV

SCALE: NTS | INTERPRET DWG PER ANSI Y14 | DWG: OF

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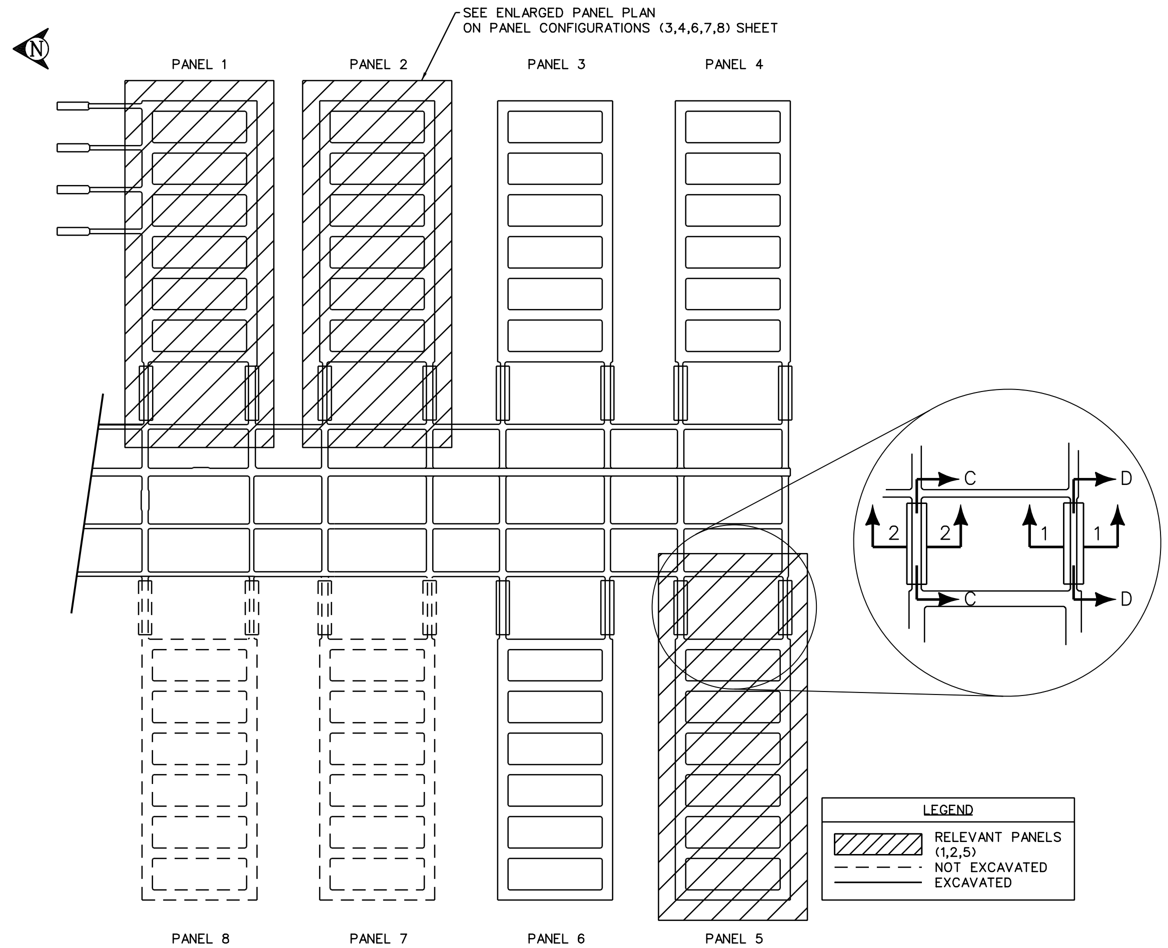
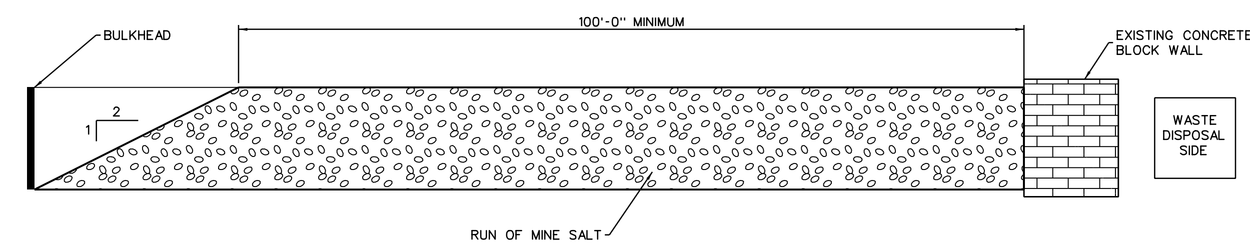


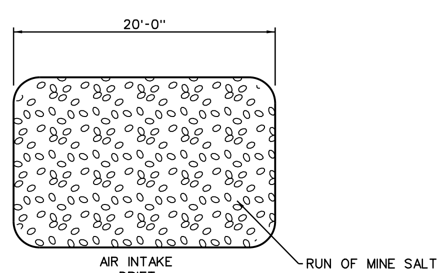
UNDERGROUND WASTE DISPOSAL PANELS

KEY PLAN

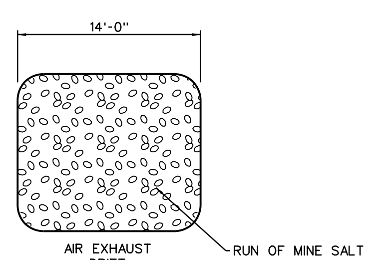


TYPICAL PANEL CLOSURE SYSTEM CROSS SECTION

(PANELS 1&2 INTAKE AND EXHAUST DRIFTS)



SECTION 1-1



SECTION 2-2

NOTES

1. FOR GENERAL NOTES SEE PANEL CONFIGURATIONS (3,4,6,7,8) SHEET.
2. FOR TYPICAL ENLARGED WASTE DISPOSAL PANEL PLAN AND TYPICAL DRIFT SECTIONS SEE PANEL CONFIGURATIONS (3,4,6,7,8) SHEET.

REV	ISSUE DESCRIPTION	DFTR DATE	CHKR DATE	COG DATE	DFTG MGR DATE	ECO	PWR

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U.S. DEPARTMENT OF ENERGY

Nuclear Waste Partnership LLC

RockSol Consulting Group, Inc.

PANEL CLOSURE SYSTEM
UNDERGROUND WASTE DISPOSAL
PANEL CONFIGURATIONS (1,2,5)

SIZE E SYS AU00 DWG NO 262-003 REV

SCALE: NTS INTERPRET DWG PER ANSI Y14 DWG: OF

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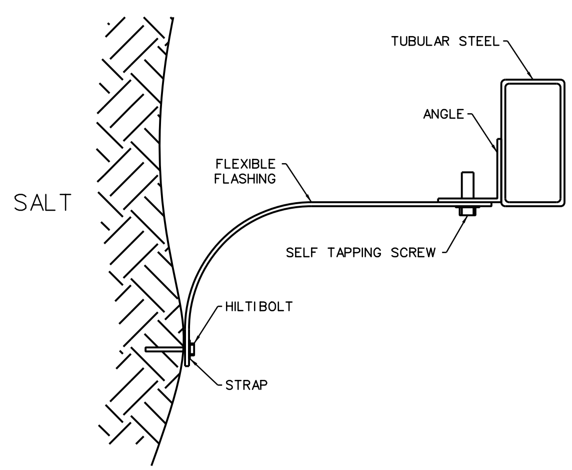
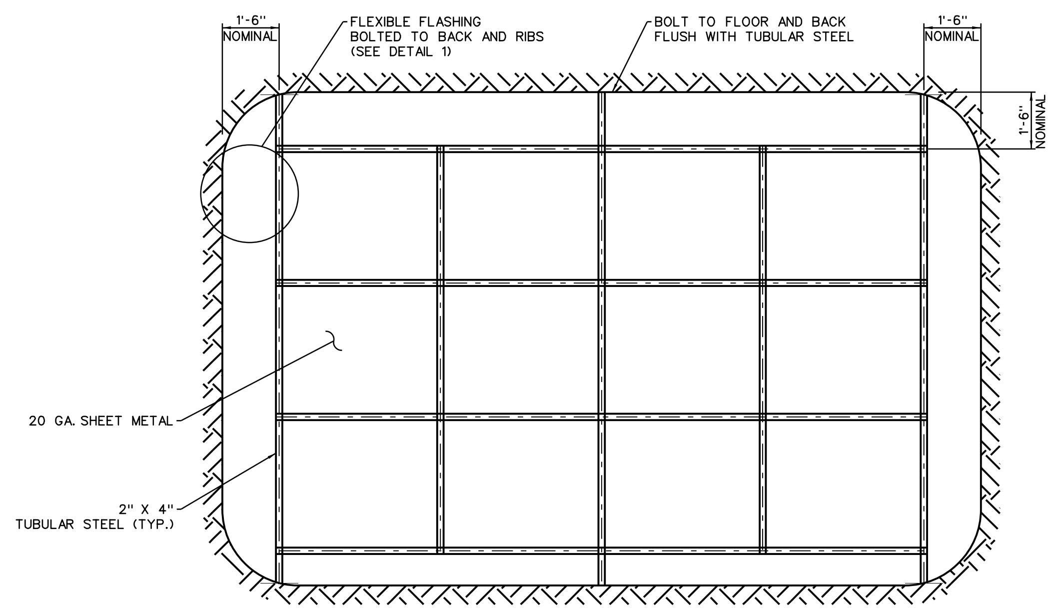


DETAIL 1
(FLEXIBLE FLASHING ATTACHMENT)



TYPICAL BULKHEAD DETAIL

CONSTRUCTION SEQUENCE

1. CONTRACTOR SHALL ENSURE THAT ROOM 1 CLOSURES ARE TIGHT AND EFFECTIVE IN ACCORDANCE WITH ROOM CLOSURE PLANS BEFORE COMMENCING WORK.
2. CONTRACTOR SHALL PLAN THE WORK IN CONSULTATION WITH WASHINGTON TRU AND SHALL EXECUTE IT ONLY AFTER APPROVAL BY WASHINGTON TRU.
3. PREPARE ALL SURFACES BY REMOVING ALL LOOSE MATERIAL AND GENERALLY SQUARING THE EXCAVATION CROSS-SECTION. THE FLOOR SURFACE SHOULD BE FLAT AND CLEAN AND SUITABLE FOR SALT PLACEMENT. OTHER SURFACES SHOULD BE CLEAN, TIGHT AND SOUND IN ACCORDANCE WITH SECTION 02222 OF THE SPECIFICATIONS.
4. RUN OF MINE SALT SHALL BE CONSTRUCTED AS REQUIRED BY SECTION 04100 OF THE SPECIFICATIONS. ASSUMED INTACT DENSITY OF COMPACTED SALT SHALL BE 135 PCF.
5. SALT SHALL BE EMPLACED FLUSH WITH THE RIBS.
6. THE VENTILATION BULKHEAD SHALL ACHIEVE 2,200 PRACTICAL UNITS.

REV	ISSUE DESCRIPTION	DFTR / DATE	CHKR / DATE	COG / DATE	DFTG MGR / DATE	ECO	PWR

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DOE:

U.S. DEPARTMENT OF ENERGY

Nuclear Waste Partnership LLC

RockSol Consulting Group, Inc.

PANEL CLOSURE SYSTEM
CONSTRUCTION DETAILS

SIZE E | SYS AU00 | DWG NO 262-004 | REV

SCALE: NOTED | INTERPRET DWG PER ANSI Y14 | DWG: OF

THIS DRAWING TAKEN FROM:
VENDOR:

Appendix D
Statistical Analysis to Evaluate Methane and Hydrogen Concentrations in Filled Panels at the Waste Isolation Pilot Plant, Revision 1

Statistical Analysis to Evaluate Methane and Hydrogen Concentrations in Filled Panels at the Waste Isolation Pilot Plant

Revision 1

February 2013

URS
Professional Solutions

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I. Introduction

The Waste Isolation Pilot Plant (WIPP) Hazardous Waste Facility Permit (Permit) requires monitoring for hydrogen and methane in filled Panels 3 through 8, unless an explosion isolation wall is installed. A *filled panel* is an underground Hazardous Waste Disposal Unit (HWDU) that will no longer receive waste for emplacement. The filled panels consist of seven closed rooms filled with vented containers of transuranic (TRU) waste. The monitoring process includes collecting samples of closed room air to determine hydrogen and methane concentrations that may be emitted from the waste containers. The purpose of the monitoring is to determine if changes in hydrogen and methane concentrations in filled panels can be correlated to early gas-generation modeling studies (Wang and Brush 1996, Devarakonda 2006, Golder Associates 2006).

II. Purpose and Scope

The purpose of this report is to evaluate using statistical methods the hydrogen and methane data collected to date, in accordance with Permit Part 4.6.5 and as specified in Permit Attachment N1. This evaluation will be used as input to the design of an appropriate panel closure system. The scope of this report covers hydrogen and methane data obtained between April 2008 and December 2012 for Panel 3 and between May 2009 and December 2012 for Panel 4. Panel 5 is a filled panel that does not require monitoring since an explosion isolation wall is installed. Panel 6 is currently being filled, and Panels 7 and 8 are not yet available for TRU waste disposal. Details for panel closures are shown in Table G-1 of Permit Attachment G.

The current panel closure system is designed to withstand a postulated flammable gas explosion. However, this element of the design may not be necessary if a postulated explosion is not possible prior to closure of the WIPP repository.

III. Background

Hydrogen and methane monitoring was conducted in compliance with Permit Attachment N1 because TRU wastes disposed in the WIPP underground panels have the potential to generate hydrogen and methane. Hydrogen can be generated by radiolysis (Devarakonda 2006) and by corrosion of iron-based materials under anoxic conditions (Wang and Brush 1996). Methane can be produced from microbial degradation of organic materials such as cellulosics, plastics, and rubber under humid or inundated conditions (Wang and Brush 1996). However, only humid conditions are expected to occur during operations and closure.

IV. Monitoring Methods and Data

Based on concepts of U.S. Environmental Protection Agency (EPA) Compendium Method TO-15 (EPA 1999), samples were collected in six-liter passivated canisters using passivated stainless steel sample lines after purging. Samples were collected using subatmospheric sampling methods, which included a pressure dilution by the analytical laboratory with ultra-high purity nitrogen prior to analysis. Hydrogen and methane concentrations were measured with a gas chromatograph/thermal conductivity detector (GC/TCD). Identification of eluted analytes was based solely on known retention times determined during calibration of the instrumentation. Quantitation was based on the results of a 5-point calibration and results were corrected for sample dilutions. The method detection limit (MDL) was determined in accordance with 40 CFR Part 136 and corrected for the sample dilutions. Data for methane and hydrogen in Panels 3 and 4 appear in Appendices C through F. When the reported result is less than the dilution-corrected MDL, the value used for the statistical evaluation is 1/2 the dilution-corrected MDL. The appendices indicate the reported results, dilution factors, MDLs, the dilution-corrected MDLs, and the values used for the statistical evaluation.

An underground HWDU is a single excavated panel consisting of seven rooms and two access drifts designated for disposal of TRU waste. Each room is approximately 300 ft (91 m) long, 33 ft (10 m) wide, and 13 ft (4 m) high. Access drifts connect the rooms and have the same cross-section. Figure 1 is a diagram of an underground disposal panel and room layout at the WIPP facility. The rooms and the two interconnecting access drifts are the areas containing emplaced wastes in Figure 1 (hexagons used to depict waste drums) and have increasing numbers starting with Room 1 for the room closest to the main access drift (known as E-300 for Panels 3 and 4), and culminating in Room 7, the room furthest from the main access drift. Two sample head locations for filled panel monitoring are shown in Figure 1 for each room, corresponding to intake and exhaust locations. Bulkheads separate Room 1 from the main access drift and the bulkhead areas also contains sample heads on both sides (Waste (W) and Accessible (A)). Sample data are identified by the source panel number, room number or “B” for bulkhead, and intake (i) or exhaust (e) function (first and capitalized for bulkheads). For example, the Panel 3 Room 7 exhaust location is coded Panel 3 7e or simply P3 7e. Similarly, Panel 3 Exhaust Bulkhead’s Waste side is coded Panel 3 EBW (or P3 EBW).

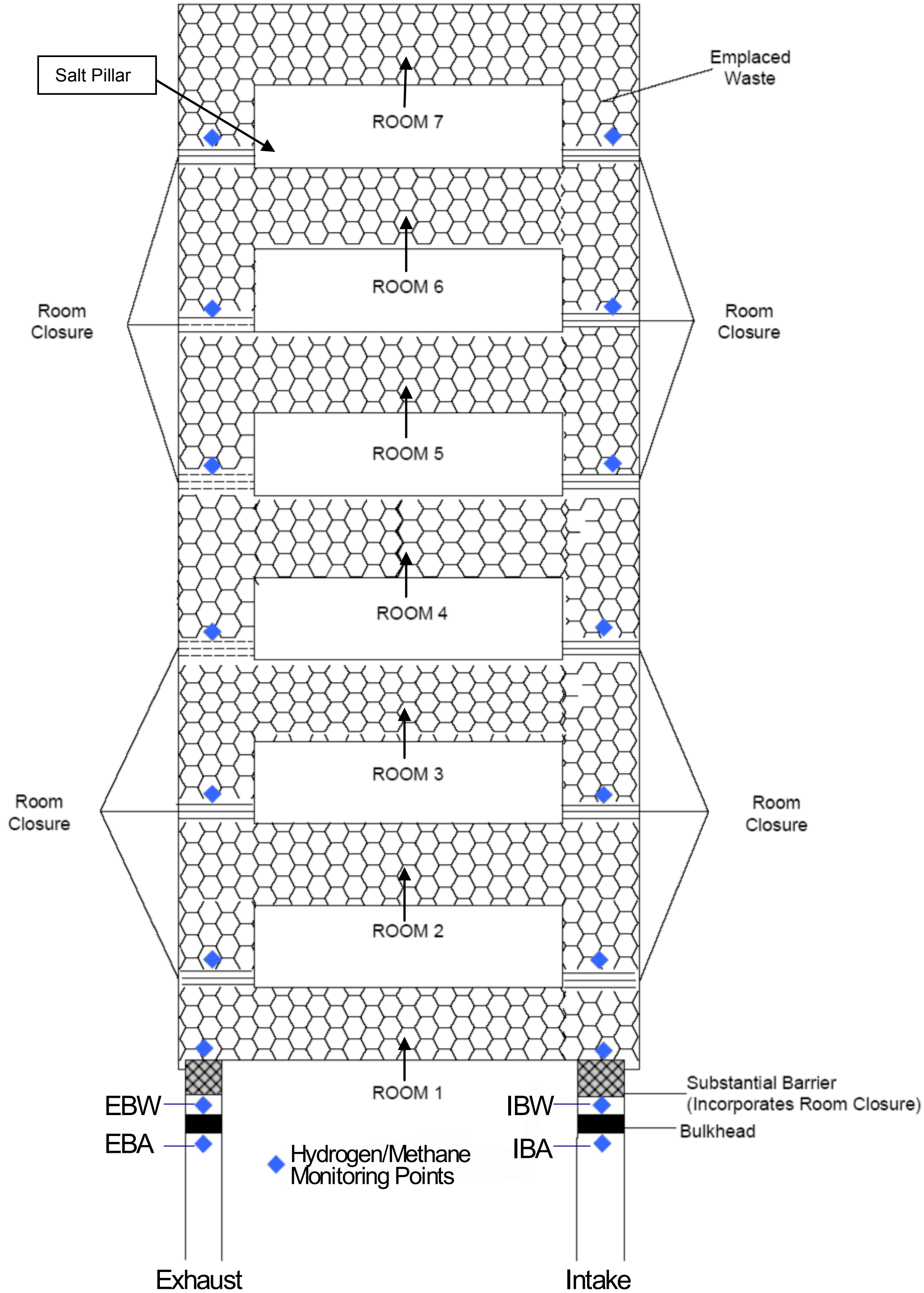

Figure 1: WIPP Disposal Panel Design and Monitoring Locations (Not to Scale)

The data set for this statistical analysis contains 856 samples in Panel 3 for hydrogen and methane and 753 samples in Panel 4. All of the samples for methane in both Panels 3 and 4 were reported as below the MDL. As such, a statistical analysis is unnecessary. Hydrogen samples exhibited both detectable and nondetectable concentrations in both Panels 3 and 4, with dilution-corrected MDLs ranging from approximately 14 ppmv to 35 ppmv.

This statistical analysis includes data for a maximum of 57 sampling events for most of the Panel 3 rooms and a maximum of 44 sampling events for most of the Panel 4 rooms. Rooms with fewer sampling events are associated with unusable sampling lines. The following sampling lines in Panels 3 and 4 were determined to be unusable:

- Panel 3 7i and 1i sampling lines were determined to be unusable on July 14, 2008 (Note: Only three samples were collected for each of these two lines and the June 2008 sample collected for Panel 3 7i was voided)
- The Panel 3 IBW sampling line was determined to be unusable on April 21, 2010 (Note: The sampling line was replaced and sampling resumed on May 25, 2010)
- The Panel 3 7e sampling line was determined to be unusable on August 30, 2010
- The Panel 3 6i sampling line was determined to be unusable on September 22, 2010
- The Panel 4 4e sampling line was determined to be unusable on April 7, 2011
- The Panel 4 6e sampling line was determined to be unusable on December 13, 2011
- The Panel 4 5e sampling line was determined to be unusable on August 14, 2012
- The Panel 3 6e sampling line was determined to be unusable on October 10, 2012

The sampling line for Panel 3 IBW was replaced because it is in an accessible location. The other unusable sampling line locations listed above are not accessible and were not replaced.

Hydrogen and methane measurement levels are monitored with respect to action levels specified in Table 4.6.5.3 of the Permit. Action Level 1 (the lowest action level) is set at 10 percent of the lower explosive limit (LEL) in air. As such, Action Level 1 is set at 4,000 ppmv for hydrogen and 5,000 ppmv for methane. Specified reporting and remedial actions are initiated if a monitoring level exceeds an action level.

V. Statistical Analysis

A. Room Averages

Mean (average) hydrogen concentrations were calculated for each room in Panels 3 and 4. Each room is represented by two values, an *exhaust mean* and an *intake mean*. This partitioning also applies to the bulkhead area. Results are presented in Tables 1 and 2 for Panels 3 and 4 respectively. The designations “exhaust” and “intake” only refer to the geographic locations of the respective sampling points. They do not indicate a flow direction for the panel because both Panels 3 and 4 are isolated from the mine ventilation system.

Table 1: Mean Concentrations of Hydrogen in Panel 3 Rooms

WIPP - Hydrogen Levels (ppmv)			
Panel	Room	Mean	
		Exhaust	Intake
3	7	104	10.8
	6	58.1	47.9
	5	60.6	37.5
	4	48.4	25.6
	3	44.6	18.5
	2	33.8	15.7
	1	24.4	10.8
	EBW	22.9	NA
	EBA	14.3	NA
	IBW	NA	14.9
	IBA	NA	13.7

The mean data for exhaust measurements in Panel 3 are presented graphically in Figure 2.

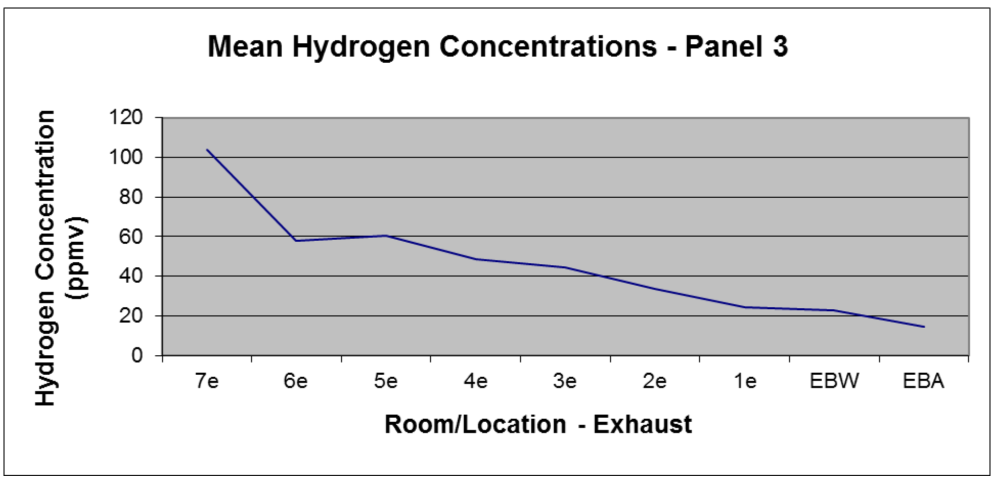

Figure 2: Average Hydrogen Concentrations at Exhaust Locations by Room/Location in Panel 3

The mean data for intake measurements in Panel 3 are presented graphically in Figure 3. Note that the maximum concentration observed for both intake and exhaust locations was 104 ppmv, with the remaining concentrations below 70 ppmv. There is also a general downward trend in hydrogen concentrations from Room 7 toward the E-300 drift.

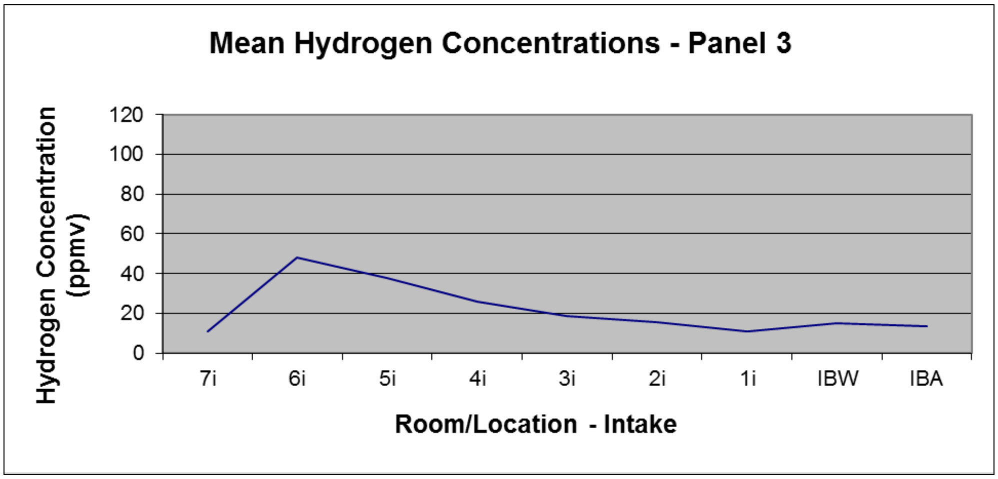

Figure 3: Average Hydrogen Concentrations at Intake Locations by Room/Location in Panel 3

Table 2 and Figures 4 and 5 present the average hydrogen concentrations for rooms and locations in Panel 4, which shows a downward trend in the hydrogen concentration from Room 7 toward the E-300 drift.

Table 2: Mean Concentrations of Hydrogen in Panel 4 Rooms

WIPP - Hydrogen Levels (ppmv)			
Panel	Room	Mean	
		Exhaust	Intake
4	7	550	445
	6	531	419
	5	494	439
	4	395	392
	3	436	387
	2	341	317
	1	281	282
	EBW	130	NA
	EBA	13.5	NA
	IBW	NA	190
	IBA	NA	20.1

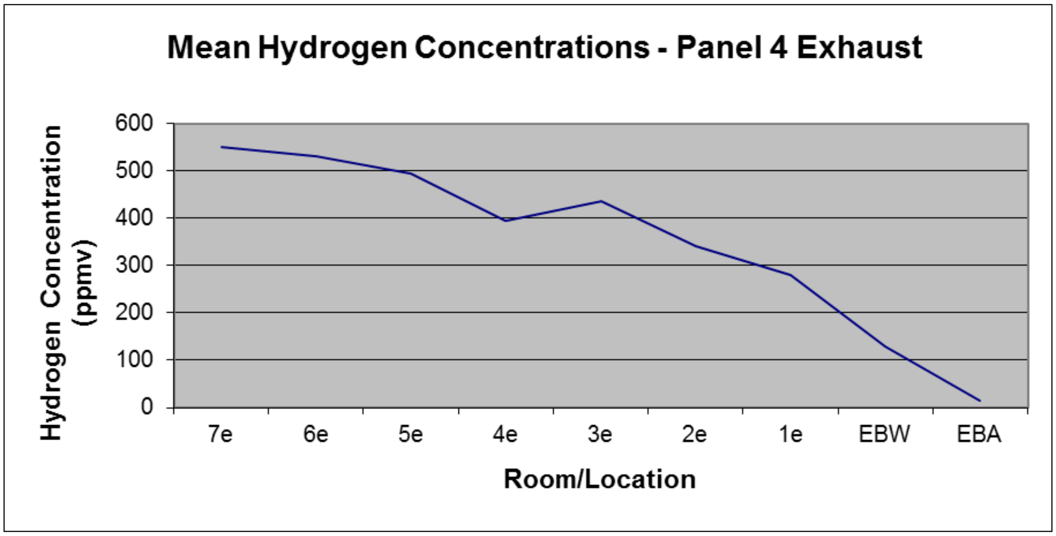

Figure 4: Average Hydrogen Concentrations at Exhaust Locations by Room/Location in Panel 4

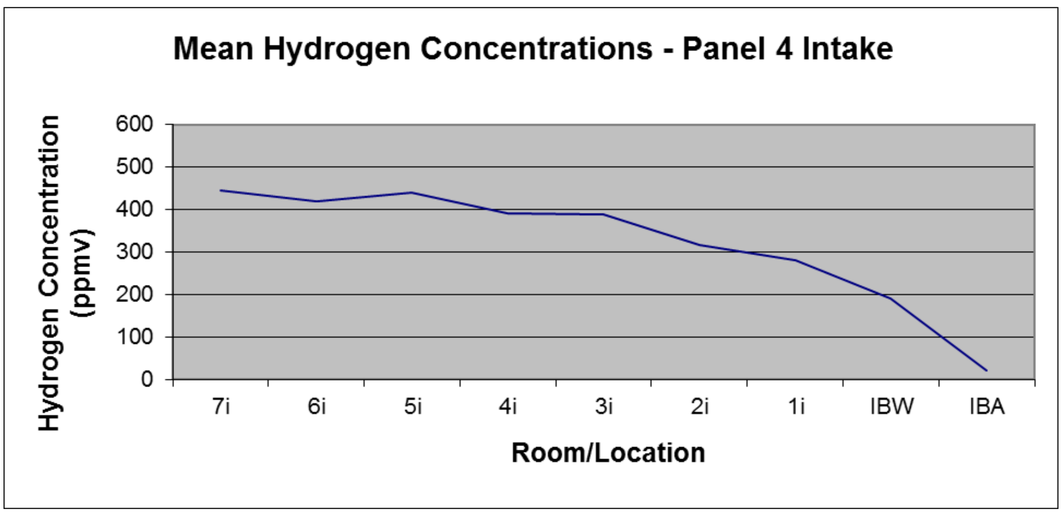

Figure 5: Average Hydrogen Concentrations at Intake Locations by Room/Location in Panel 4

B. Box-and-Whisker Plots

Figure 6 is a *box-and-whisker plot* of the hydrogen concentrations for Panel 3. In contrast to the mean, which describes the central tendency of a data set, a box-and-whisker plot displays the range of concentration values observed in the sample data. A box-and-whisker plot is composed of a central box divided by a median line (50% of sample data above, 50% below), with two lines extending out from the box, called whiskers. The length of the central box indicates the spread of the bulk of the data, the central 50%, which is called the *interquartile range* (IQR). The IQR is bounded by the 25th and 75th percentiles, with the median located at the 50th percentile. The length of the whiskers shows how extensive the tails of the distribution are. The width of the box has no particular meaning.

Unusually large or small data are displayed by white (hollow circles) and red dots (solid circles) on the plot. The white dots indicate data that are less than three IQRs from the 25th and 75th percentiles, whereas the red dots are data that are more than three IQRs from the 25th and 75th percentiles. Using these conventions, the graphs show the relative ranges of the distributions being compared, the central tendencies, outliers, and other aspects that allow for a visual, qualitative comparison of two or more distributions.

Figure 6 displays the distribution of monitoring data from each monitoring location in Panel 3. Sample values range from a high of approximately 350 ppmv in Room 7e to non-detects in rooms and locations closer to the E-300 drift. The general downward trend from Room 7 toward the E-300 drift is also apparent.

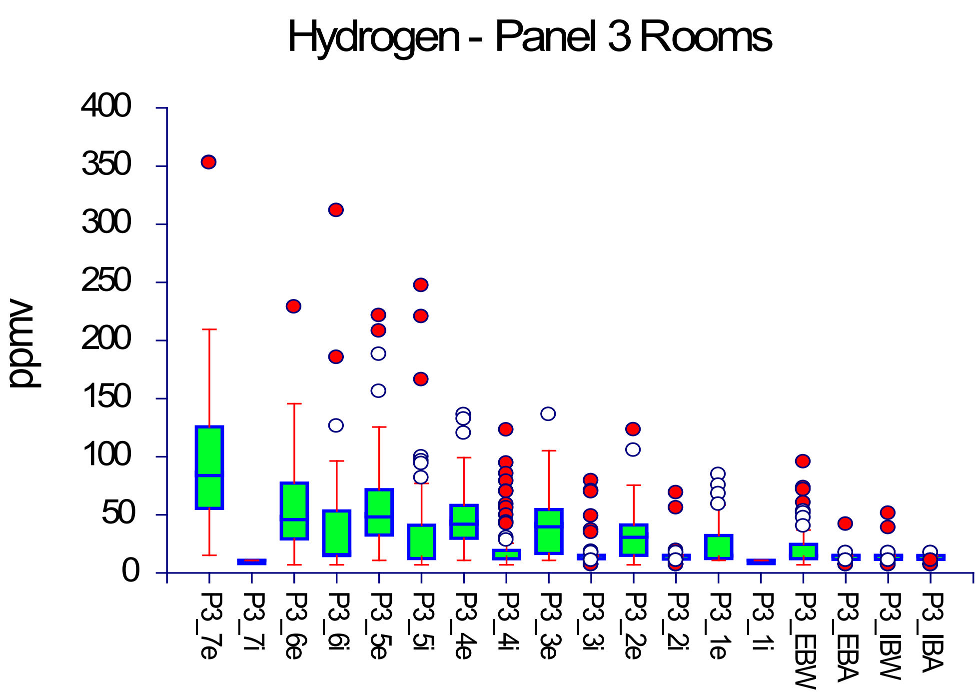

Figure 6: Box-and-Whisker Plot of Hydrogen Concentrations in Panel 3

Figure 7 is a box-and-whisker plot of Panel 3 data with the lower action level (i.e., Action Level 1) plotted on the graph. The lower action level for hydrogen is 4,000 ppmv, which is substantially greater than any concentration observed in Panel 3 monitoring.

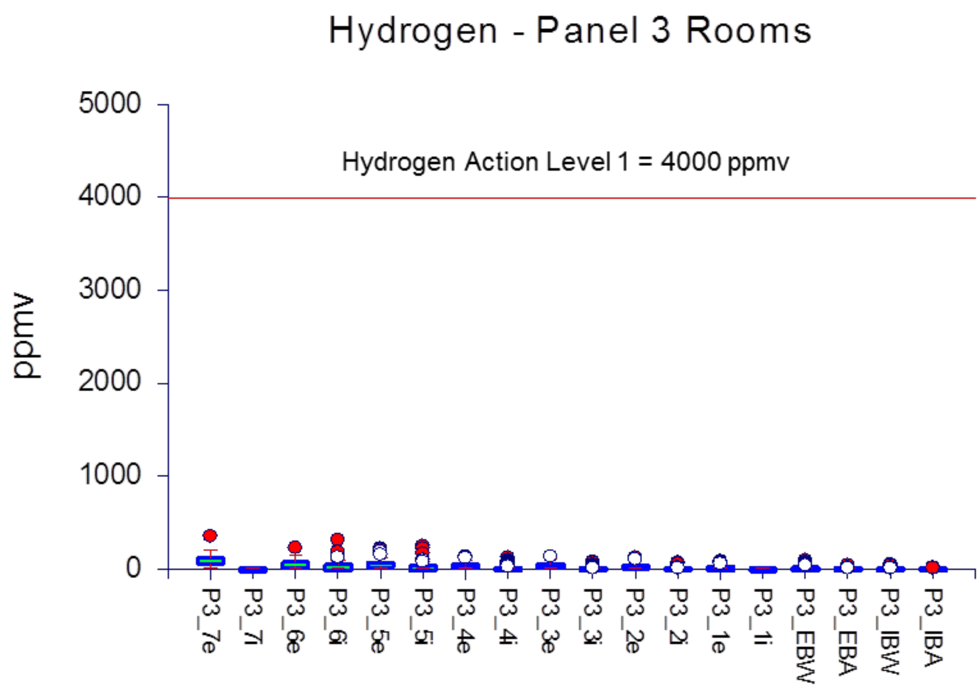

Figure 7: Box-and-Whisker Plot of Hydrogen Concentrations in Panel 3 Compared to Action Level 1

Figure 8 is a box-and-whisker plot of the hydrogen concentrations for Panel 4. Figure 8 shows that the sample data in Panel 4 span a greater range than those for Panel 3, with Panel 4 data slightly exceeding 1,000 ppmv in the Room 6 exhaust monitoring location. The general downward trend from Room 7 toward the E-300 drift is also apparent. Figure 9 plots the Panel 4 data in relation to the hydrogen lower action level. None of the data poses a challenge to the lower action level.

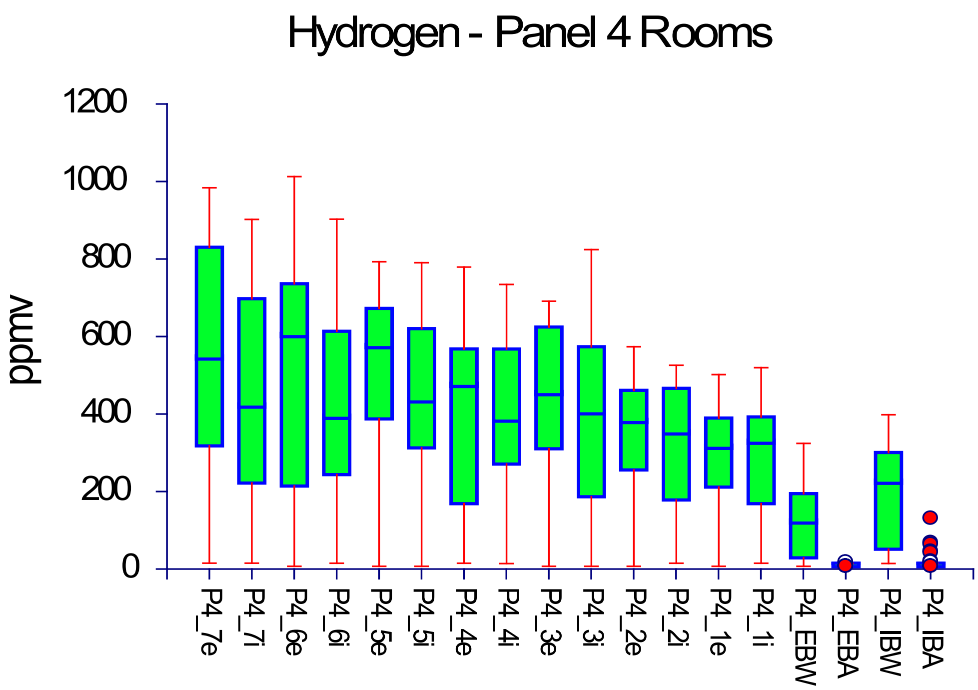

Figure 8: Box-and-Whisker Plot of Hydrogen Concentrations in Panel 4

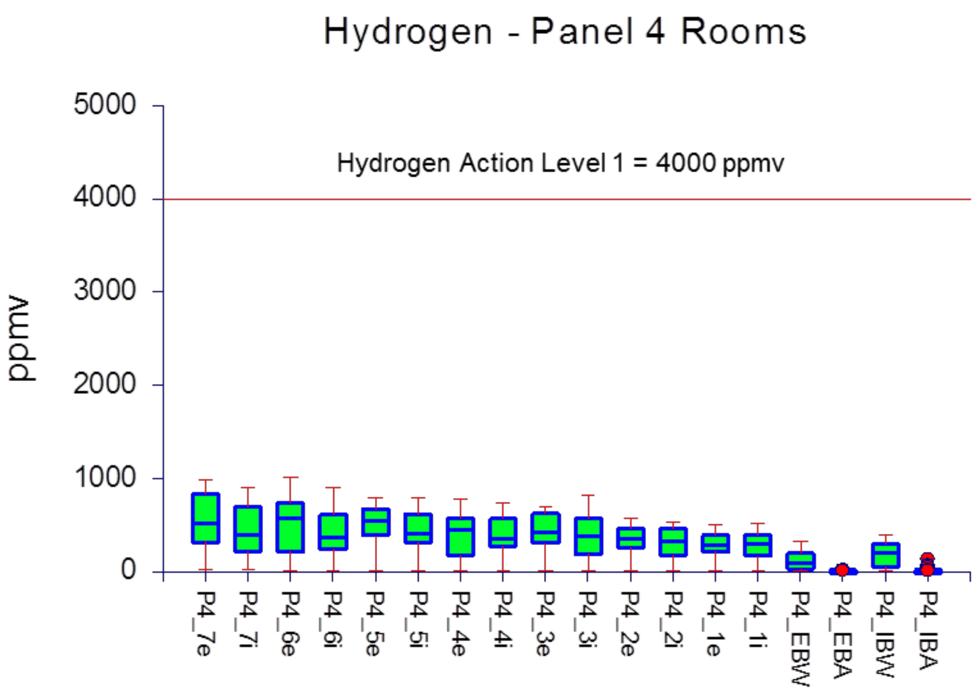

Figure 9: Box-and-Whisker Plot of Hydrogen Concentrations in Panel 4 Compared to Action Level 1

C. Time Series Plots

In addition to the central tendencies and concentration ranges (minimums/maximums), how the data are distributed over time is of interest for correlating concentration data to the early gas-generation modeling studies. Figures 10 and 11 show time series plots for hydrogen concentrations in Panel 3, Room 7. Note that only two samples are available to construct Figure 11, both of which are nondetects and equal in value. Figures 12 and 13 show time series plots for hydrogen concentrations in Panel 4, Room 7. Full suites of time series plots for Panels 3 and 4 appear in Appendices A and B respectively.

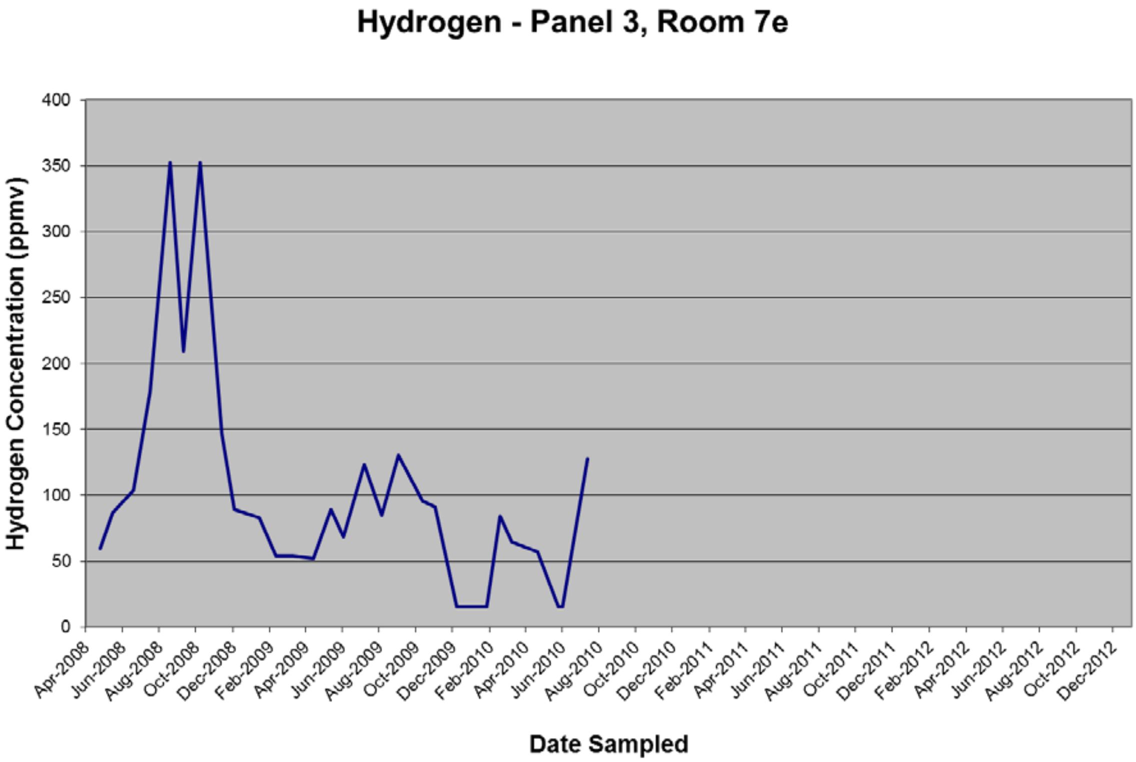

Figure 10: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 7e

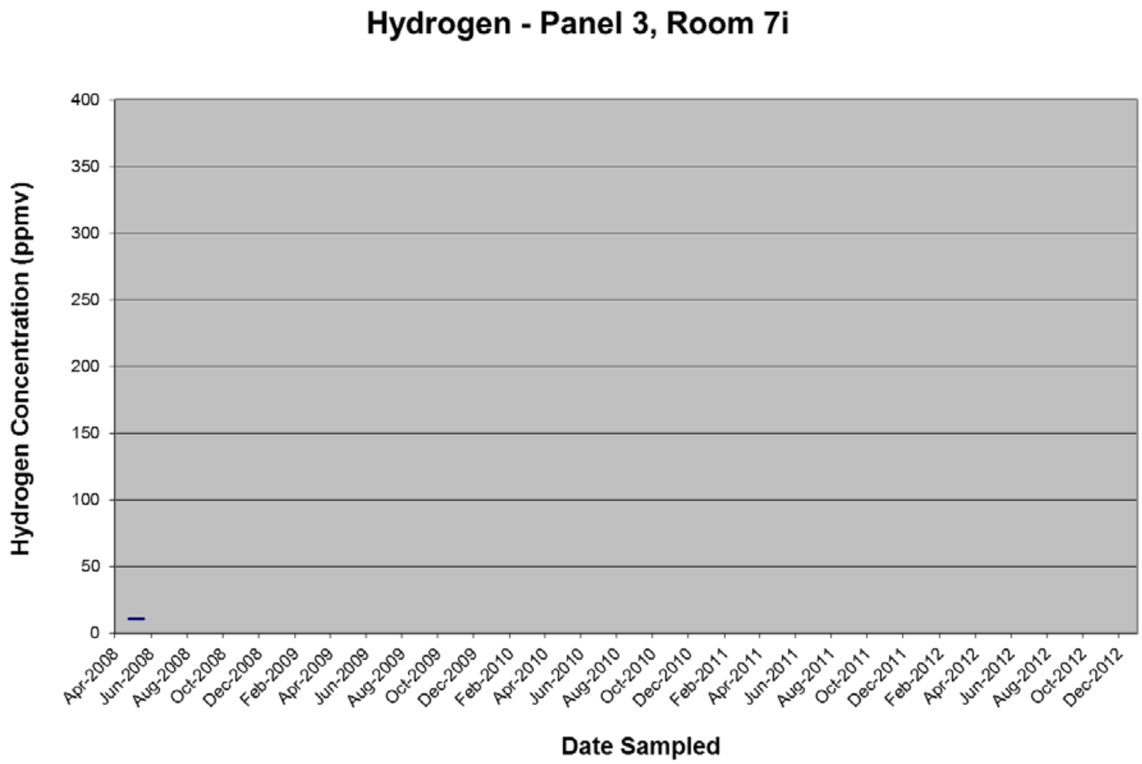

Figure 11: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 7i

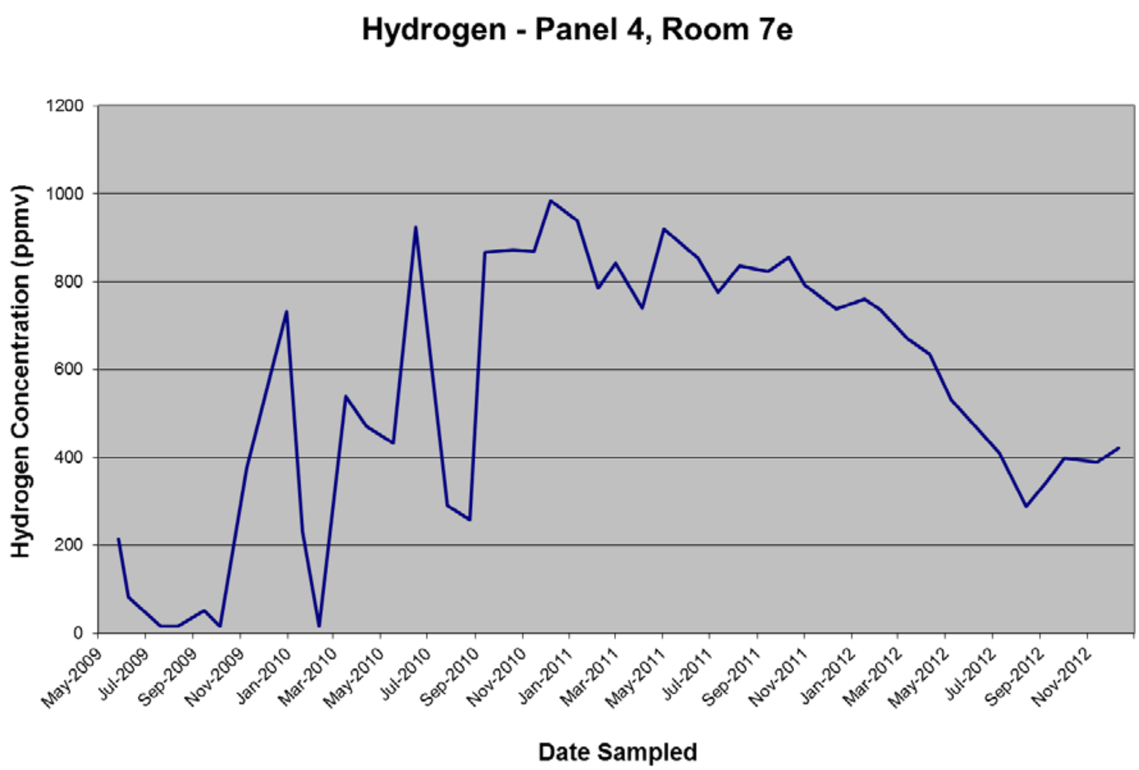

Figure 12: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 7e

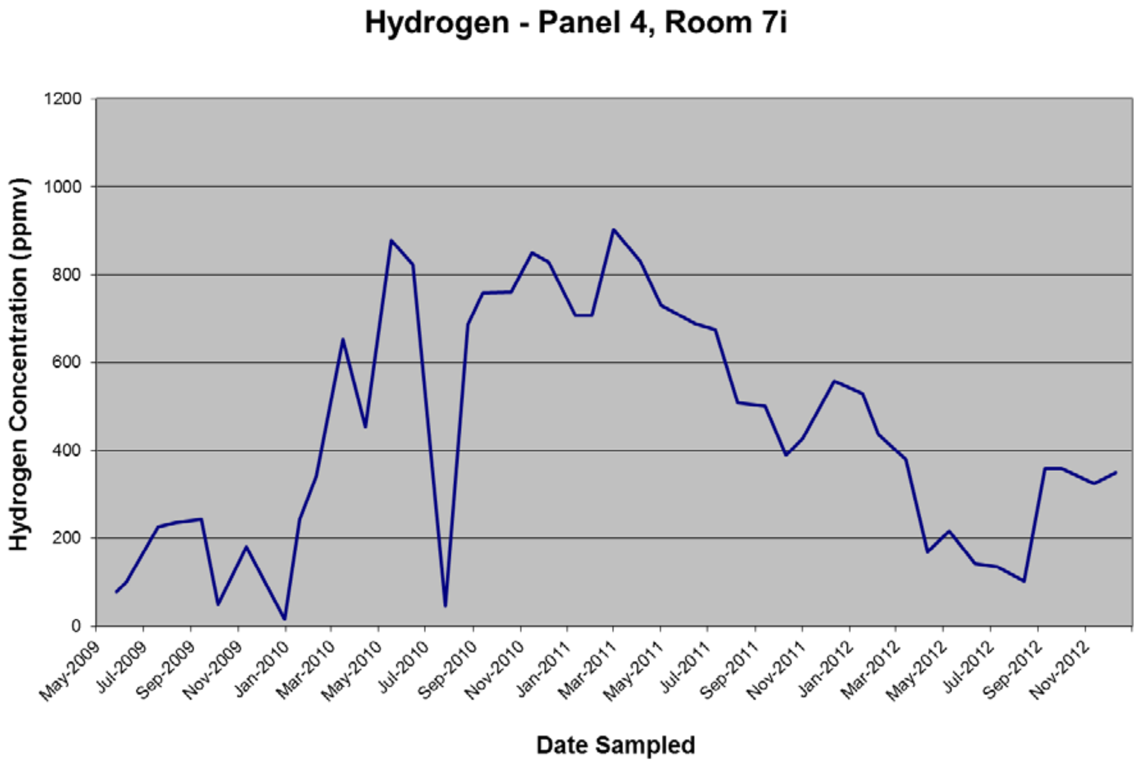

Figure 13: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 7i

D. Hydrogen Concentration Plots

While time series plots show hydrogen concentrations for individual room and bulkhead locations, hydrogen concentration plots present an aggregated picture of these locations simultaneously. Most importantly, hydrogen concentration plots display the degree to which hydrogen concentrations fluctuate from the time a room was closed. Accessible bulkhead locations (IBA and EBA) have been excluded since they are outside the filled panels.

1. Panel 3 Hydrogen Concentration Plots

Figure 14 presents the hydrogen concentration data for rooms in Panel 3. The graph plots the number of months since the associated room was closed on the x-axis and the hydrogen concentration on the y-axis. Figures 15 through 17 plot respectively the median, mean, and maximum hydrogen concentrations versus months since the room was closed.

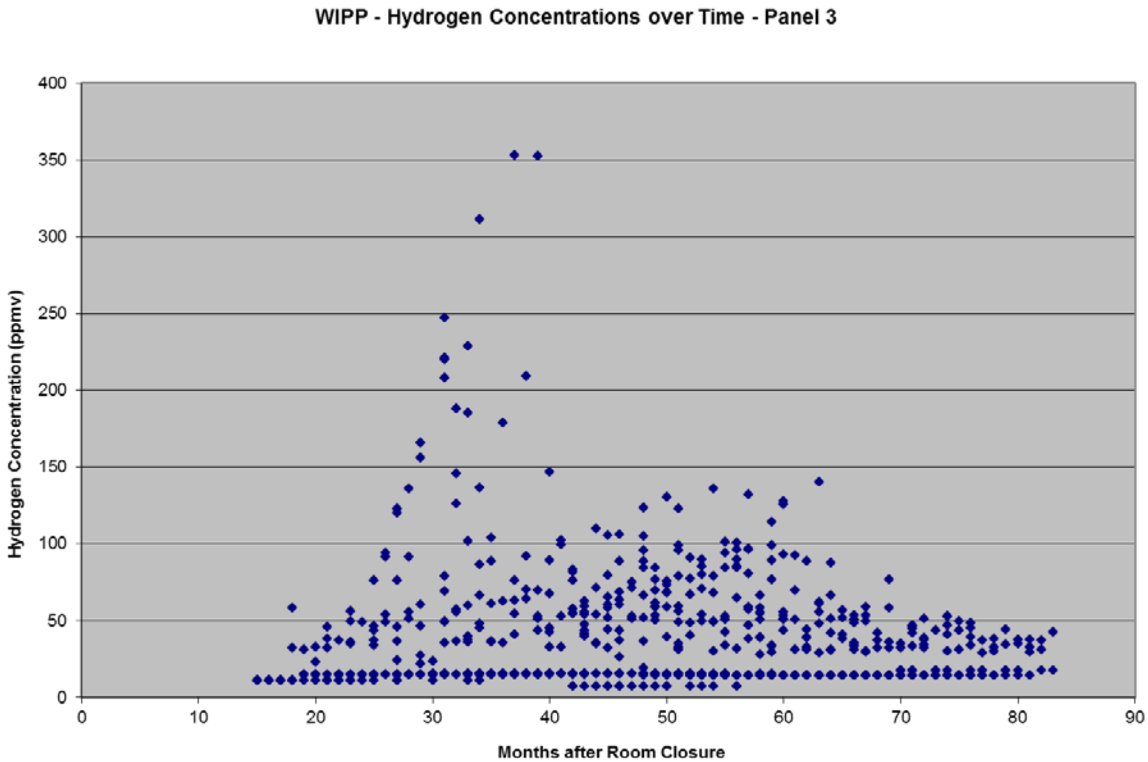

Figure 14: Plot of Hydrogen Concentrations in Panel 3

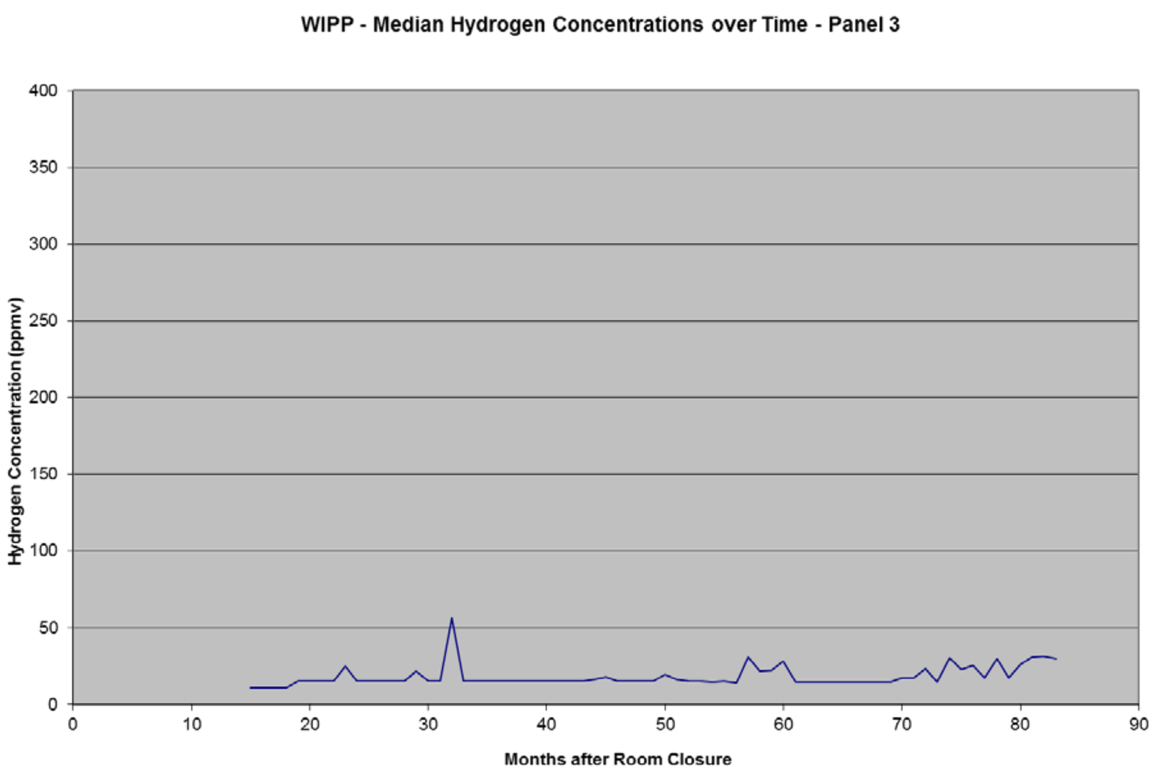

Figure 15: Plot of Median Hydrogen Concentrations in Panel 3

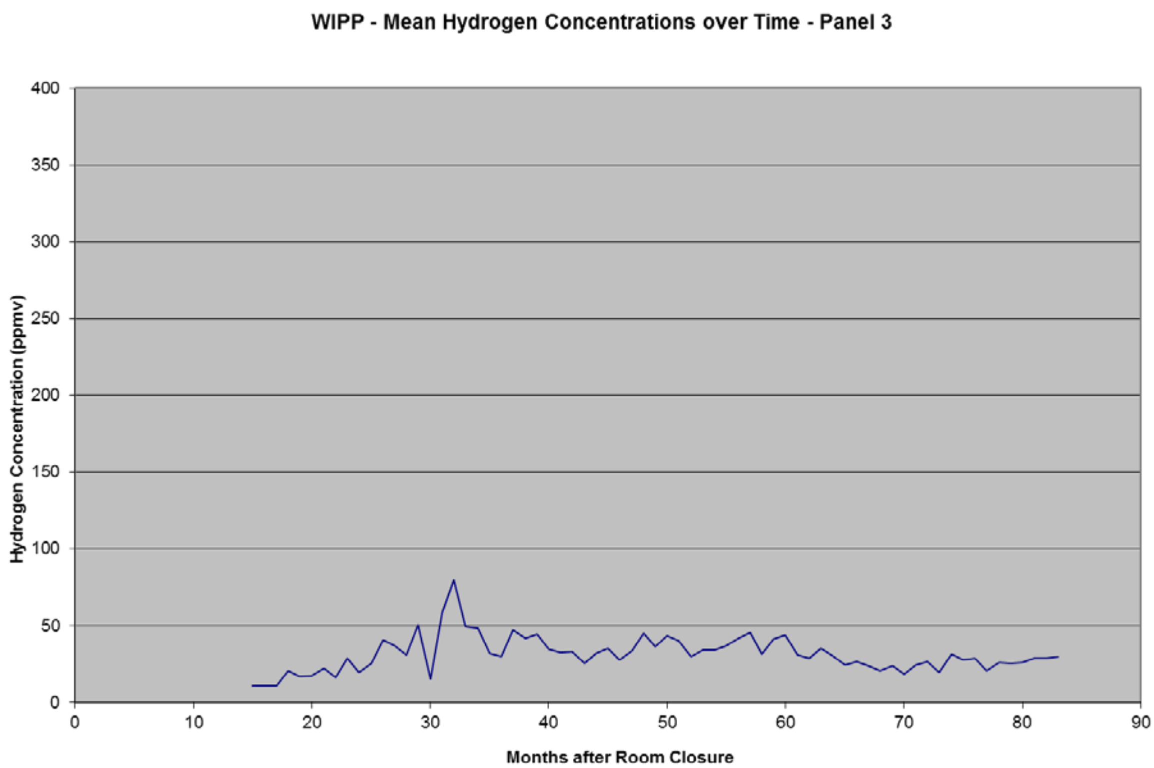

Figure 16: Plot of Mean Hydrogen Concentrations in Panel 3

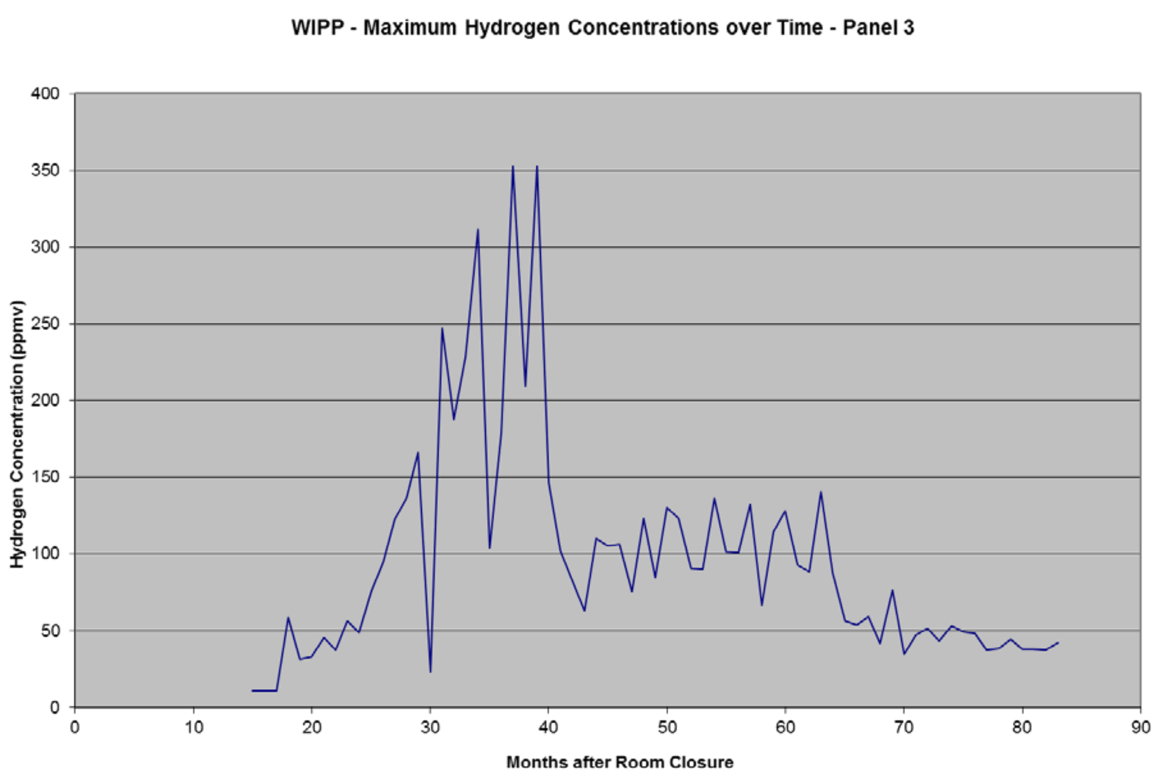

Figure 17: Plot of Maximum Hydrogen Concentrations in Panel 3

2. Panel 4 Hydrogen Concentration Plots

Figure 18 presents the hydrogen concentration data for rooms in Panel 4. Figures 19 through 21 plot respectively the median, mean, and maximum hydrogen concentrations versus months since the room was closed.

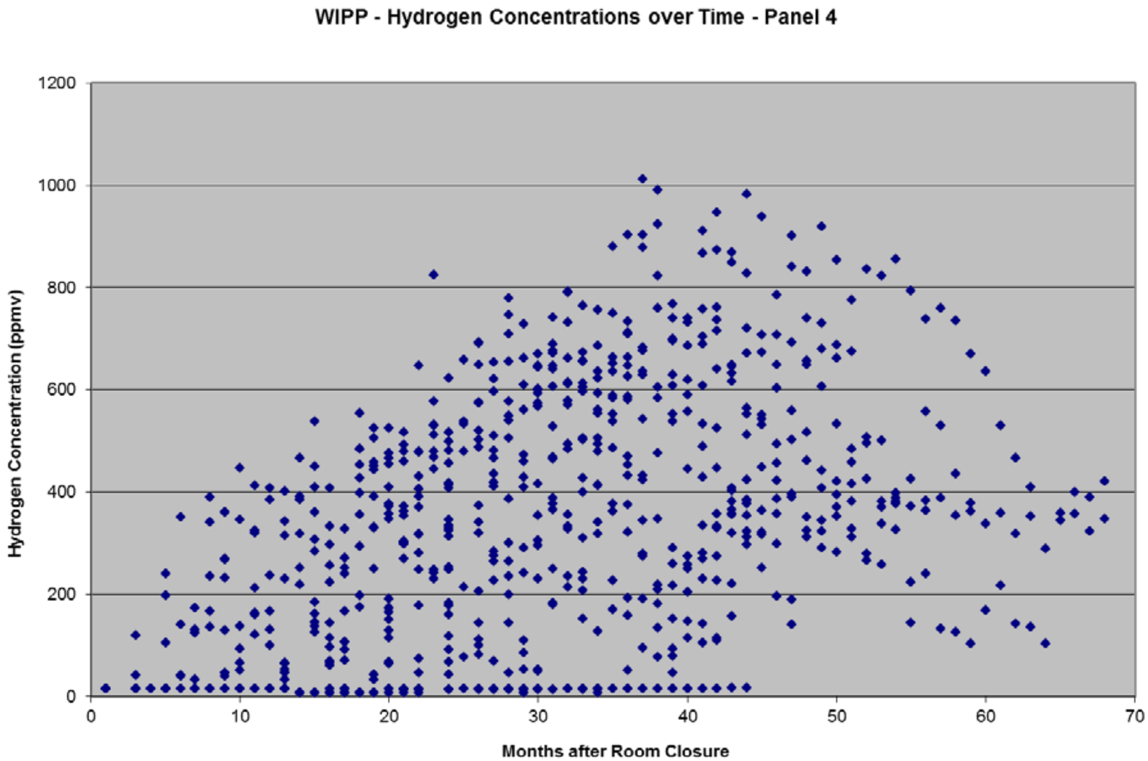

Figure 18: Plot of Hydrogen Concentrations in Panel 4

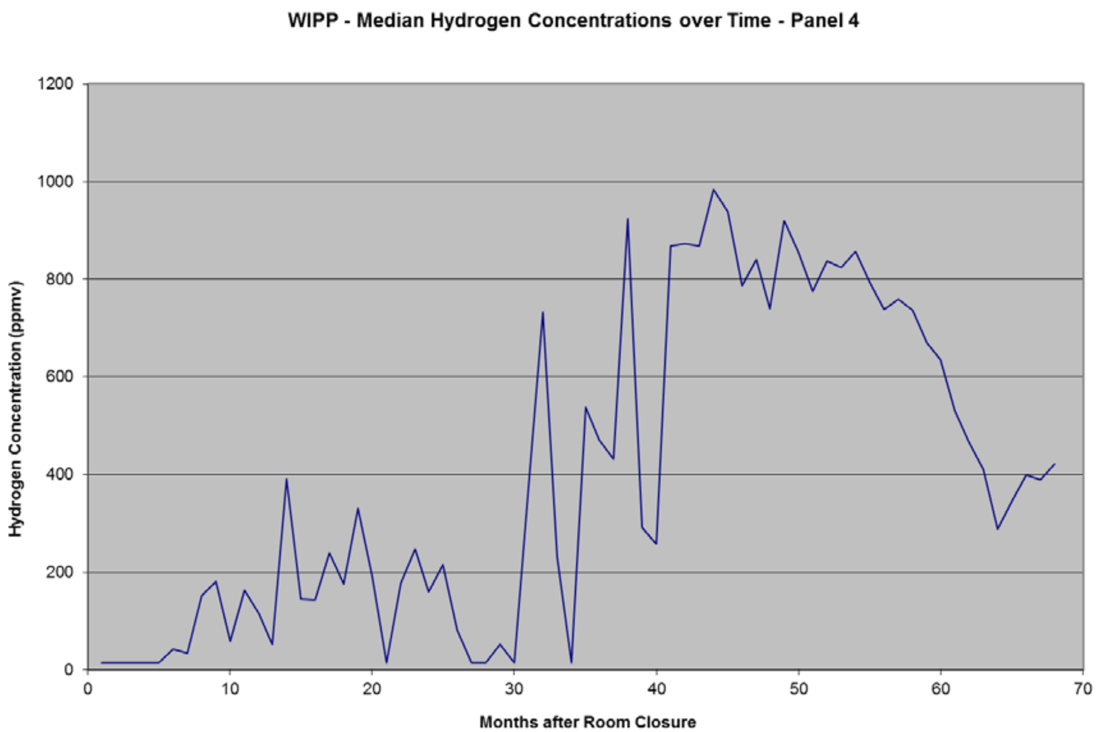

Figure 19: Plot of Median Hydrogen Concentrations in Panel 4

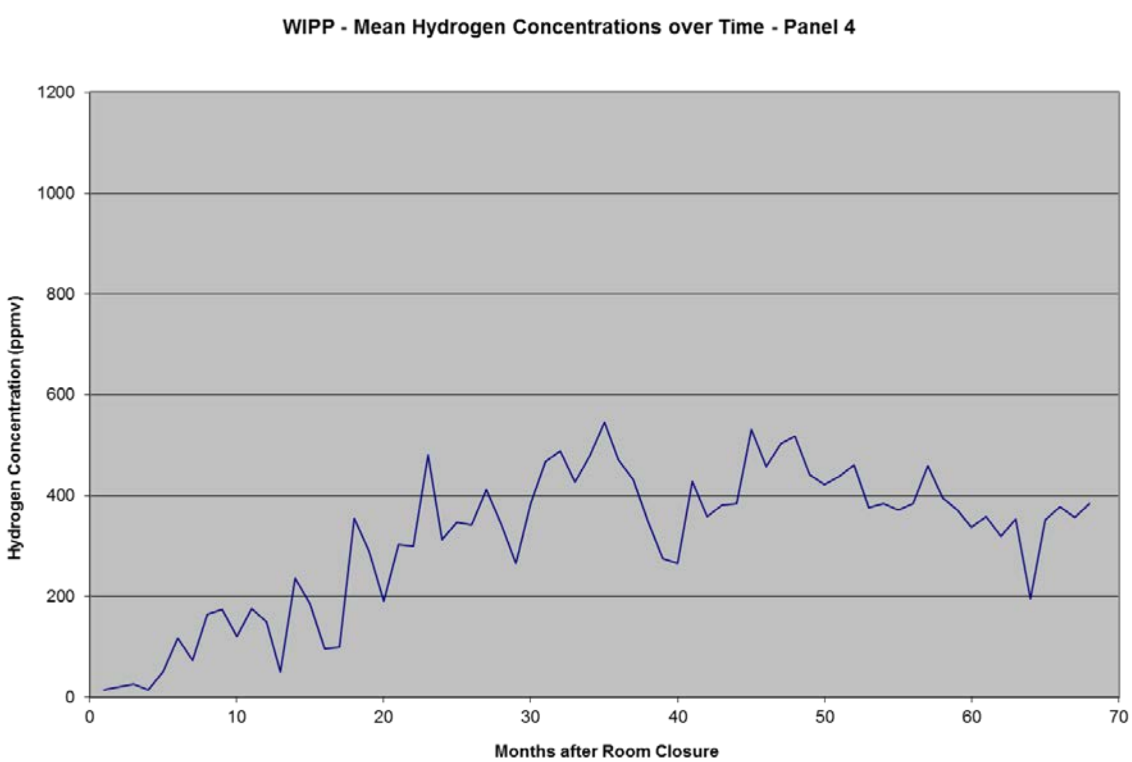

Figure 20: Plot of Mean Hydrogen Concentrations in Panel 4

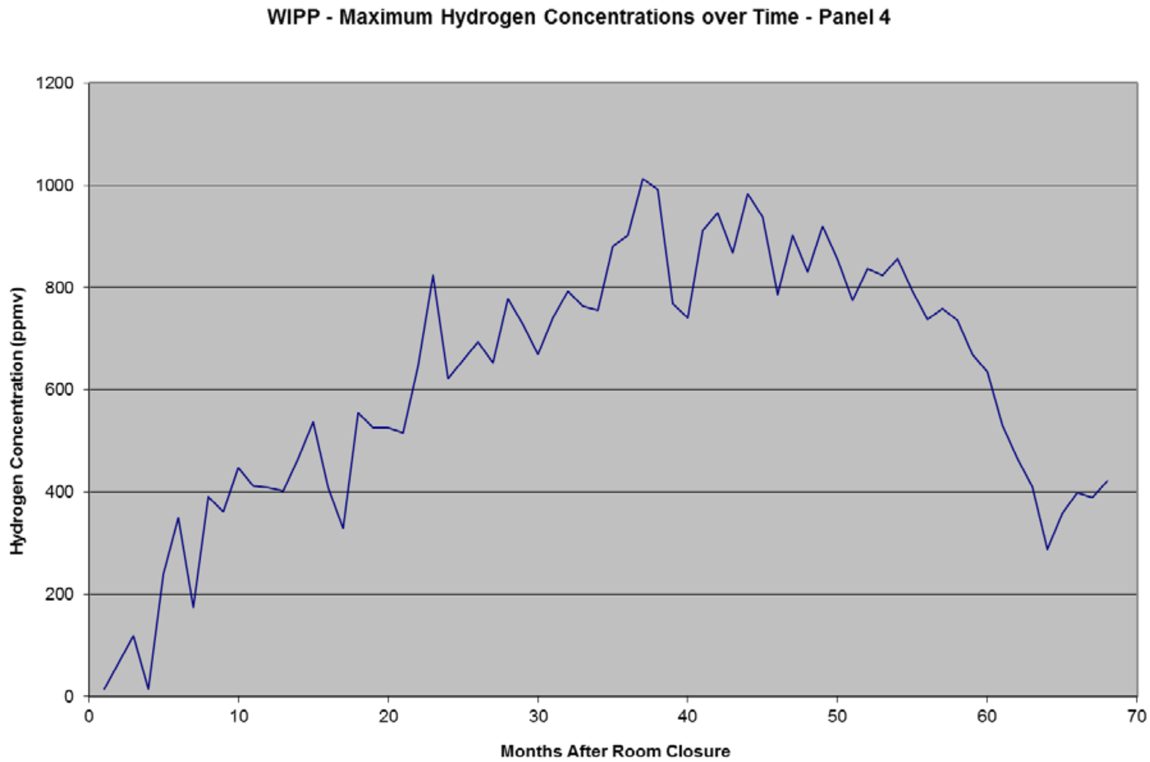

Figure 21: Plot of Maximum Hydrogen Concentrations in Panel 4

E. Linear Regression on Hydrogen Concentration Data

Hydrogen concentration plots show the concentration of hydrogen in closed rooms over time. The change in hydrogen concentration over time is believed to be related to the hydrogen generation rate and the rate at which hydrogen leaves the disposal room. The change in hydrogen concentration over time can be analyzed in a quantitative way to predict the length of time necessary for hydrogen concentrations to accumulate to explosive levels. Linear regression has been used to quantify the change in hydrogen concentration with time in Panels 3 and 4. Again, accessible bulkhead locations (IBA and EBA) were excluded.

1. Panel 3 Regression Plots

Figures 22 through 24 plot respectively the median, mean, and maximum hydrogen concentrations versus the number of months since rooms in Panel 3 were closed. The best-fit line is drawn through each data set. Figures 25 and 26 re-plot the maximum hydrogen concentration in relation to Action Level 1 (4,000 ppmv) and the LEL (40,000 ppmv).

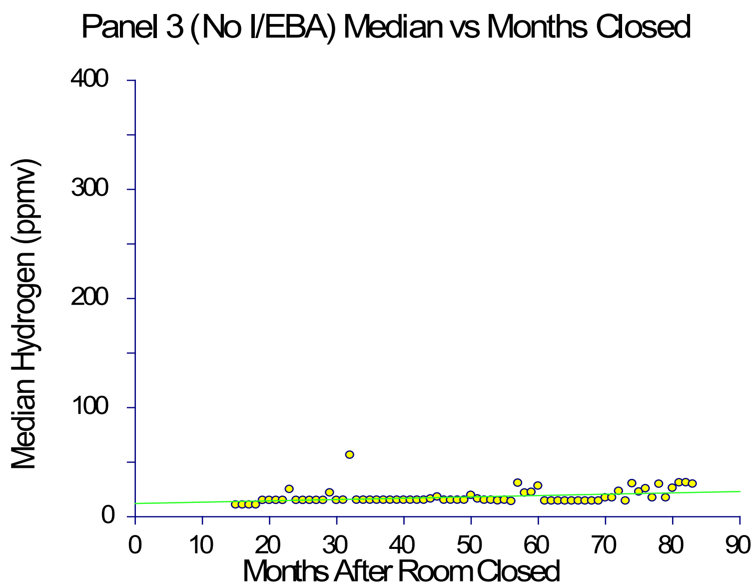

Figure 22: Regression of Median Hydrogen Concentrations in Panel 3

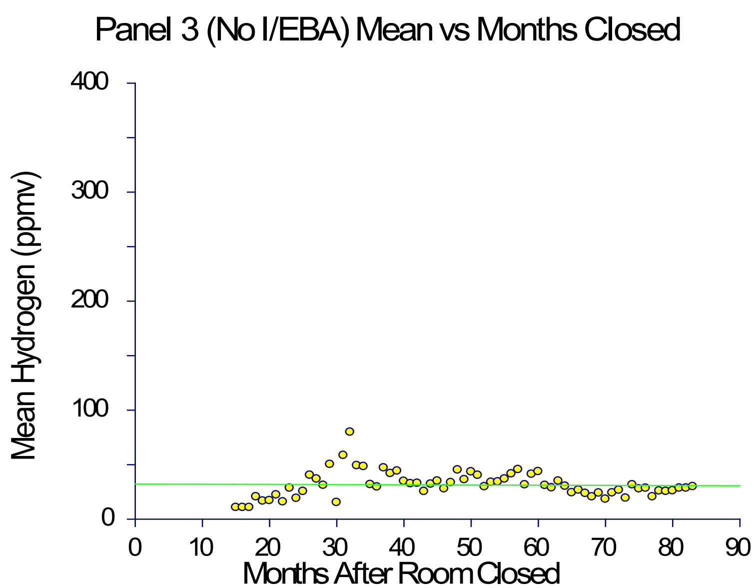

Figure 23: Regression of Mean Hydrogen Concentrations in Panel 3

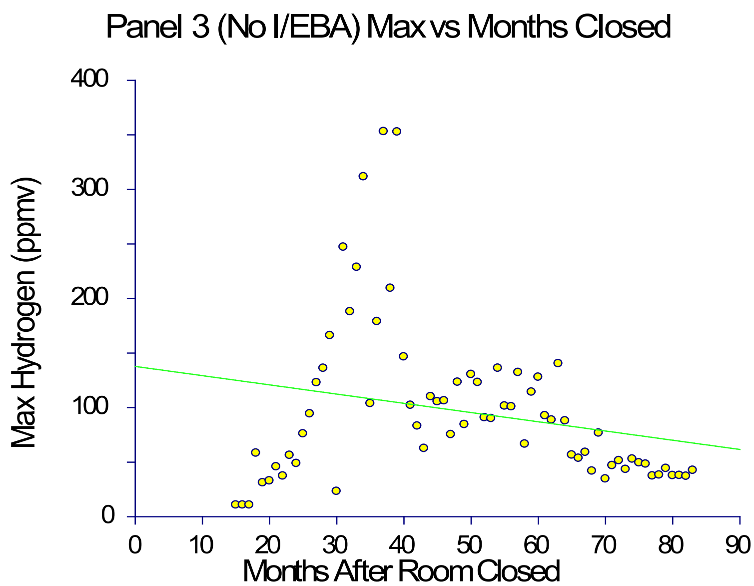

Figure 24: Regression of Maximum Hydrogen Concentrations in Panel 3

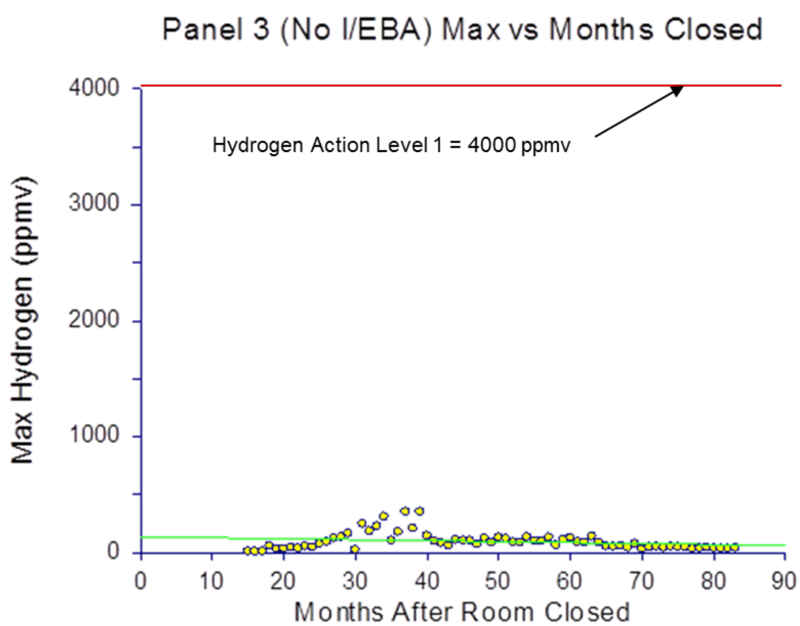

Figure 25: Regression of Maximum Hydrogen Concentrations in Panel 3 Compared to Action Level 1

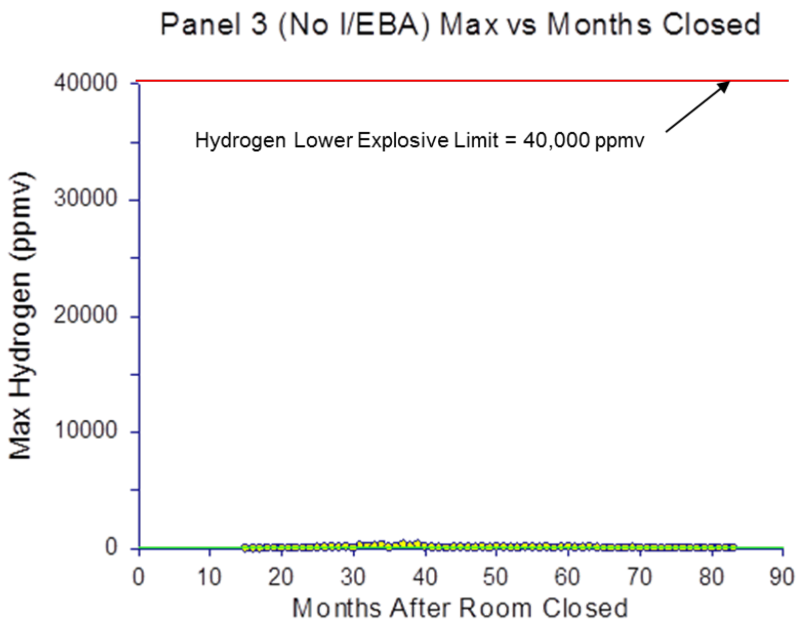

Figure 26: Regression of Maximum Hydrogen Concentrations in Panel 3 Compared to the Lower Explosive Limit

Because the regression equation for the maximum hydrogen concentrations shown in Figures 24 through 26 has a negative slope (i.e., downward trend), the hydrogen concentration will not reach Action Level 1 or LEL.

2. Panel 4 Regression Plots

Figures 27 through 29 plot respectively the median, mean, and maximum hydrogen concentrations versus the number of months since rooms in Panel 4 were closed. Figures 30 and 31 plot the maximum hydrogen concentrations in relation to Action Level 1 (4,000 ppmv) and the LEL (40,000 ppmv).

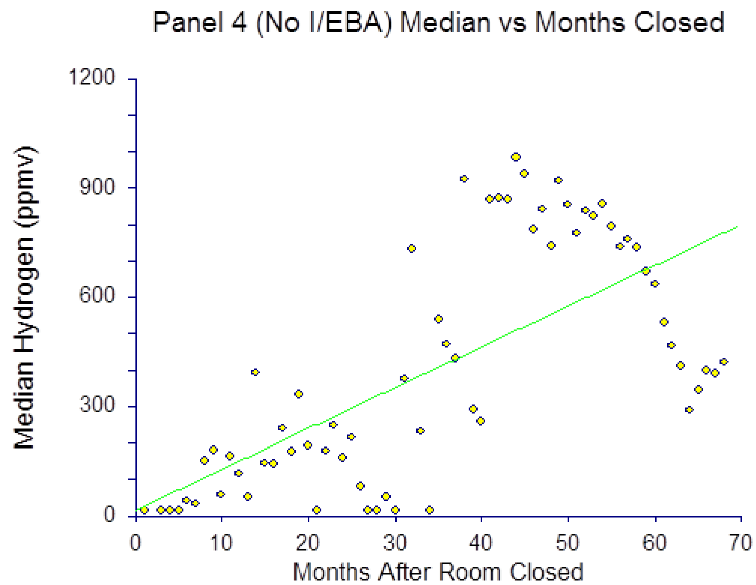

Figure 27: Regression of Median Hydrogen Concentrations in Panel 4

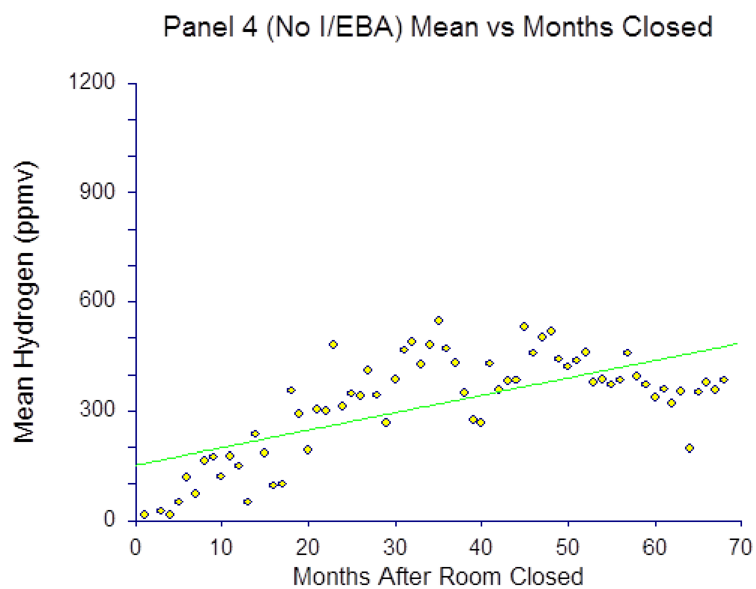

Figure 28: Regression of Mean Hydrogen Concentrations in Panel 4

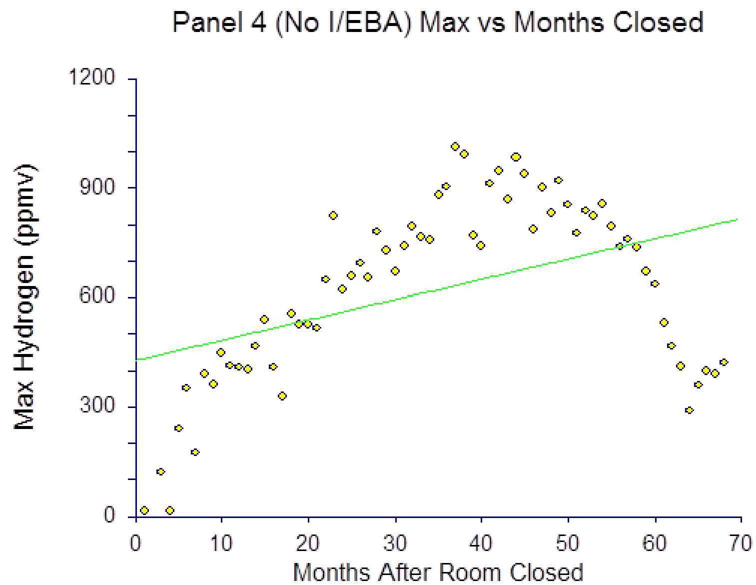

Figure 29: Regression of Maximum Hydrogen Concentrations in Panel 4

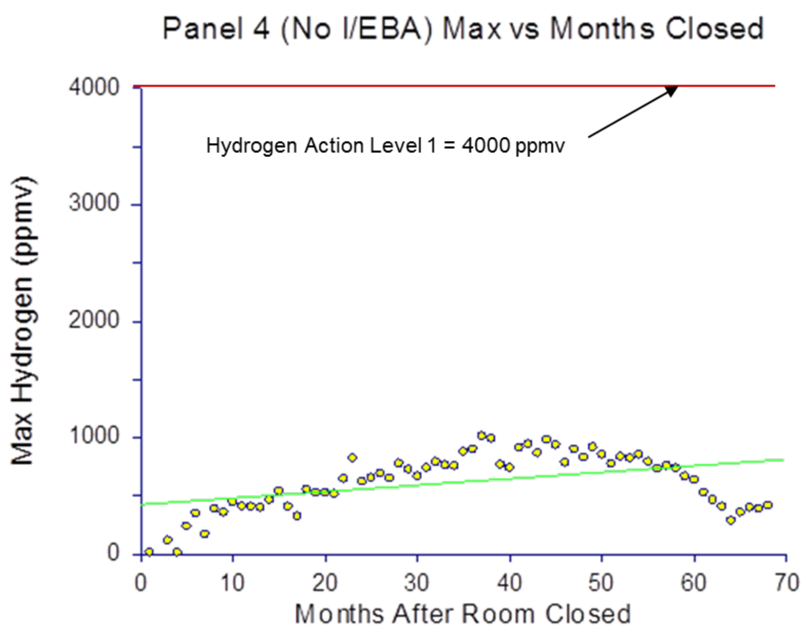

Figure 30: Regression of Maximum Hydrogen Concentrations in Panel 4 Compared to Action Level 1

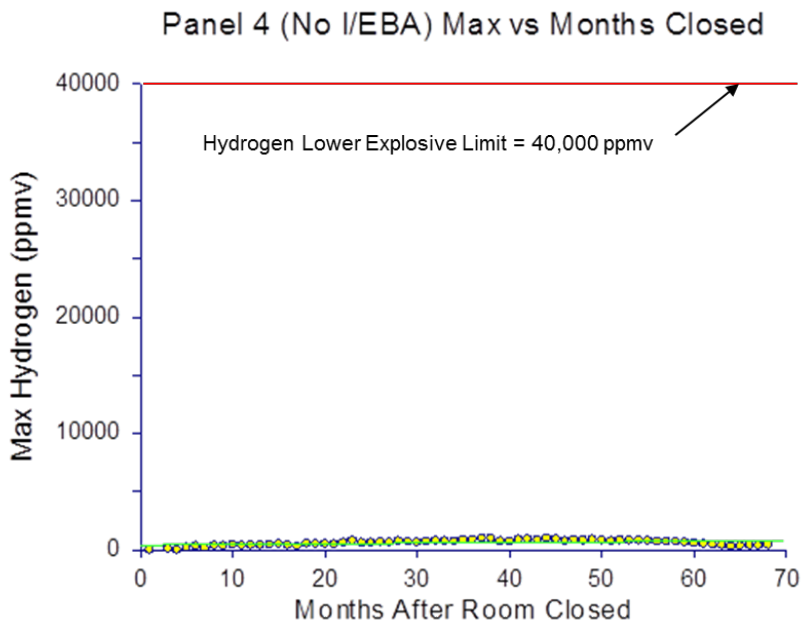

Figure 31: Regression of Maximum Hydrogen Concentrations in Panel 4 Compared to the Lower Explosive Limit

Using the regression equation for the maximum hydrogen concentrations shown in Figures 29 through 31, the hydrogen concentrations will reach Action Level 1 in approximately 50 years, assuming this historical rate of hydrogen concentration change.

VI. Discussion

The statistical analysis has revealed several pertinent results:

- Rooms further from the main access drift tend to show higher average concentrations than rooms closer to the drift. This phenomenon can be seen in Figures 2 through 5. Rooms further from the main access drift have a longer time period during which hydrogen may accumulate given that ventilation barriers were installed after completion of waste emplacement in each room.

- Box-and-whisker plots (Figures 6 through 9) also show that rooms closer to the main access drift generally have lower hydrogen than rooms further away. Box-and-whisker plots including the lower action level show that all sample data are substantially below Action Level 1.

- Time series plots reveal that hydrogen concentration maximums are temporary and that concentrations can fall to near non-detectable levels after peaking.

- Hydrogen concentration plots in Panel 3 rooms show a peak in hydrogen concentrations followed by a sustained period of low hydrogen levels, which is ongoing according to the latest sample data. Hydrogen concentration plots in

Panel 4 rooms show erratically rising concentrations, with maximum levels exhibiting a leveling off trend or most recently a decline.

- Linear regression of hydrogen concentration data shows varying results in Panels 3 and 4. The regression model predicts a continued decline of Panel 3 hydrogen concentrations, thus neither Action Level 1 nor the LEL will ever be reached, as shown in Table 3. In Panel 4, the hydrogen levels have risen slowly since the panel rooms were filled and closed. The regression model predicts it will be over 50 years in Panel 4 before hydrogen levels rise to Action Level 1. Moreover, the regression models indicate it would take more than 580 years for the hydrogen levels to rise to the LEL in Panel 4 (Table 3).

Table 3: Predicted Time to Exceedance of Hydrogen Regulatory Thresholds in Panels 3 and 4

WIPP - Hydrogen Levels		
Panel	Predicted Time to Exceedance (Years)	
	Action Level 1	Lower Explosive Limit
3	Never	Never
4	50+	580+

The rooms and panels are not completely sealed to the outside areas of the mine, which may contribute to the fluctuations observed in the room hydrogen levels. Changes in mine ventilation, changes in the efficacy of bulkheads in a dynamic environment subject to salt creep, and other factors could influence hydrogen accumulation to an unknown degree.

VII. Summary

The air monitoring data in Panels 3 and 4 indicate methane concentrations are below the MDL.

Hydrogen concentrations in Panels 3 and 4 have remained substantially below the action level of 4,000 ppmv during the entire monitoring program. The maximum hydrogen concentration observed (1,013 ppmv) slightly exceeded 25 percent of the lower action level, indicating no challenge to either the action level or LEL of 4 percent (40,000 ppmv). Regression models indicate that hydrogen levels would not rise to the LEL in Panels 3 or 4 during the operational period of the WIPP (Table 3).

VIII. References

Devarakonda, 2006. Letter from M. Devarakonda to D. Mercer: *Estimation of Hydrogen Generation Rates from Radiolysis in WIPP Panels*, Washington TRU Solutions LLC, July 26, 2006.

EPA, 1999. *Compendium Method TO-15: Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry*, EPA 625/R-96/010b. Center for Environmental Research Information, Office of Research and Development, Cincinnati, OH, January 1999.

Golder Associates, 2006. Letter from Golder Associates Inc. to Rick Chavez: *Early Time Generation of Methane and Hydrogen in Filled Panels at the WIPP*, November 30, 2006.

Wang and Brush, 1996. Letter from Yifeng Wang and Larry Brush to Martin S. Tierney: *Estimates of Gas-Generation Parameters for the Long-Term WIPP Performance*, Sandia National Laboratories, January 26, 1996.

Waste Isolation Pilot Plant Hazardous Waste Facility Permit, NM 4890139088-TSDF issued by the New Mexico Environment Department.

Appendix A

Time Series Plots for Hydrogen Concentrations in Panel 3

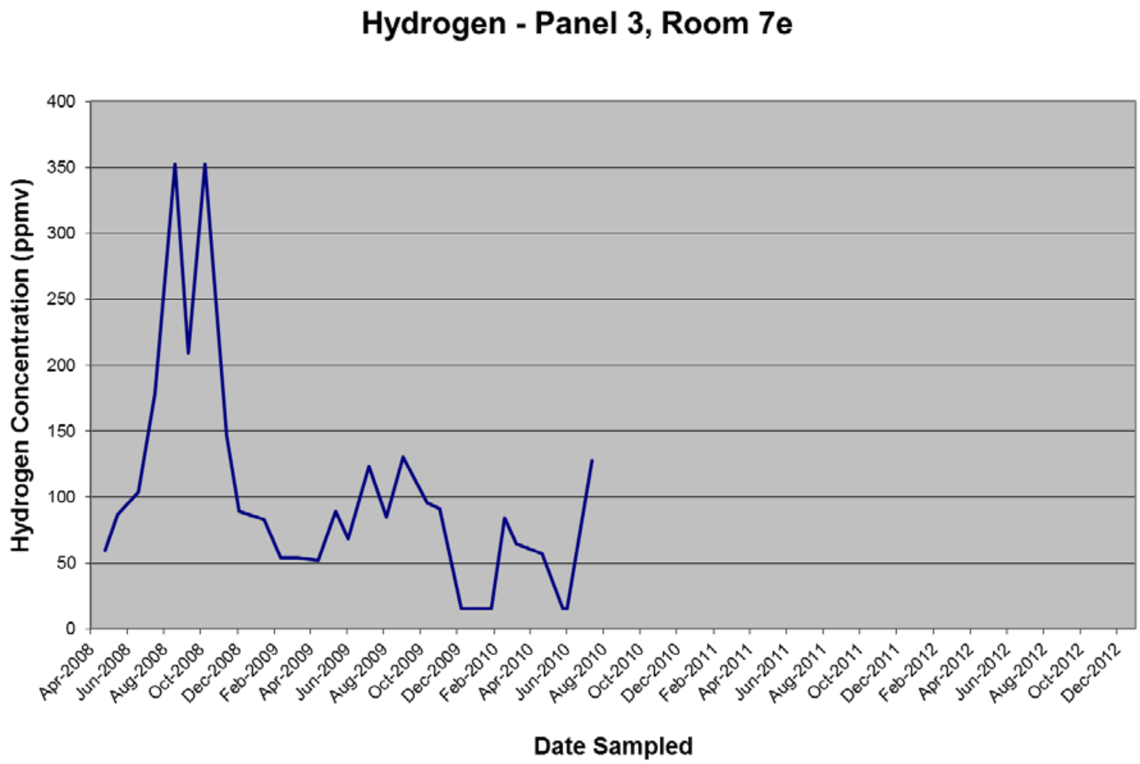

Figure A1: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 7e

The *Time Series Plot of Hydrogen Concentrations in Panel 3, Room 7i* has been omitted here due to a lack of data. The plot does appear in the main body of the report as Figure 11 on page 16. Only two samples are represented, each of which has a statistical evaluation concentration of 10.79 ppmv. These data appear in the table on page 89.

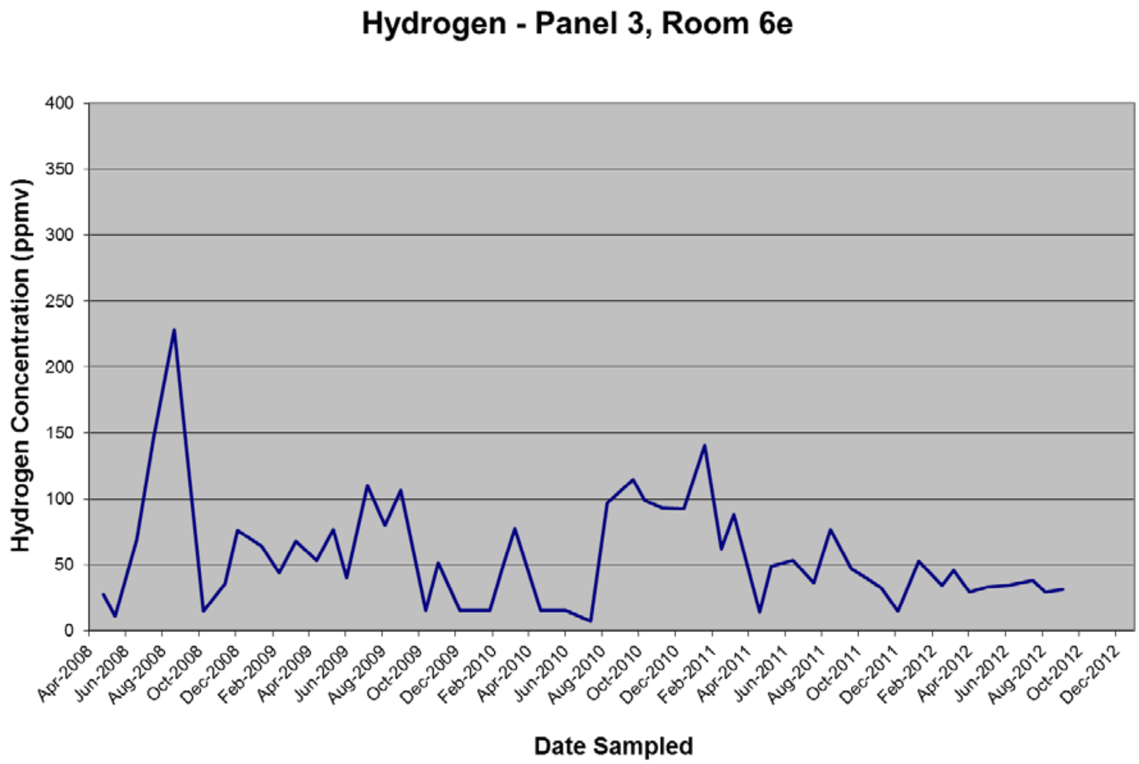

Figure A2: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 6e

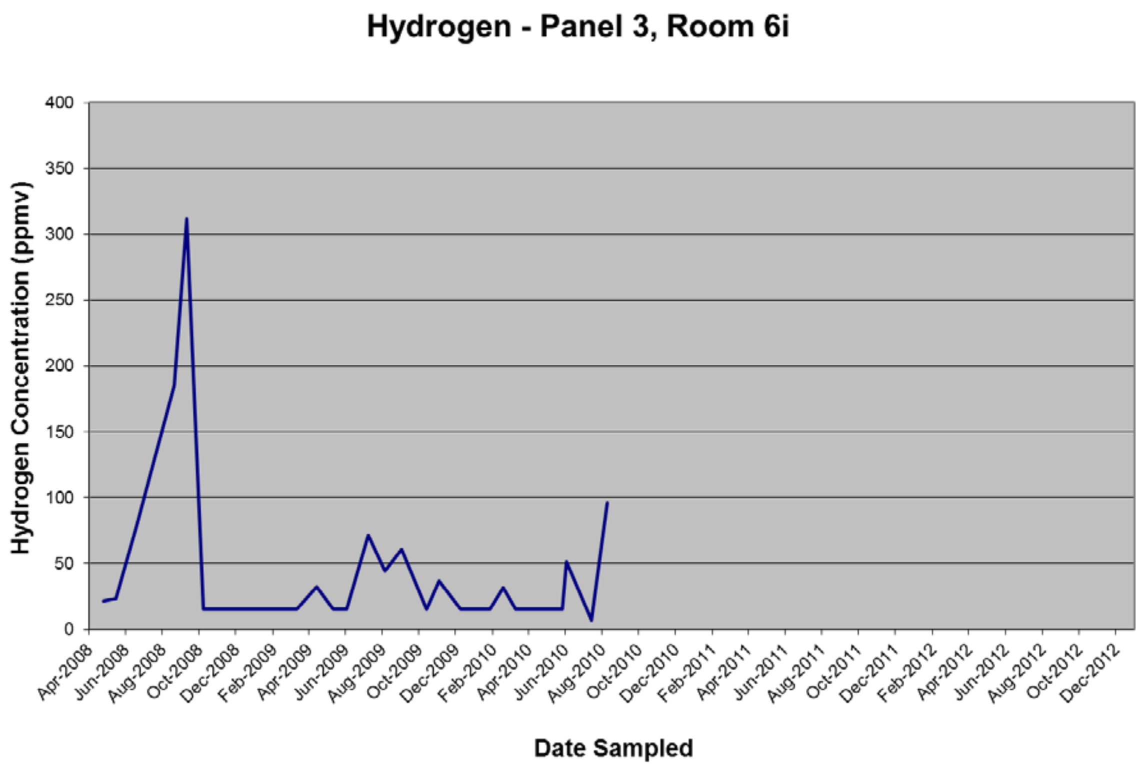

Figure A3: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 6i

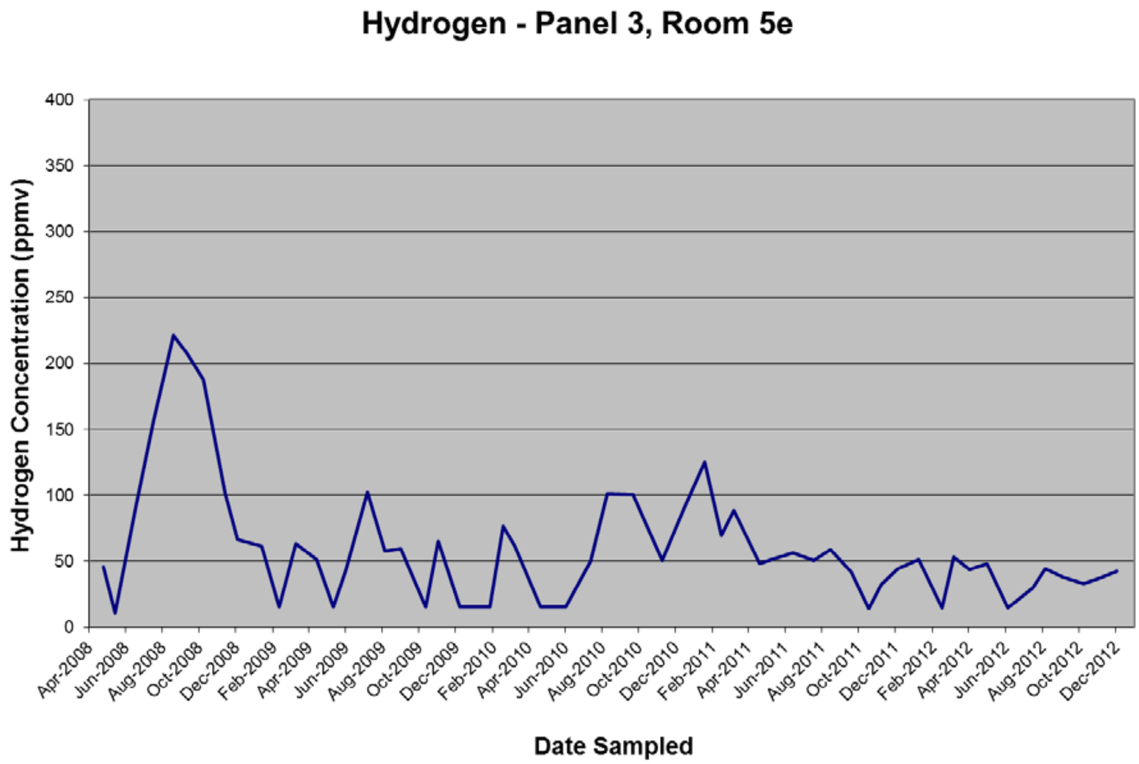

Figure A4: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 5e

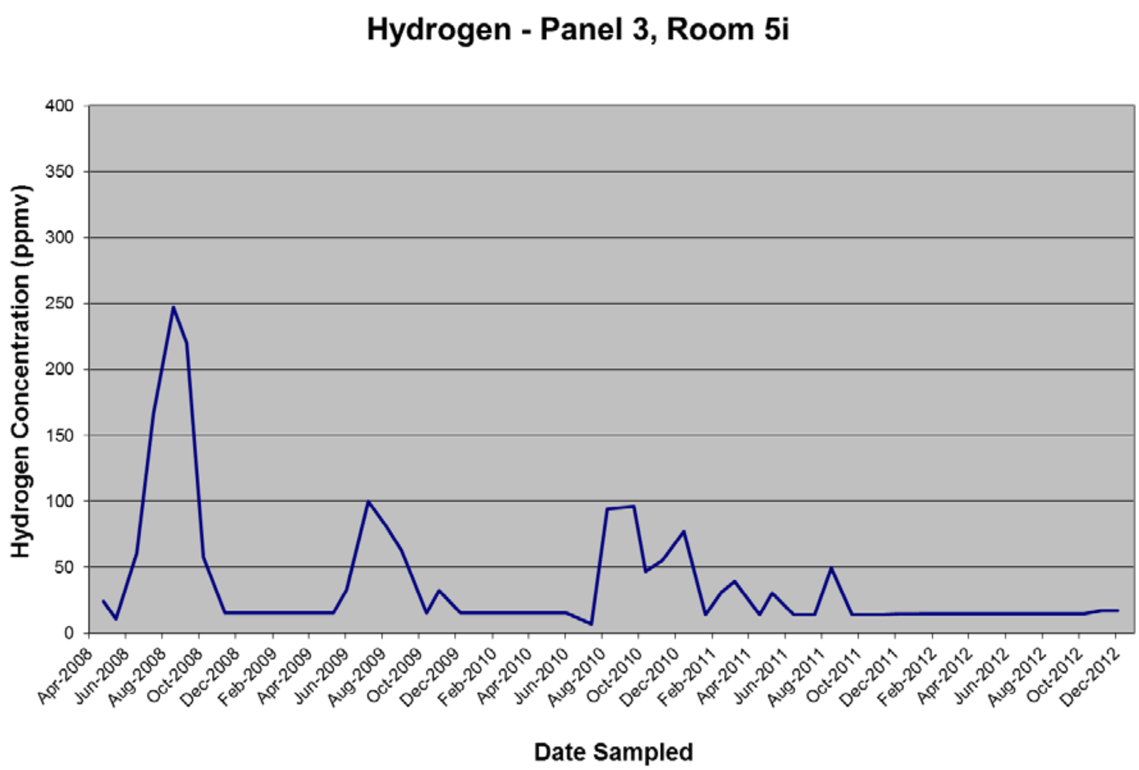

Figure A5: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 5i

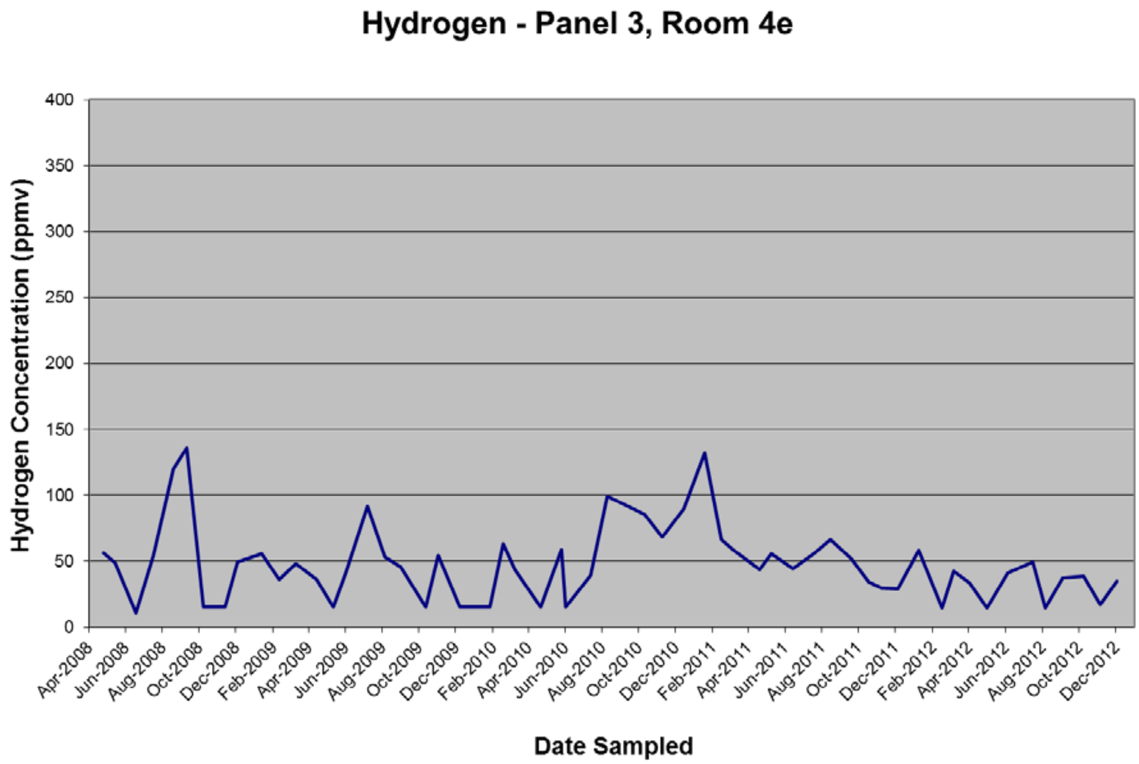

Figure A6: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 4e

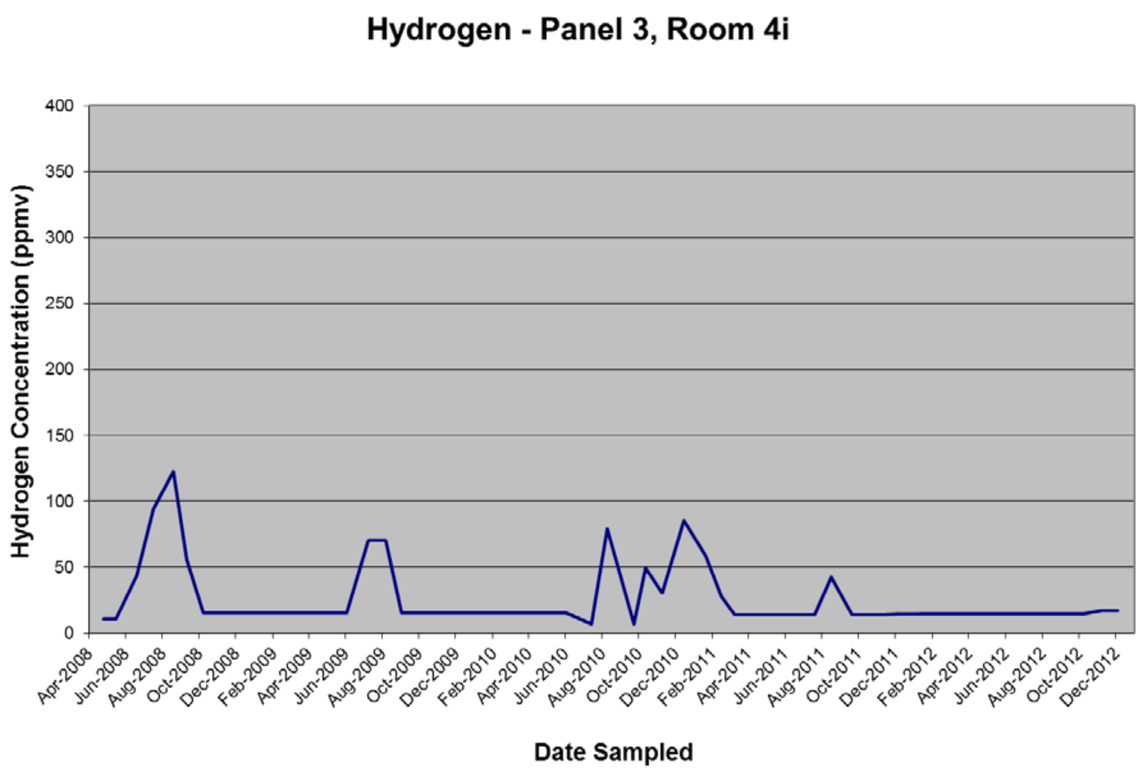

Figure A7: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 4i

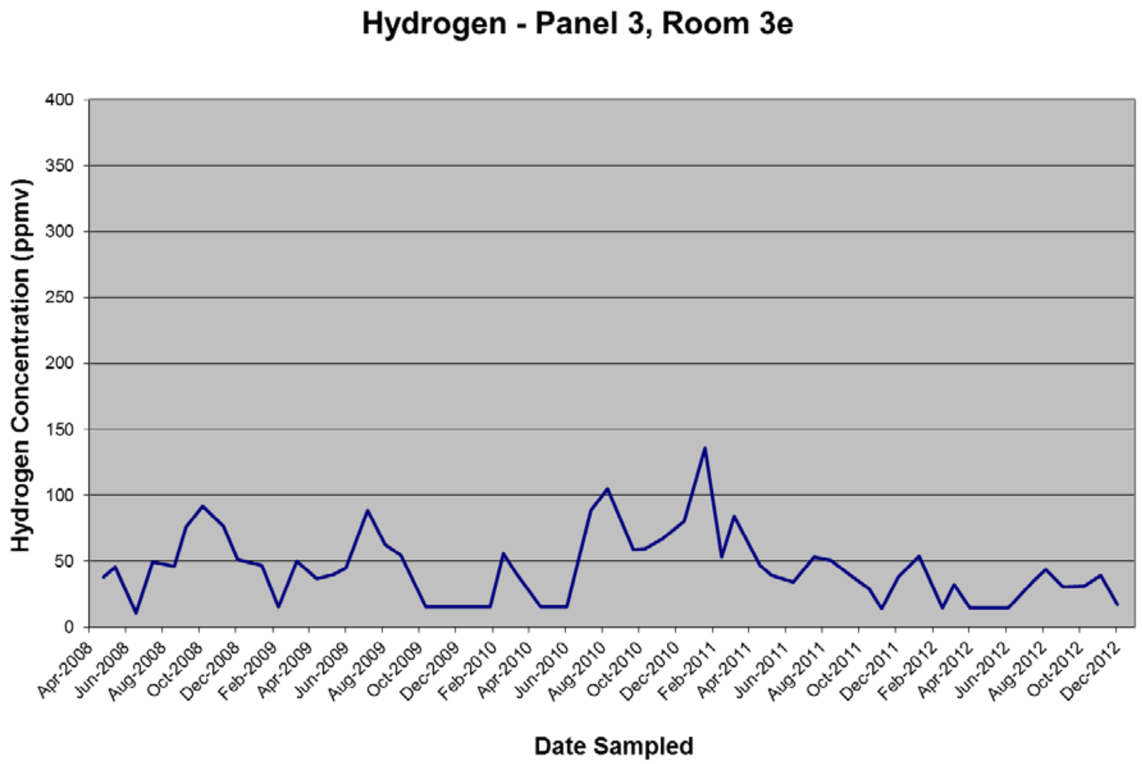

Figure A8: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 3e

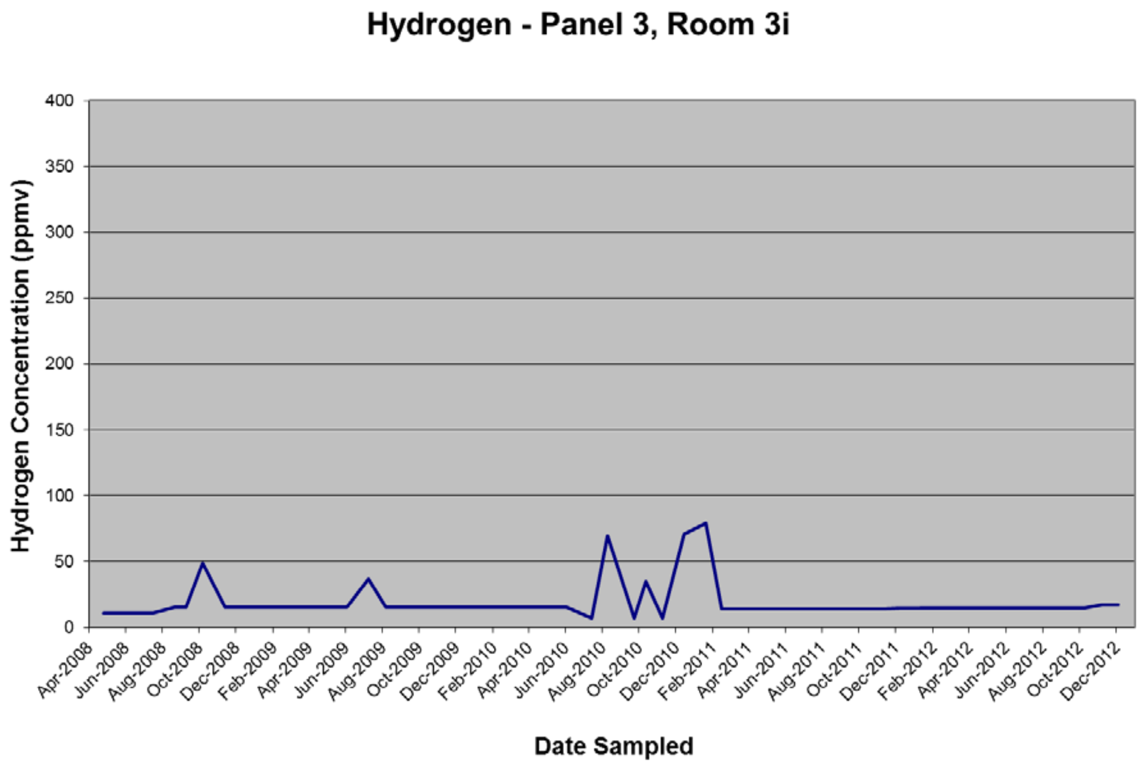

Figure A9: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 3i

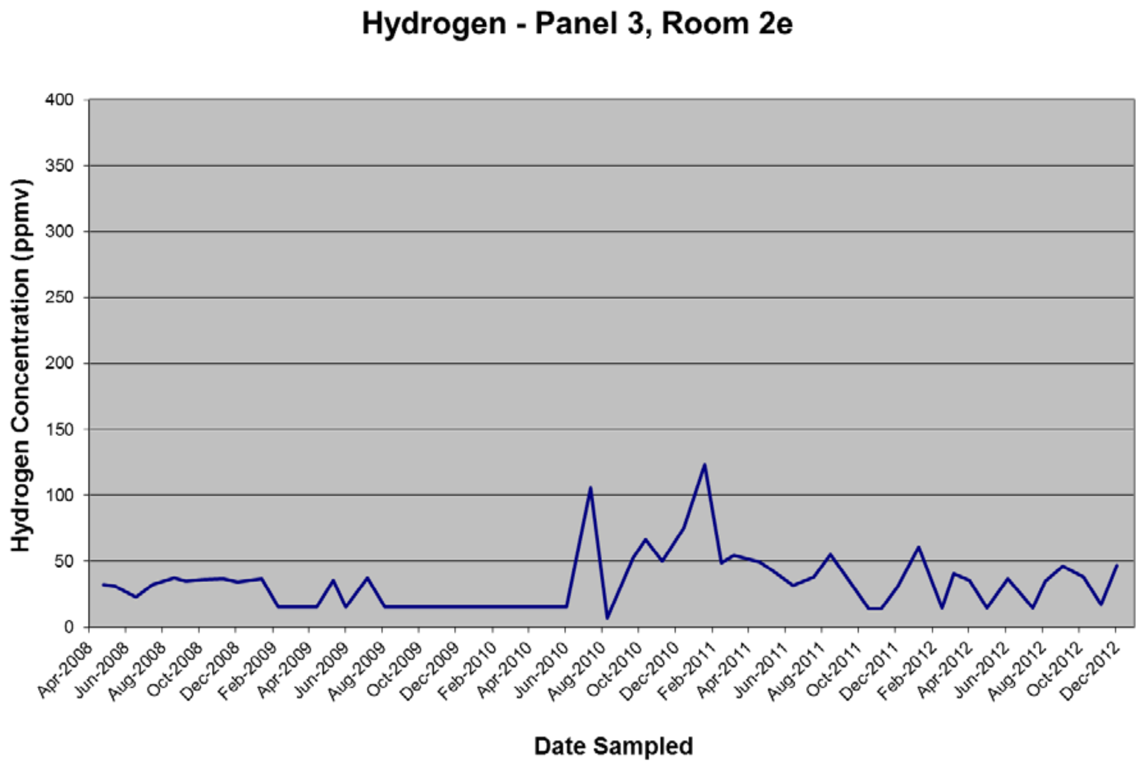

Figure A10: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 2e

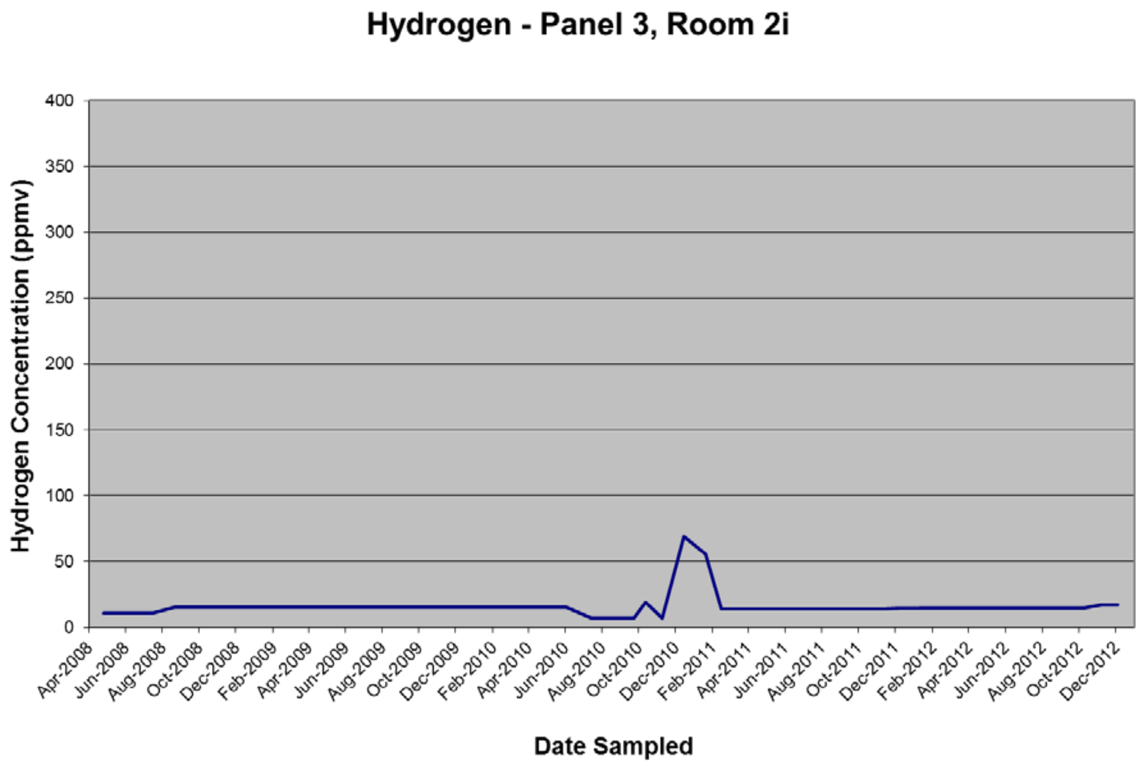

Figure A11: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 2i

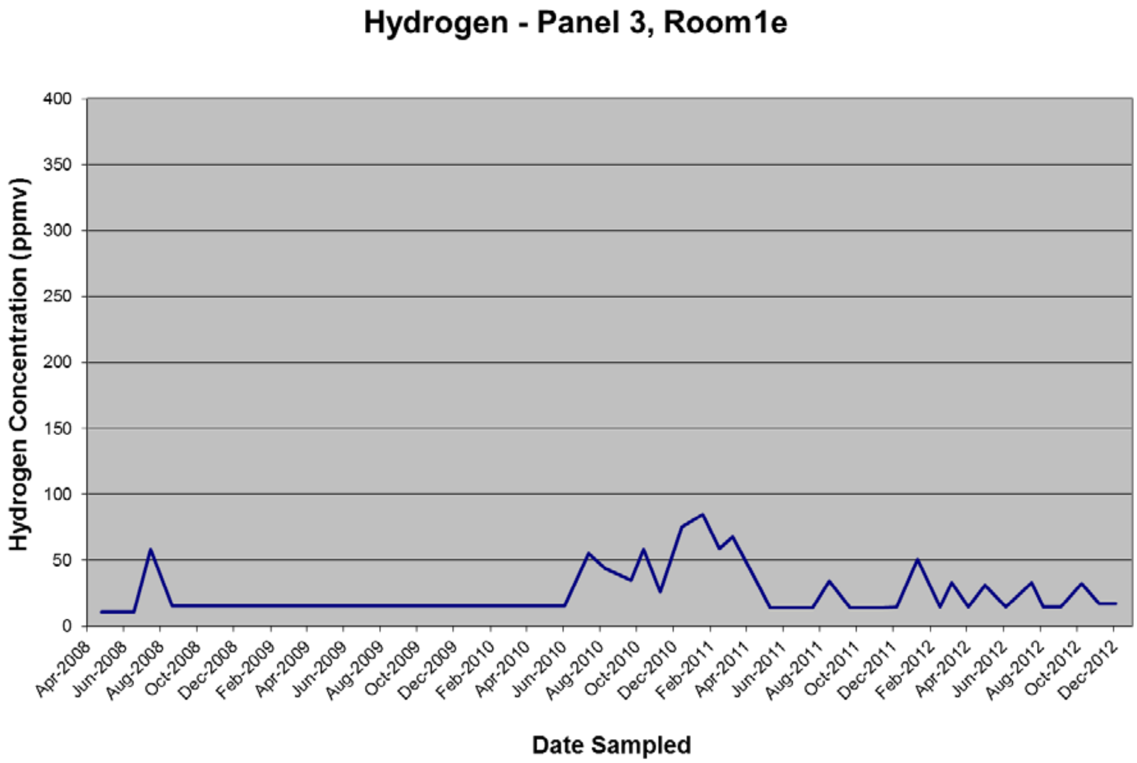

Figure A12: Time Series Plot of Hydrogen Concentrations in Panel 3, Room 1e

The *Time Series Plot of Hydrogen Concentrations in Panel 3, Room 1i* has been omitted due to a lack of data. Only three samples exist at this location, each of which has a statistical evaluation concentration of 10.79 ppmv. These data appear in the table on page 101.

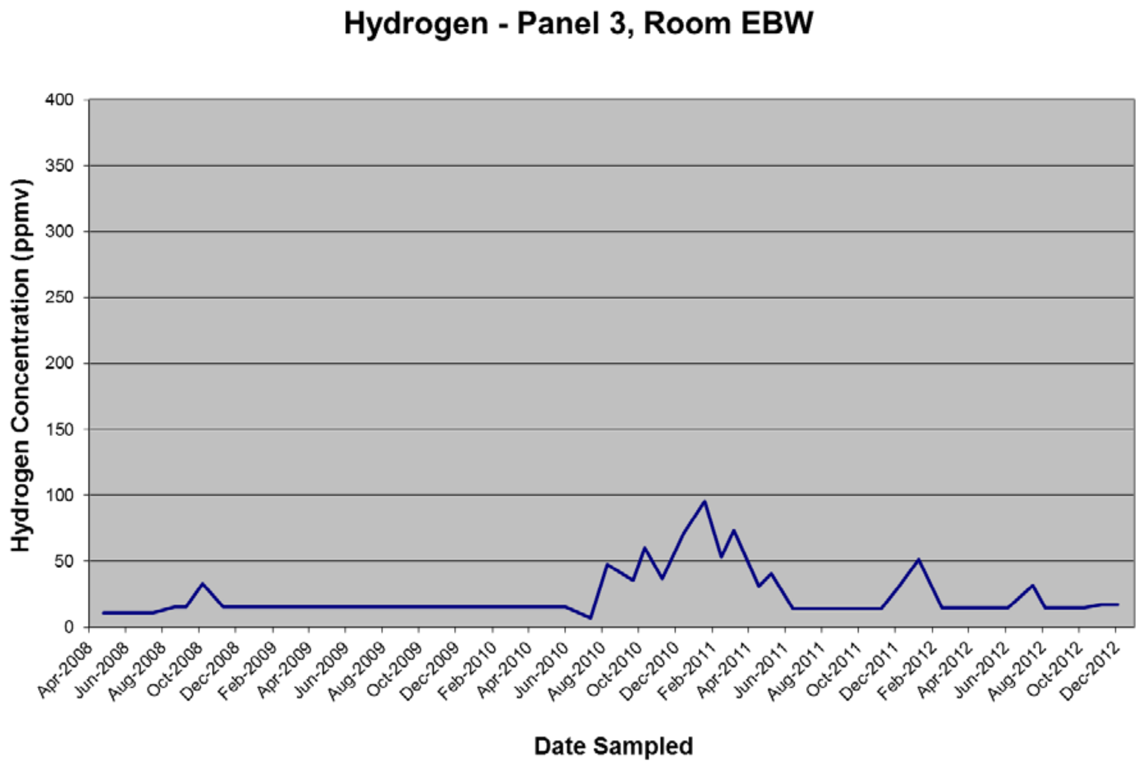

Figure A13: Time Series Plot of Hydrogen Concentrations in Panel 3, EBW

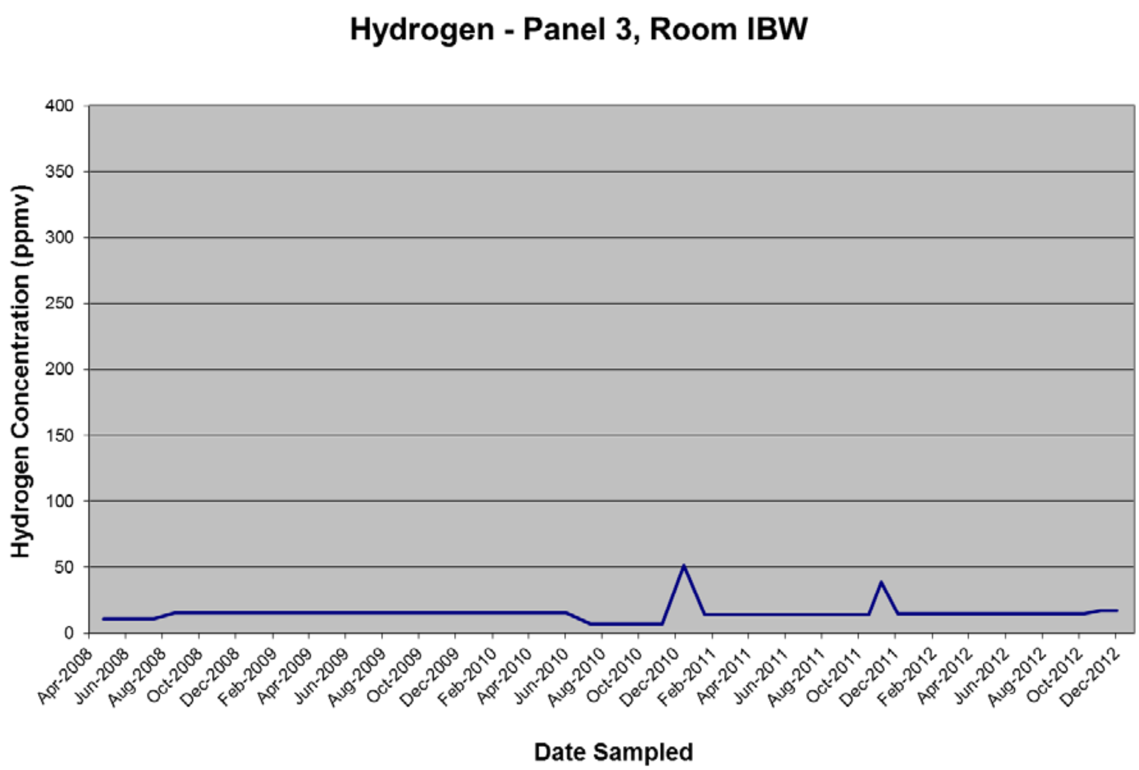

Figure A14: Time Series Plot of Hydrogen Concentrations in Panel 3, IBW

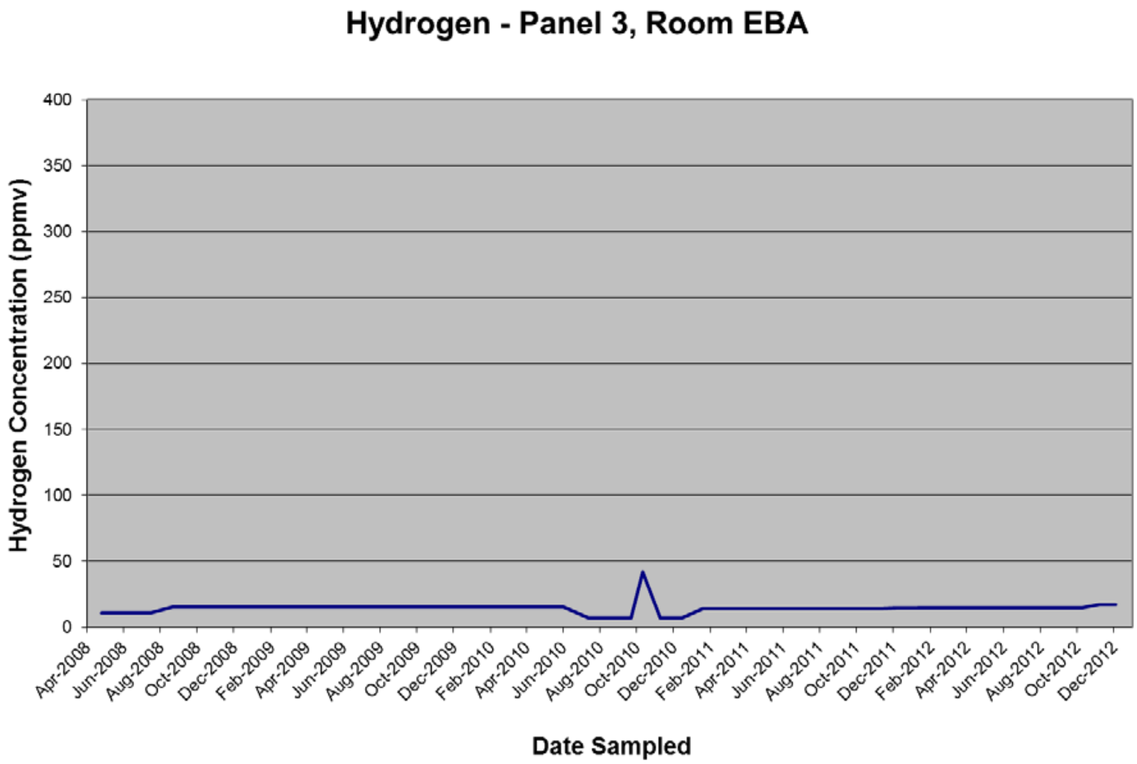

Figure A15: Time Series Plot of Hydrogen Concentrations in Panel 3, EBA

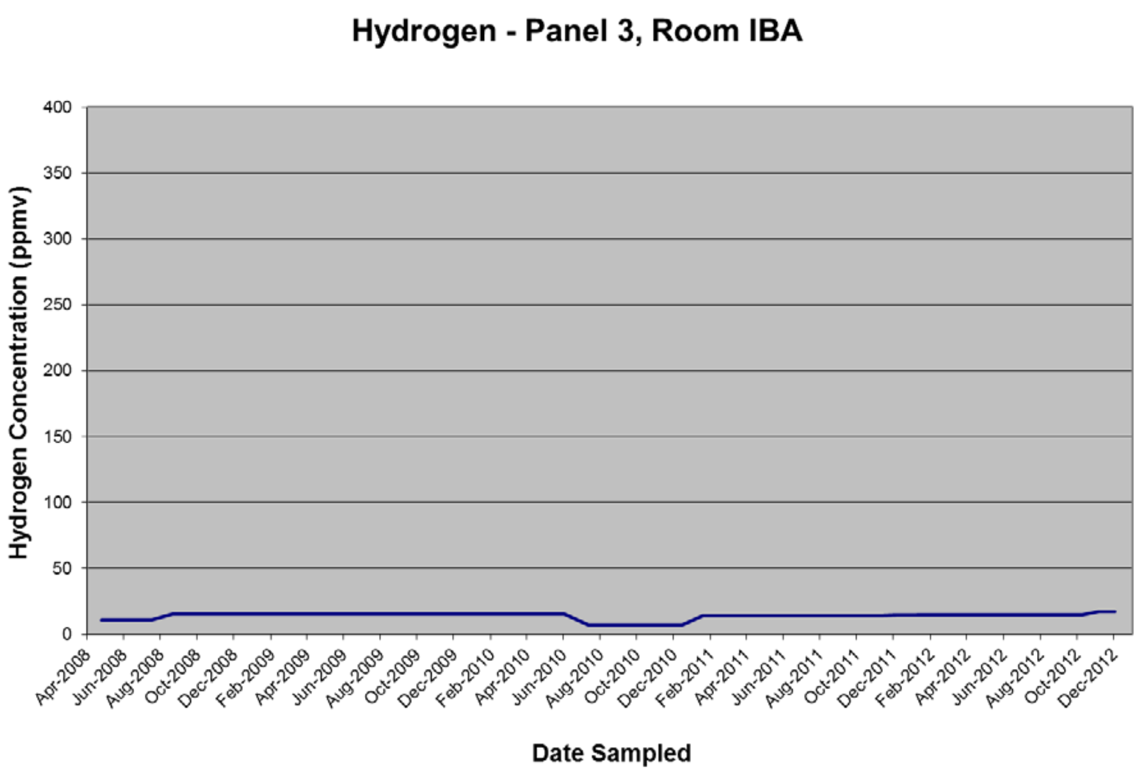

Figure A16: Time Series Plot of Hydrogen Concentrations in Panel 3, IBA

Appendix B

Time Series Plots for Hydrogen Concentrations in Panel 4

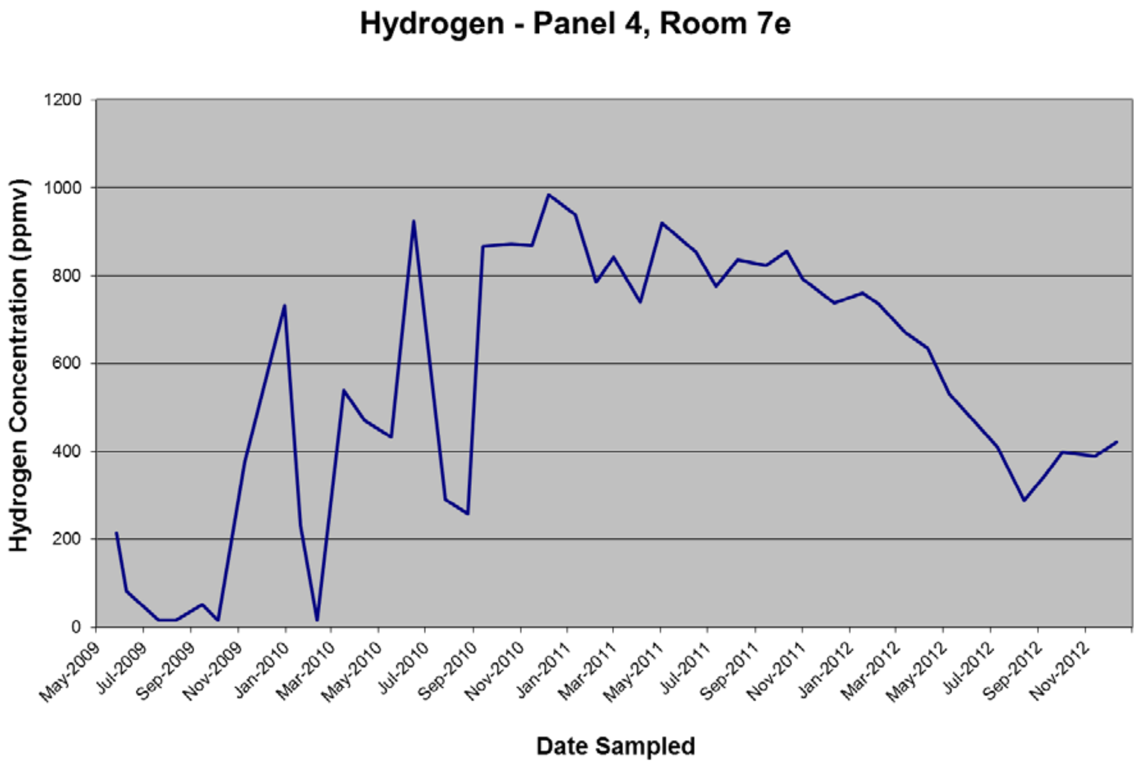

Figure B1: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 7e

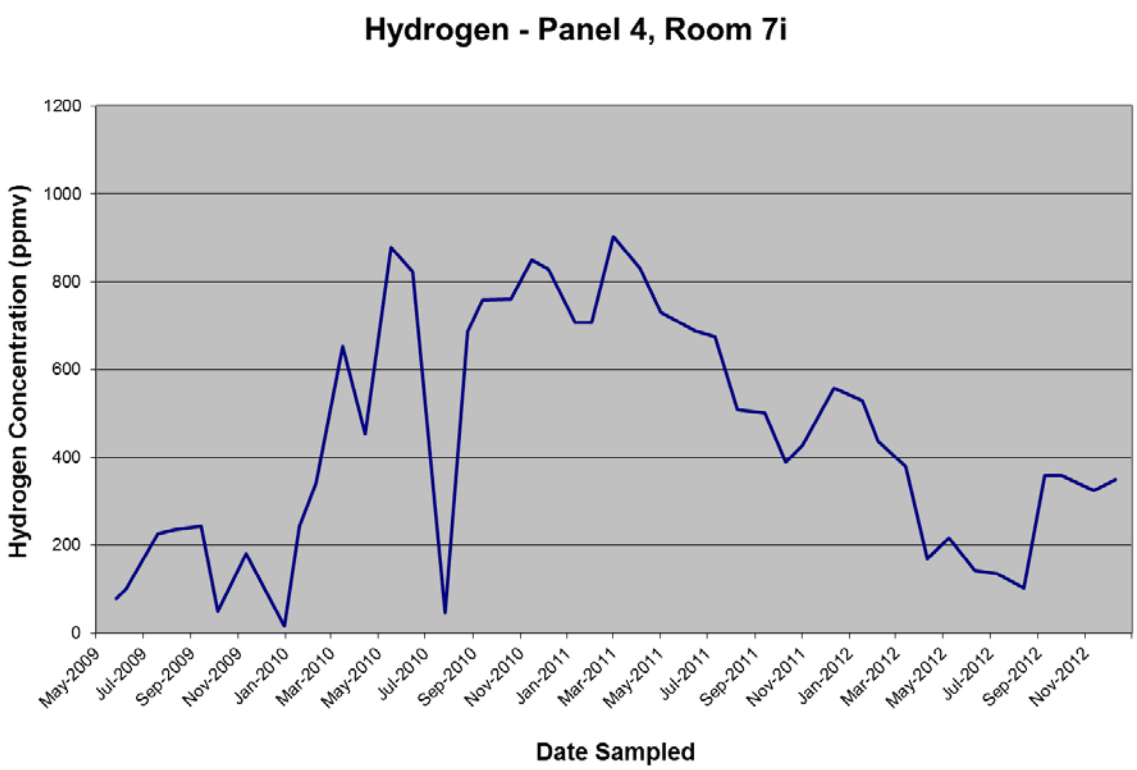

Figure B2: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 7i

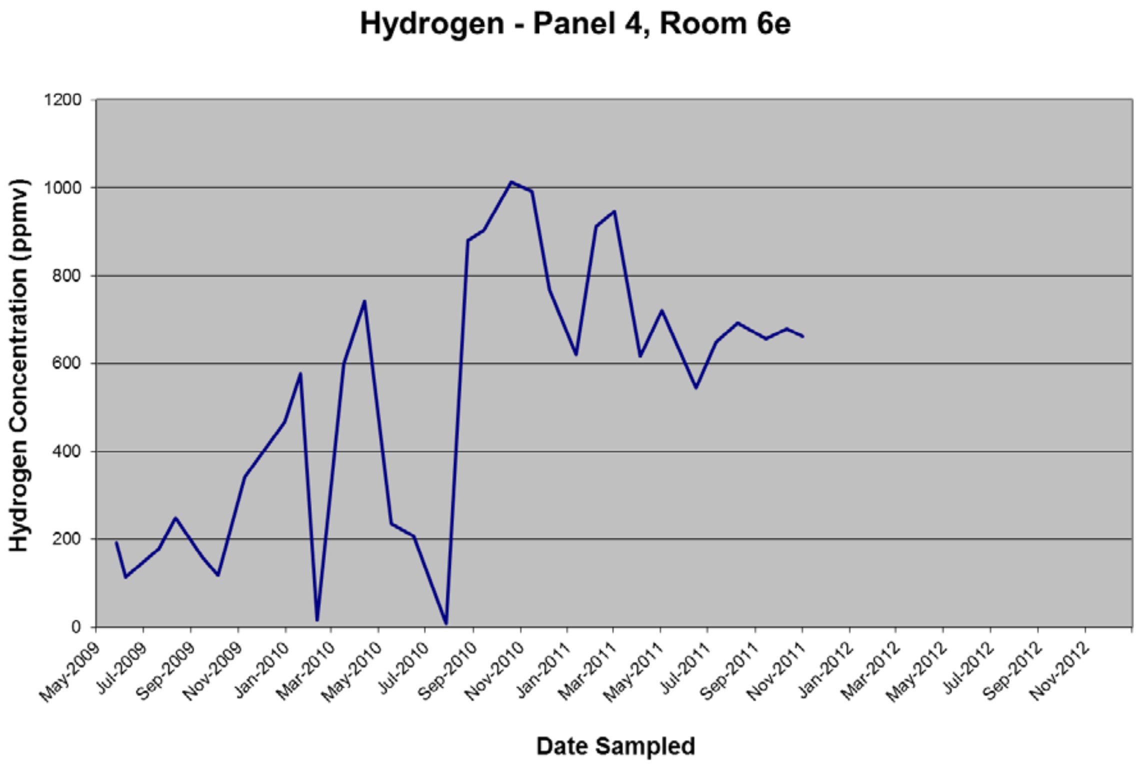

Figure B3: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 6e

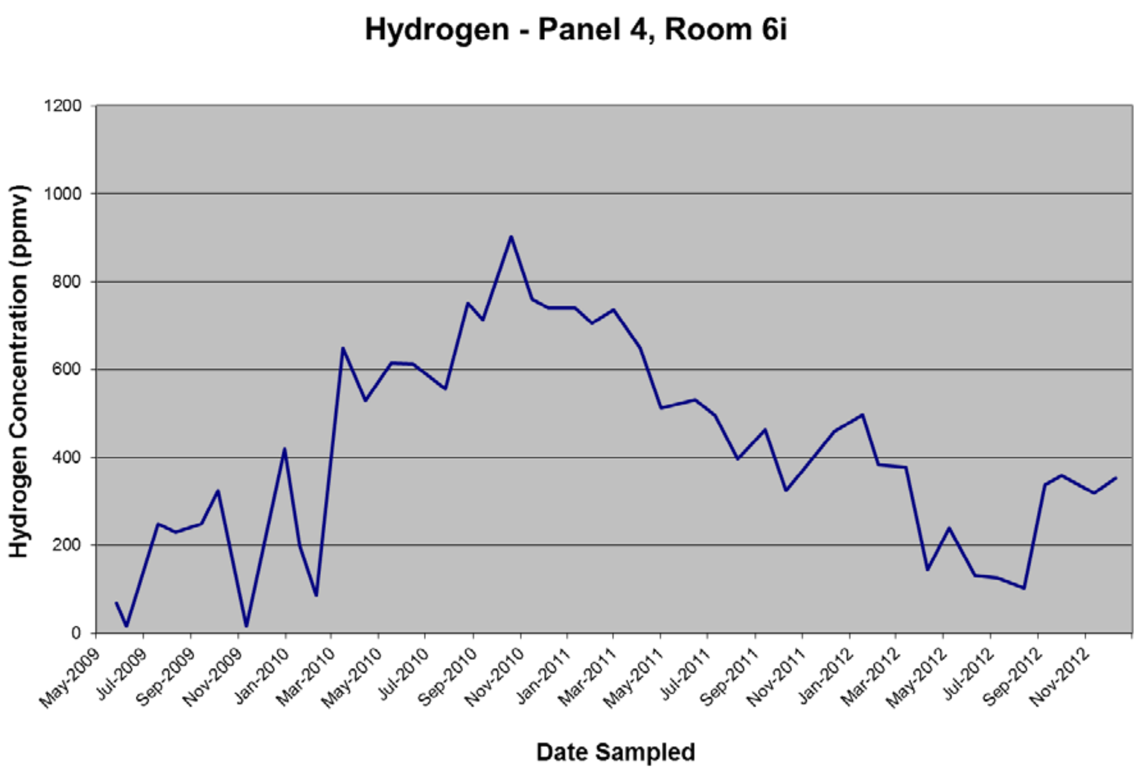

Figure B4: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 6i

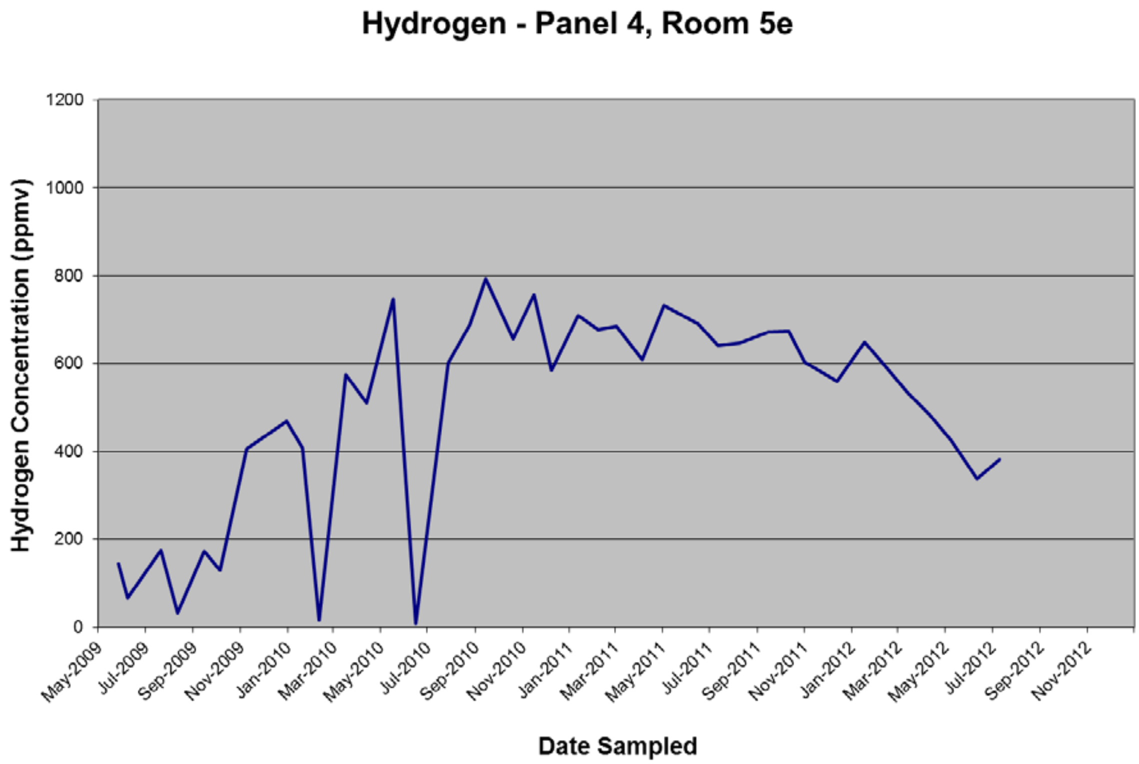

Figure B5: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 5e

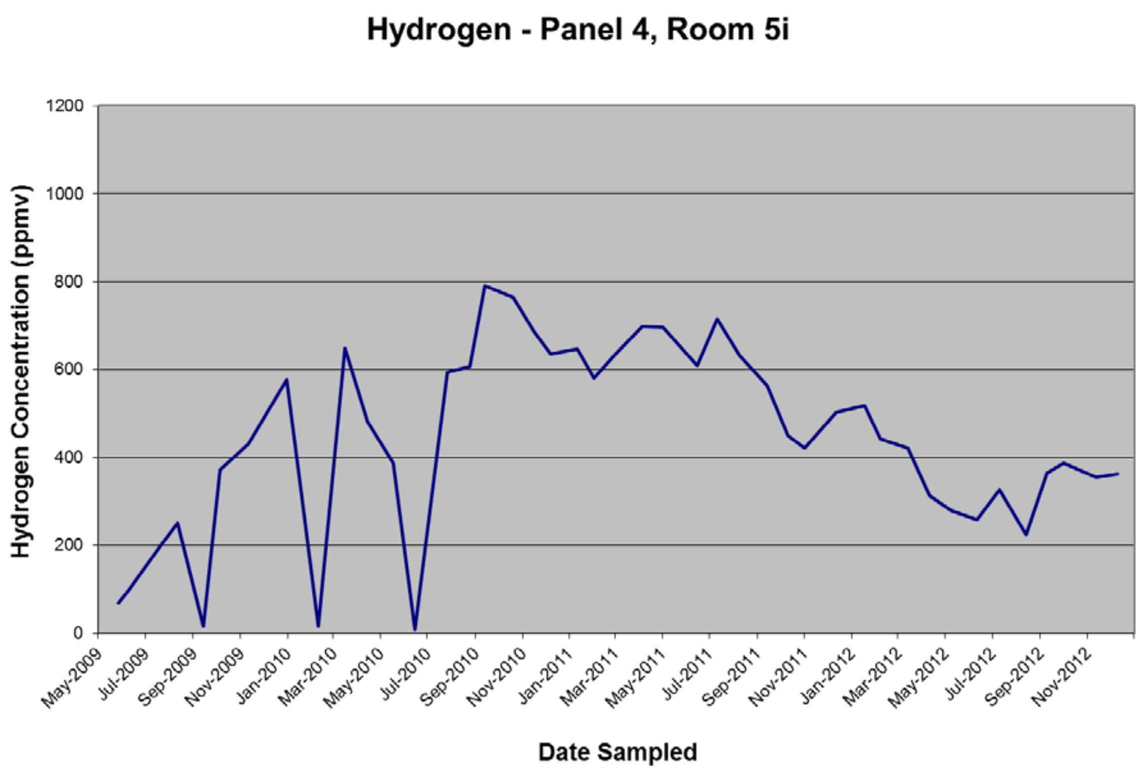

Figure B6: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 5i

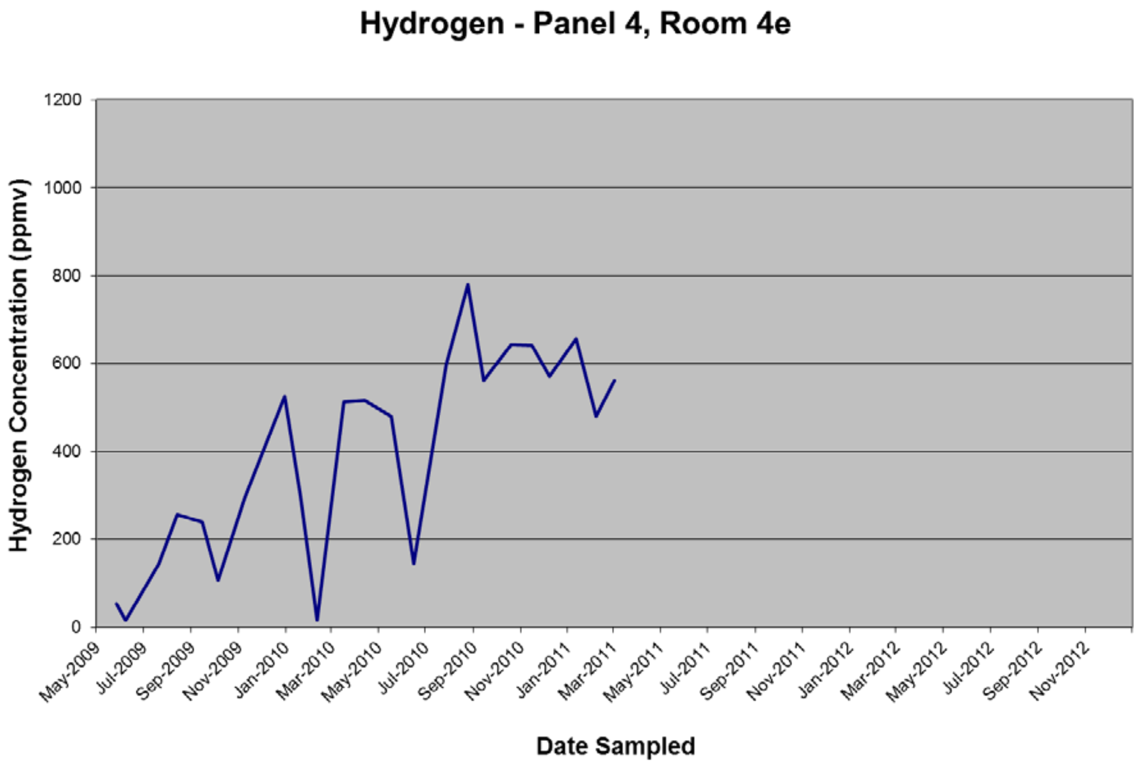

Figure B7: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 4e

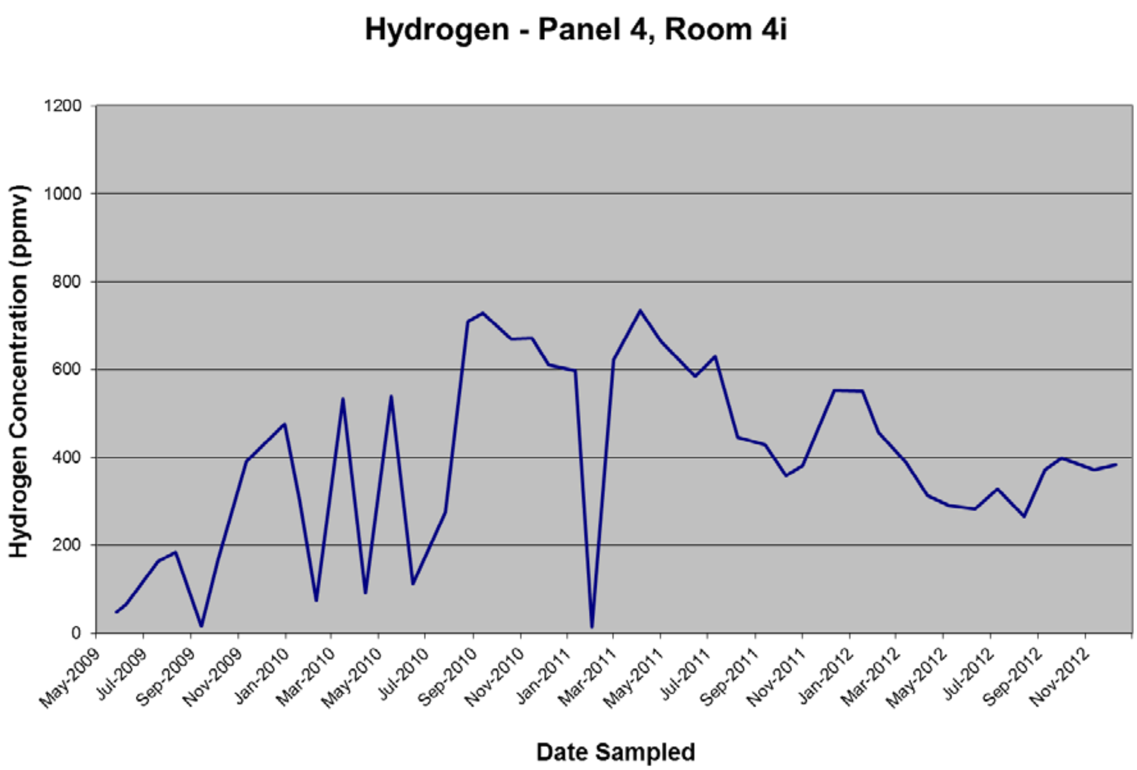

Figure B8: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 4i

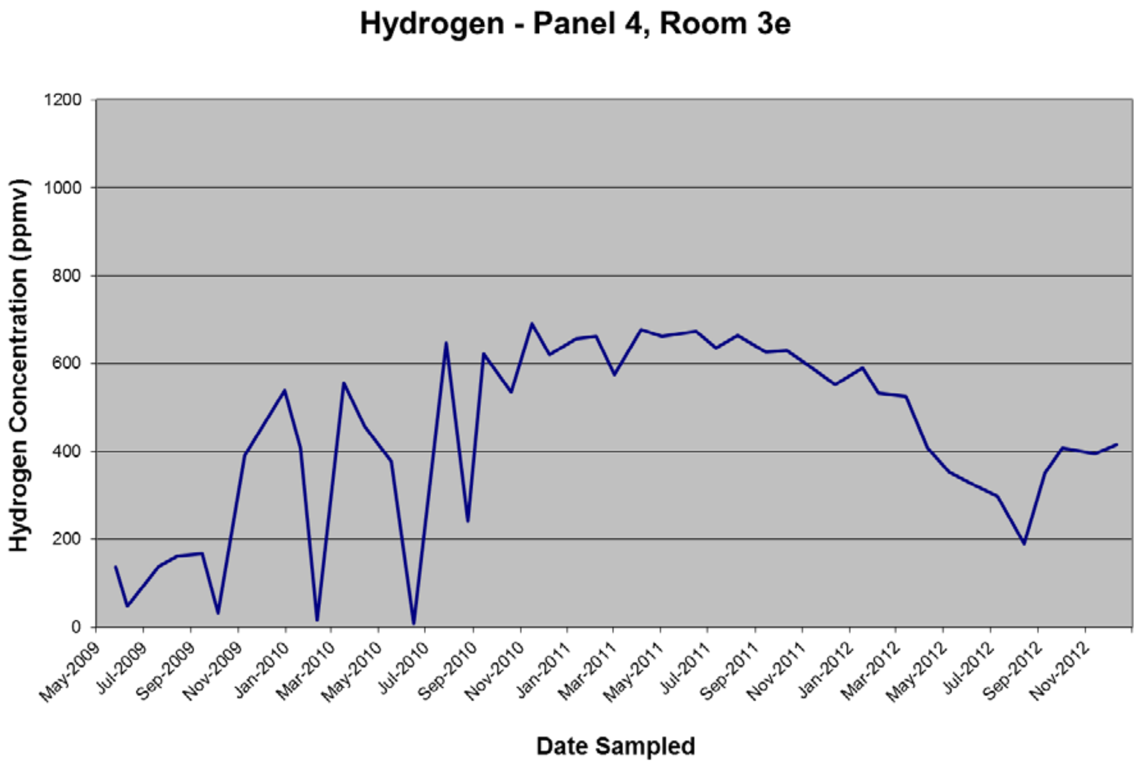

Figure B9: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 3e

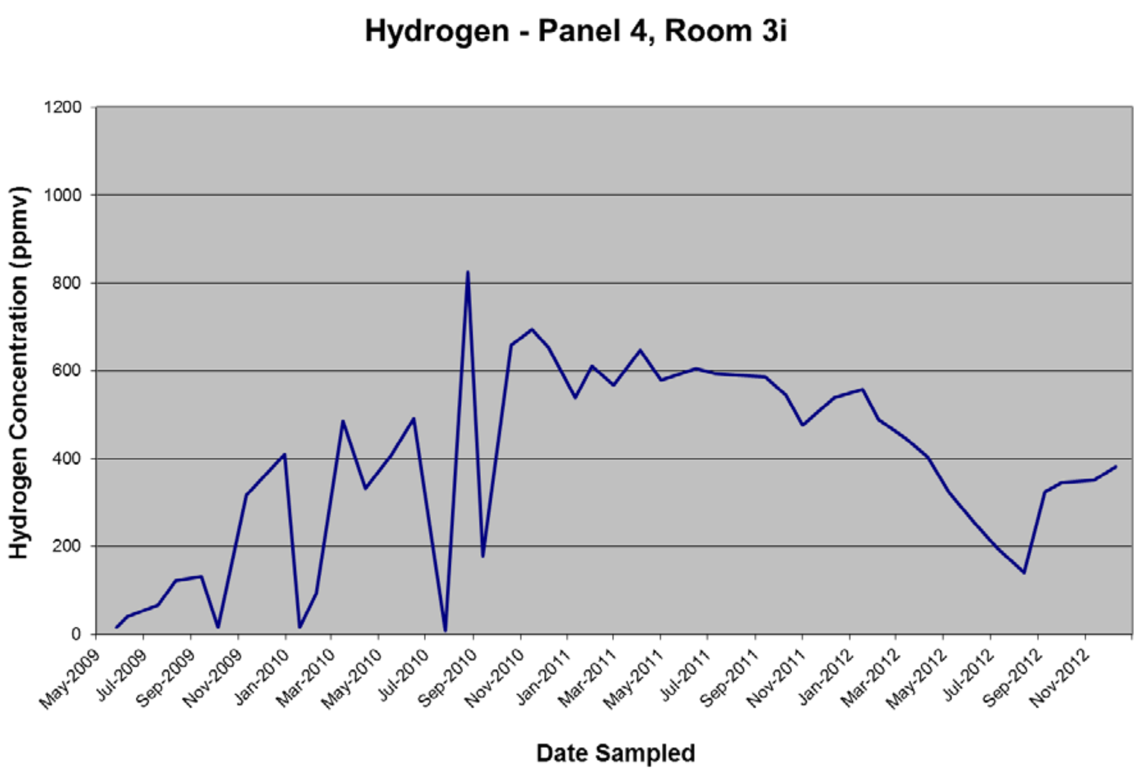

Figure B10: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 3i

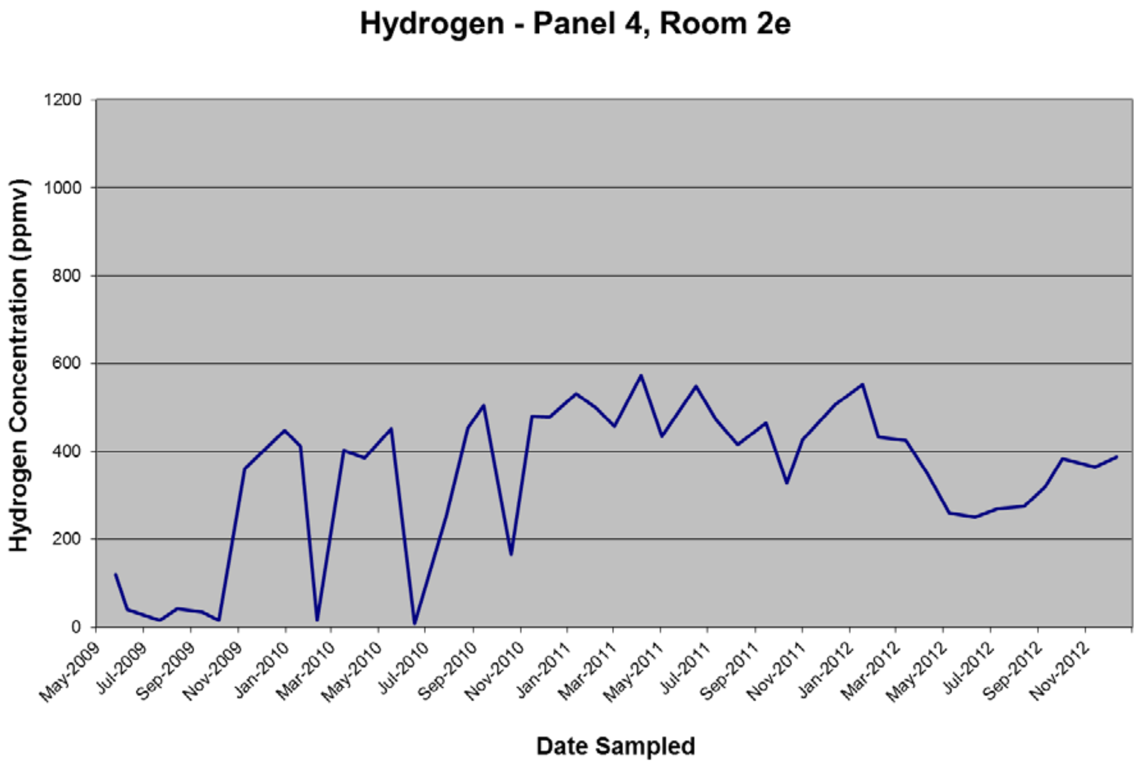

Figure B11: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 2e

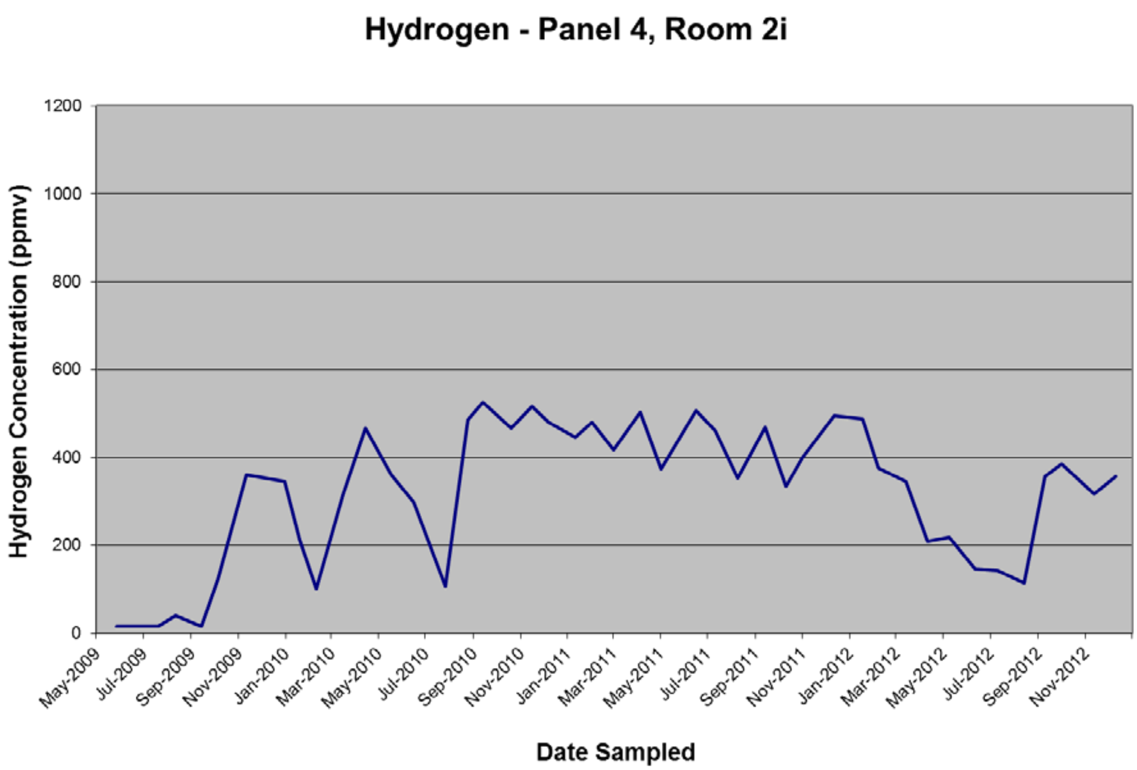

Figure B12: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 2i

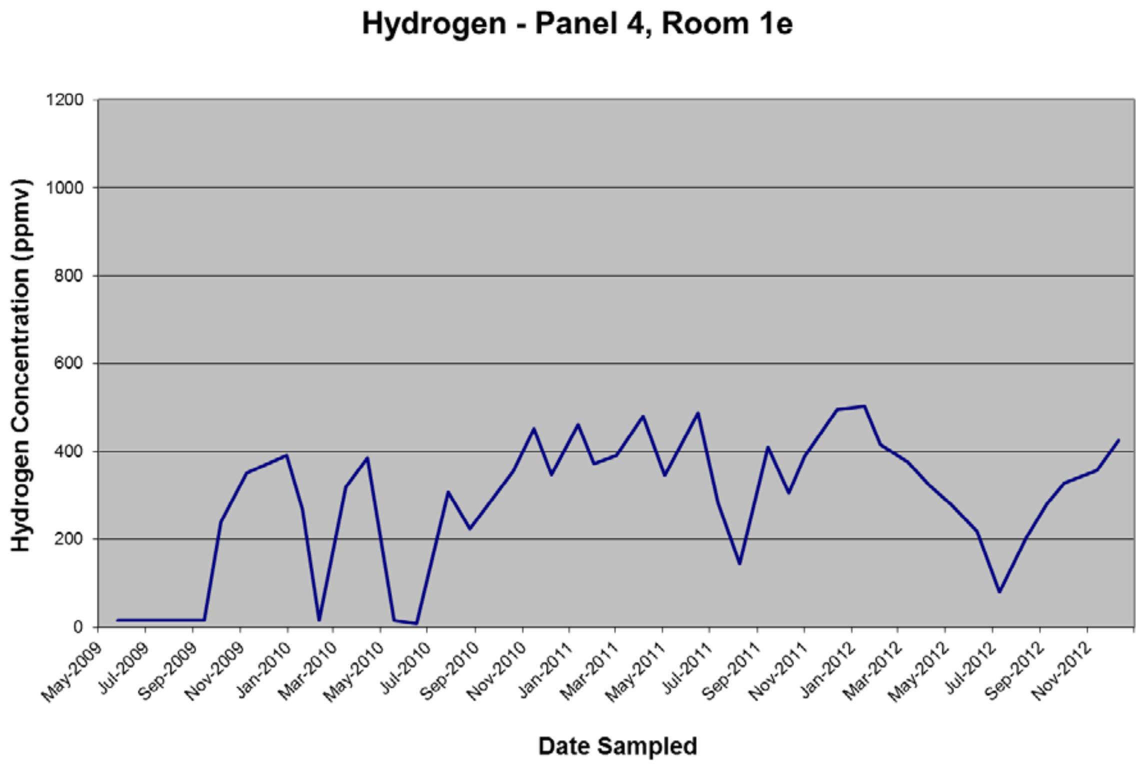

Figure B13: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 1e

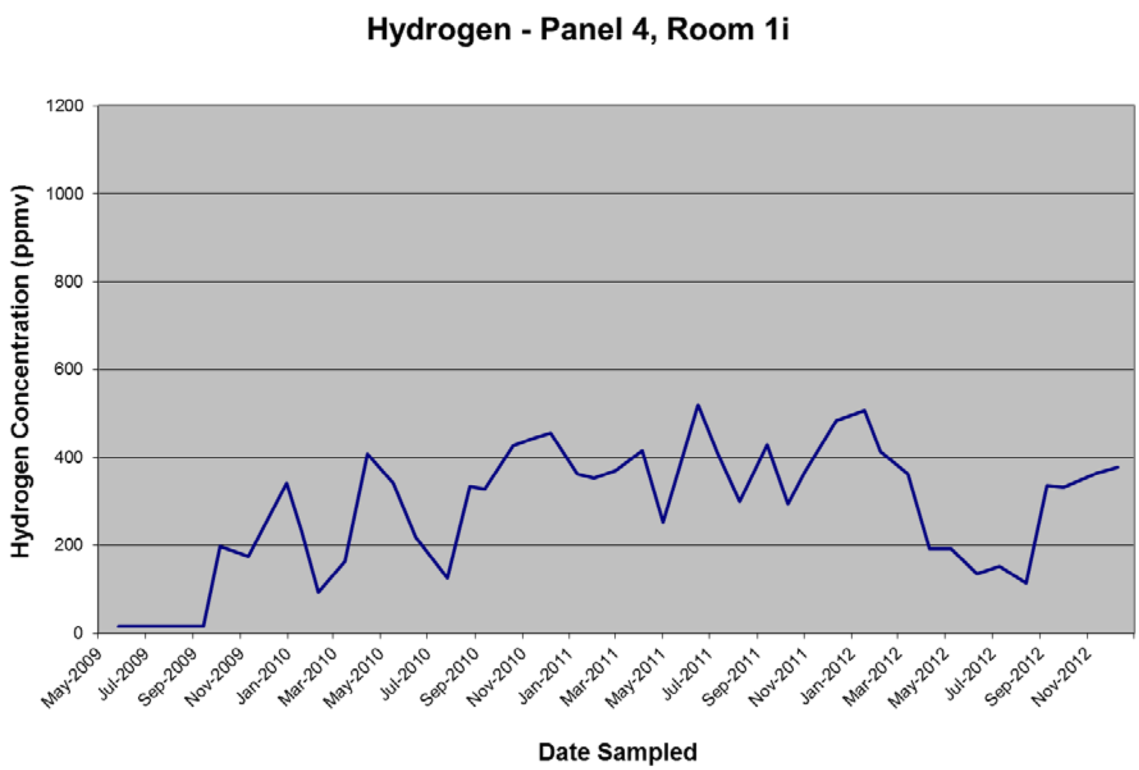

Figure B14: Time Series Plot of Hydrogen Concentrations in Panel 4, Room 1i

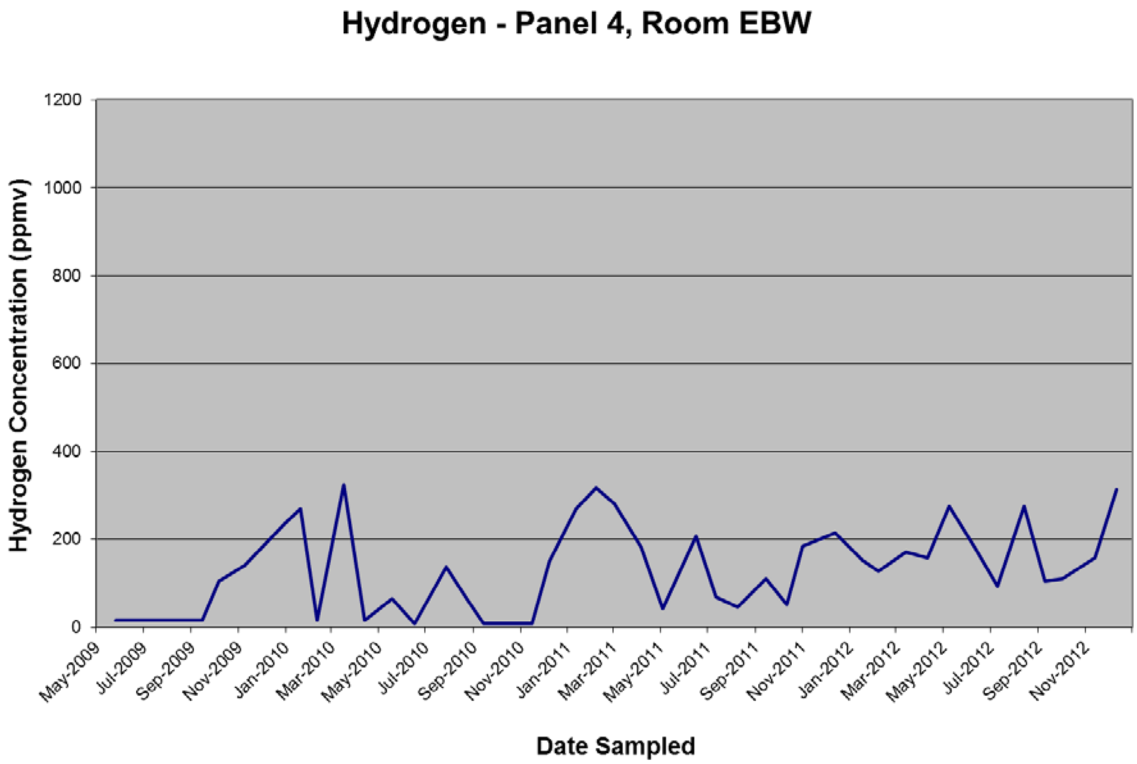

Figure B15: Time Series Plot of Hydrogen Concentrations in Panel 4, Room EBW

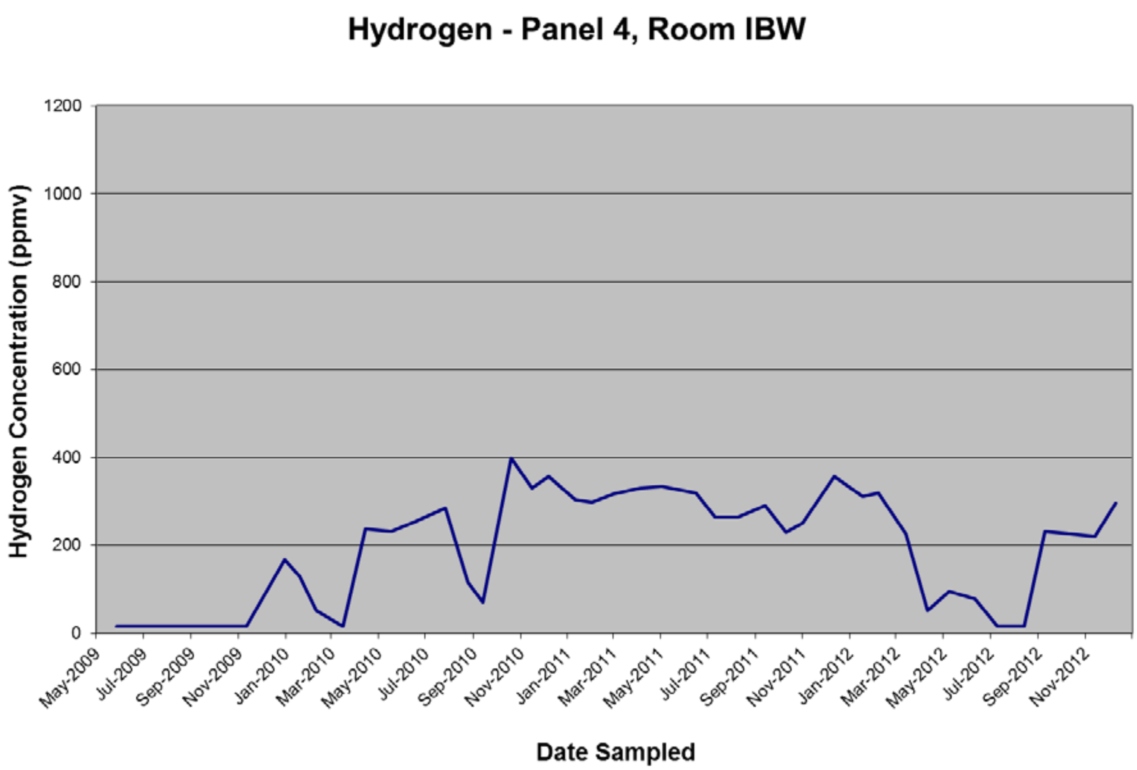

Figure B16: Time Series Plot of Hydrogen Concentrations in Panel 4, Room IBW

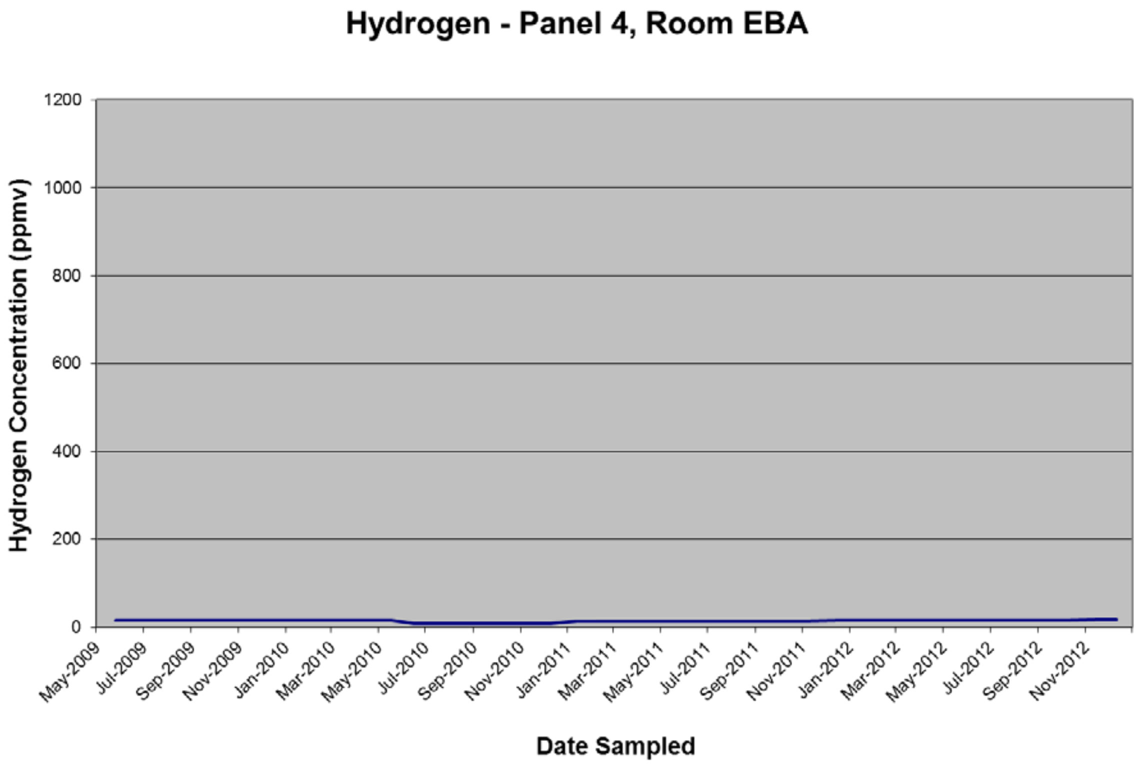

Figure B17: Time Series Plot of Hydrogen Concentrations in Panel 4, Room EBA

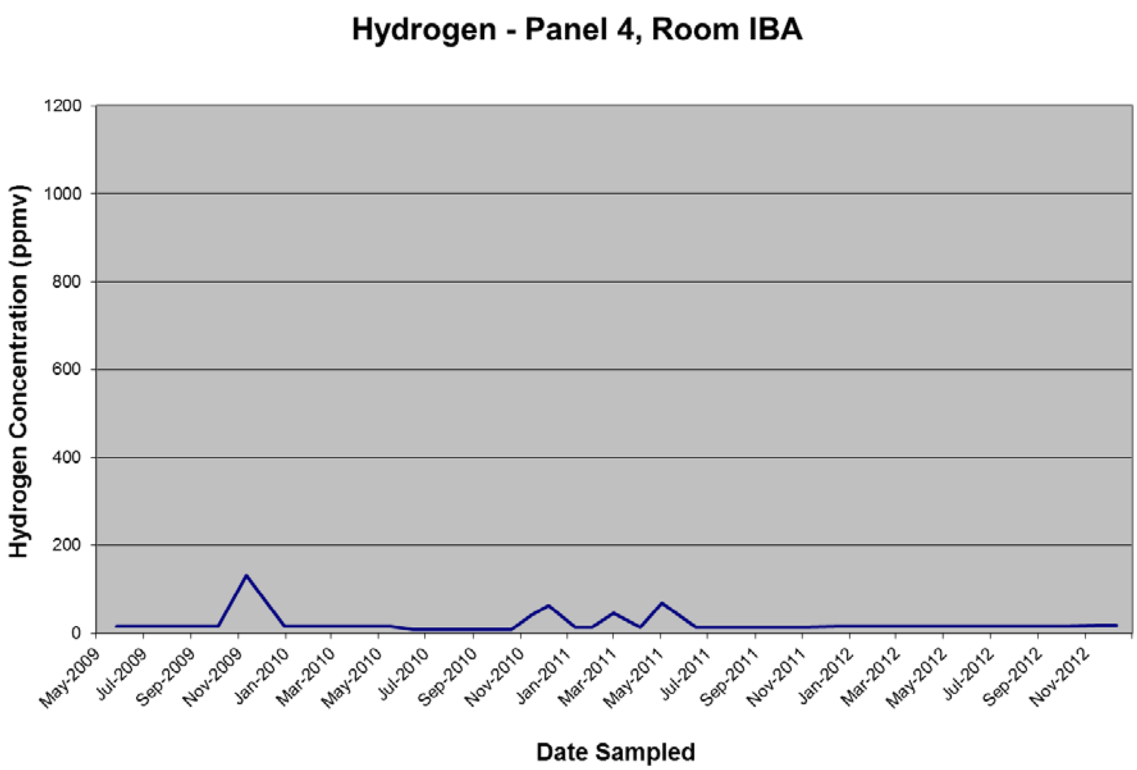

Figure B18: Time Series Plot of Hydrogen Concentrations in Panel 4, Room IBA

Appendix C

Panel 3 Methane Data

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 7e	3176	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3213	5/15/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3281	6/19/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3340	7/16/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3405	8/19/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3453	9/10/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3509	10/8/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3582	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3621	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3720	1/13/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3777	2/10/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3844	3/11/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3919	4/14/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3990	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4048	6/2/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4106	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4165	8/5/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4236	9/1/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4333	10/12/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4375	11/2/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4465	12/8/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4626	1/26/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4724	2/17/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4790	3/9/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4958	4/20/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5082	5/25/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5117	6/1/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5255	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 7i	3175	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3222	5/19/2008	5/23/2008	N.D.	2	17.99	35.98	17.99

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 6e	3178	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3212	5/14/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3280	6/19/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3339	7/16/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3426	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3452	9/10/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3508	10/8/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3581	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3620	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3719	1/13/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3776	2/10/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3843	3/10/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3918	4/14/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3989	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4047	6/2/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4107	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4166	8/5/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4237	9/1/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4334	10/12/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4376	11/2/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4466	12/8/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4627	1/26/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4725	2/17/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4791	3/9/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4959	4/20/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5083	5/25/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5118	6/1/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5256	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5349	8/9/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5475	9/21/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5534	10/11/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5627	11/8/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5746	12/14/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5844	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5930	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6018	3/8/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6131	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6213	5/9/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6313	6/14/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6427	7/18/2011	7/28/2011	N.D.	2	23.97	47.94	23.97
	6495	8/15/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6573	9/19/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6646	10/17/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6718	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6773	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6858	1/9/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6961	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7011	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7084	4/2/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7162	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7235	6/4/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7362	7/16/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7420	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7505	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 6i	3166	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3221	5/15/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3289	6/19/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3348	7/16/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3412	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3460	9/10/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3516	10/8/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3589	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3628	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3723	1/14/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3784	2/11/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3847	3/11/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3922	4/14/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3986	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4055	6/2/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4114	7/8/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4171	8/5/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4244	9/2/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4341	10/13/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4383	11/3/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4473	12/9/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4634	1/27/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4732	2/18/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4800	3/10/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4966	4/21/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5090	5/26/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5125	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5263	7/14/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5356	8/10/2010	8/17/2010	N.D.	2	21.39	42.78	21.39

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 5e	3179	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3211	5/14/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3279	6/17/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3338	7/16/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3403	8/19/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3451	9/10/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3507	10/8/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3580	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3619	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3718	1/13/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3775	2/10/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3842	3/10/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3917	4/14/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3988	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4046	6/1/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4108	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4167	8/5/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4238	9/1/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4335	10/12/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4377	11/2/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4467	12/8/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4628	1/26/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4726	2/17/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4792	3/9/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4960	4/20/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5084	5/25/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5119	6/1/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5257	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5350	8/9/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5476	9/21/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5535	10/11/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5628	11/8/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5747	12/14/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5845	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5931	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6019	3/8/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6132	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6214	5/9/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6314	6/14/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6428	7/18/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6496	8/15/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6574	9/19/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6647	10/17/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6719	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6774	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6859	1/9/2012	1/13/2012	N.D.	2	17.45	34.90	17.45
	6962	2/16/2012	2/22/2012	N.D.	2	17.45	34.90	17.45
	7012	3/6/2012	3/9/2012	N.D.	2	17.45	34.90	17.45
	7085	4/2/2012	4/9/2012	N.D.	2	17.45	34.90	17.45
	7163	5/1/2012	5/4/2012	N.D.	2	17.45	34.90	17.45
	7236	6/4/2012	6/8/2012	N.D.	2	17.45	34.90	17.45
	7363	7/16/2012	7/23/2012	N.D.	2	17.45	34.90	17.45
	7421	8/6/2012	8/10/2012	N.D.	2	17.45	34.90	17.45
	7506	9/4/2012	9/7/2012	N.D.	2	17.45	34.90	17.45
	7617	10/8/2012	10/16/2012	N.D.	2	17.45	34.90	17.45
	7687	11/5/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7773	12/3/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 5i	3177	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3220	5/15/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3288	6/19/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3347	7/16/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3411	8/19/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3459	9/10/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3515	10/8/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3588	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3627	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3722	1/13/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3783	2/11/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3846	3/11/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3921	4/14/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3985	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4054	6/2/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4115	7/8/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4176	8/6/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4245	9/2/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4342	10/13/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4384	11/3/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4474	12/9/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4635	1/27/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4733	2/18/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4801	3/10/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4967	4/21/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5091	5/26/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5126	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5264	7/14/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5357	8/10/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5483	9/22/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5541	10/12/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5634	11/9/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5753	12/15/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5851	1/19/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5937	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6025	3/9/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6138	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6220	5/10/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6320	6/15/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6436	7/19/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6502	8/16/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6580	9/20/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6651	10/17/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6725	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6780	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6865	1/10/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6968	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7018	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7091	4/3/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7169	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7242	6/5/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7369	7/17/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7427	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7512	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7623	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7693	11/6/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7779	12/4/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 4e	3174	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3210	5/14/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3278	6/17/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3337	7/16/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3402	8/19/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3450	9/10/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3506	10/8/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3579	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3618	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3717	1/13/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3774	2/10/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3841	3/10/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3916	4/14/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3987	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4045	6/1/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4109	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4168	8/5/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4239	9/1/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4336	10/12/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4378	11/2/2009	11/12/2009	N.D.	2.1	22.21	46.64	23.32
	4468	12/8/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4629	1/26/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4727	2/17/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4793	3/9/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4961	4/20/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5085	5/25/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5120	6/1/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5258	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5351	8/9/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5477	9/21/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5536	10/11/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5629	11/8/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5748	12/14/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5846	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5932	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6020	3/8/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6133	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6215	5/9/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6315	6/14/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6429	7/18/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6497	8/15/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6575	9/19/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6648	10/17/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6720	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6775	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6860	1/9/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6963	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7013	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7086	4/2/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7164	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7237	6/4/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7364	7/16/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7422	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7507	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7618	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7688	11/5/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7774	12/3/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 4i	3170	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3219	5/15/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3287	6/19/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3346	7/16/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3410	8/19/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3458	9/10/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3514	10/8/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3587	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3626	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3721	1/13/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3782	2/10/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3845	3/11/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3920	4/14/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3984	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4053	6/2/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4116	7/8/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4177	8/6/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4246	9/2/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4343	10/13/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4385	11/3/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4475	12/9/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4636	1/27/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4734	2/18/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4802	3/10/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4968	4/21/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5092	5/26/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5127	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5265	7/14/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5358	8/10/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5484	9/22/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5542	10/12/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5635	11/9/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5754	12/15/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5852	1/19/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5938	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6026	3/9/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6139	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6221	5/10/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6321	6/15/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6437	7/19/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6503	8/16/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6581	9/20/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6656	10/18/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6726	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6781	12/6/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6866	1/10/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6969	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7019	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7092	4/3/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7170	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7243	6/5/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7370	7/17/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7428	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7513	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7624	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7694	11/6/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7780	12/4/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 3e	3172	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3209	5/14/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3277	6/17/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3336	7/15/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3401	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3449	9/8/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3505	10/6/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3578	11/10/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3617	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3712	1/12/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3773	2/9/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3834	3/12/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3911	4/13/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3979	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4044	6/1/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4110	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4169	8/5/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4240	9/1/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4337	10/12/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4379	11/3/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4469	12/8/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4630	1/26/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4728	2/17/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4796	3/10/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4962	4/21/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5086	5/26/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5121	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5259	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5352	8/9/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5478	9/21/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5537	10/11/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5630	11/8/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5749	12/14/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5847	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5933	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6021	3/8/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6134	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6216	5/9/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6316	6/14/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6430	7/18/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6498	8/15/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6576	9/19/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6649	10/17/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6721	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6776	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6861	1/9/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6964	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7014	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7087	4/2/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7165	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7238	6/4/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7365	7/16/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7423	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7508	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7619	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7689	11/5/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7775	12/3/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 3i	3171	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3218	5/14/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3286	6/17/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3345	7/15/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3409	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3457	9/8/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3513	10/6/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3586	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3625	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3714	1/12/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3781	2/10/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3836	3/12/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3913	4/13/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3981	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4052	6/2/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4117	7/8/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4178	8/6/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4247	9/2/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4344	10/13/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4386	11/3/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4476	12/9/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4637	1/27/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4735	2/18/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4803	3/10/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4969	4/21/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5093	5/26/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5128	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5266	7/14/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5359	8/10/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5485	9/22/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5543	10/12/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5636	11/9/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5755	12/15/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5853	1/19/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5939	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6027	3/9/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6140	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6222	5/10/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6322	6/15/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6438	7/19/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6504	8/16/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6582	9/20/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6657	10/18/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6727	11/8/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6782	12/6/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6867	1/10/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6970	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7020	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7093	4/3/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7171	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7244	6/5/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7371	7/17/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7429	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7514	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7625	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7695	11/6/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7781	12/4/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 2e	3164	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3208	5/14/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3276	6/17/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3335	7/15/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3400	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3448	9/8/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3504	10/6/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3577	11/10/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3616	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3711	1/12/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3772	2/9/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3833	3/12/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3910	4/13/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3978	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4043	6/1/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4111	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4170	8/5/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4241	9/1/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4338	10/13/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4380	11/3/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4470	12/8/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4631	1/26/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4729	2/17/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4797	3/10/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4963	4/21/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5087	5/26/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5122	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5260	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5353	8/9/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5479	9/21/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5538	10/12/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5631	11/8/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5750	12/14/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5848	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5934	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6022	3/8/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6135	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6217	5/10/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6317	6/14/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6431	7/18/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6499	8/15/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6577	9/19/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6650	10/17/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6722	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6777	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6862	1/9/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6965	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7015	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7088	4/2/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7166	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7239	6/4/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7366	7/16/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7424	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7509	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7620	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7690	11/6/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7776	12/3/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 2i	3162	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3217	5/14/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3285	6/17/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3344	7/15/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3408	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3456	9/8/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3512	10/6/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3585	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3624	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3713	1/12/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3780	2/10/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3835	3/12/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3912	4/13/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3980	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4051	6/2/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4118	7/8/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4179	8/6/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4248	9/2/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4345	10/13/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4387	11/3/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4477	12/9/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4638	1/27/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4736	2/18/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4804	3/10/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4970	4/21/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5094	5/26/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5129	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5267	7/14/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5360	8/10/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5486	9/22/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5544	10/12/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5637	11/9/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5756	12/15/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5854	1/19/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5940	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6028	3/9/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6141	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6223	5/10/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6323	6/15/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6439	7/19/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6505	8/16/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6583	9/20/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6658	10/18/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6728	11/8/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6783	12/6/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6868	1/10/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6971	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7021	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7094	4/3/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7172	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7245	6/5/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7372	7/17/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7430	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7515	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7626	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7696	11/6/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7782	12/4/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 1e	3163	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3207	5/14/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3293	6/17/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3334	7/15/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3399	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3447	9/8/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3503	10/6/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3575	11/10/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3614	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3709	1/12/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3770	2/9/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3831	3/11/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3908	4/13/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3976	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4041	6/1/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4112	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4172	8/6/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4242	9/1/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4339	10/13/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4381	11/3/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4471	12/9/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4632	1/26/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4730	2/17/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4798	3/10/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4964	4/21/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5088	5/26/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5123	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5261	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5354	8/10/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5480	9/21/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5539	10/12/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5632	11/9/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5751	12/15/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5849	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5935	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6023	3/9/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6136	4/19/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6218	5/10/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6318	6/15/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6433	7/19/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6506	8/16/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6584	9/20/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6659	10/18/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6729	11/8/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6784	12/6/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6869	1/10/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6972	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7022	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7095	4/3/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7173	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7246	6/5/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7373	7/17/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7431	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7516	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7627	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7697	11/6/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7783	12/4/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 1i	3169	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3216	5/19/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3284	6/19/2008	6/25/2008	N.D.	2	17.99	35.98	17.99

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Location EBW	3165	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3215	5/15/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3283	6/17/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3342	7/15/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3407	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3455	9/8/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3511	10/6/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3584	11/10/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3623	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3716	1/12/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3779	2/9/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3838	3/12/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3915	4/13/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3983	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4049	6/2/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4105	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4164	8/5/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4235	9/1/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4332	10/12/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4374	11/2/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4464	12/8/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4625	1/26/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4723	2/17/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4789	3/9/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4957	4/20/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5081	5/25/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5116	6/1/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5254	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5347	8/9/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5474	9/21/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5533	10/11/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5626	11/8/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5745	12/14/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5843	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5929	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6017	3/8/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6130	4/18/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6212	5/9/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6312	6/14/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6432	7/18/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6500	8/15/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6578	9/19/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6652	10/17/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6723	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6778	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6863	1/9/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6966	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7016	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7089	4/2/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7167	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7240	6/4/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7367	7/16/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7425	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7510	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7621	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7691	11/6/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7777	12/4/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Location EBA	3167	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3214	5/15/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3282	6/19/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3341	7/15/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3406	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3454	9/8/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3510	10/6/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3583	11/10/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3622	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3715	1/12/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3778	2/9/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3837	3/12/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3914	4/13/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3982	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4050	6/2/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4104	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4163	8/5/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4234	9/1/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4331	10/12/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4373	11/2/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4463	12/8/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4624	1/26/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4722	2/17/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4788	3/9/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4956	4/20/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5080	5/25/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5115	6/1/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5253	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5346	8/9/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5473	9/21/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5532	10/11/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5625	11/8/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5744	12/14/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5842	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5928	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6016	3/8/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6129	4/18/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6211	5/9/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6311	6/14/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6435	7/19/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6501	8/16/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6579	9/20/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6653	10/17/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6724	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6779	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6864	1/10/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6967	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7017	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7090	4/3/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7168	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7241	6/5/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7368	7/16/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7426	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7511	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7622	10/9/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7692	11/6/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7778	12/4/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Location IBW	3173	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3224	5/15/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3292	6/19/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3350	7/16/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3414	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3462	9/10/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3518	10/8/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3591	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3630	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3725	1/14/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3786	2/11/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3840	3/10/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3924	4/15/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3992	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4040	6/1/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4103	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4181	8/6/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4250	9/2/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4347	10/13/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4372	11/2/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4479	12/9/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4640	1/27/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4738	2/18/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4795	3/9/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	5078	5/25/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5130	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5252	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5362	8/10/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5487	9/22/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5531	10/11/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5624	11/8/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5743	12/14/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5841	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5927	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6015	3/8/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6128	4/18/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6210	5/9/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6309	6/14/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6426	7/18/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6494	8/15/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6571	9/19/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6654	10/18/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6716	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6771	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6857	1/9/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6959	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7009	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7083	4/2/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7161	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7234	6/4/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7361	7/16/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7419	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7504	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7615	10/8/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7686	11/5/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7772	12/3/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Location IBA	3168	4/24/2008	4/30/2008	N.D.	2	17.99	35.98	17.99
	3223	5/15/2008	5/23/2008	N.D.	2	17.99	35.98	17.99
	3291	6/19/2008	6/25/2008	N.D.	2	17.99	35.98	17.99
	3349	7/16/2008	7/22/2008	N.D.	2	17.99	35.98	17.99
	3413	8/20/2008	8/22/2008	N.D.	2	23.74	47.48	23.74
	3461	9/10/2008	9/12/2008	N.D.	2	23.74	47.48	23.74
	3517	10/8/2008	10/10/2008	N.D.	2	23.74	47.48	23.74
	3590	11/13/2008	11/18/2008	N.D.	2	23.74	47.48	23.74
	3629	12/3/2008	12/6/2008	N.D.	2	23.74	47.48	23.74
	3724	1/14/2009	1/21/2009	N.D.	2	23.74	47.48	23.74
	3785	2/11/2009	2/13/2009	N.D.	2	23.74	47.48	23.74
	3839	3/10/2009	3/27/2009	N.D.	2	23.74	47.48	23.74
	3923	4/15/2009	4/22/2009	N.D.	2	23.74	47.48	23.74
	3991	5/12/2009	5/15/2009	N.D.	2	23.74	47.48	23.74
	4039	6/1/2009	6/8/2009	N.D.	2	23.74	47.48	23.74
	4102	7/7/2009	7/10/2009	N.D.	2	22.21	44.42	22.21
	4180	8/6/2009	8/13/2009	N.D.	2	22.21	44.42	22.21
	4249	9/2/2009	9/4/2009	N.D.	2	22.21	44.42	22.21
	4346	10/13/2009	10/15/2009	N.D.	2	22.21	44.42	22.21
	4371	11/2/2009	11/12/2009	N.D.	2	22.21	44.42	22.21
	4478	12/9/2009	12/15/2009	N.D.	2	22.21	44.42	22.21
	4639	1/27/2010	2/2/2010	N.D.	2	22.21	44.42	22.21
	4737	2/18/2010	2/23/2010	N.D.	2	22.21	44.42	22.21
	4794	3/9/2010	3/12/2010	N.D.	2	22.21	44.42	22.21
	4954	4/20/2010	4/28/2010	N.D.	2	22.21	44.42	22.21
	5079	5/25/2010	5/28/2010	N.D.	2	22.21	44.42	22.21
	5131	6/2/2010	6/7/2010	N.D.	2	22.21	44.42	22.21
	5251	7/13/2010	7/19/2010	N.D.	2	21.39	42.78	21.39
	5361	8/10/2010	8/17/2010	N.D.	2	21.39	42.78	21.39
	5488	9/22/2010	9/27/2010	N.D.	2	21.39	42.78	21.39
	5530	10/11/2010	10/18/2010	N.D.	2	21.39	42.78	21.39
	5623	11/8/2010	11/15/2010	N.D.	2	21.39	42.78	21.39
	5742	12/14/2010	12/20/2010	N.D.	2	21.39	42.78	21.39
	5840	1/18/2011	1/24/2011	N.D.	2	23.97	47.94	23.97
	5926	2/15/2011	2/21/2011	N.D.	2	23.97	47.94	23.97
	6014	3/8/2011	3/11/2011	N.D.	2	23.97	47.94	23.97
	6127	4/18/2011	4/26/2011	N.D.	2	23.97	47.94	23.97
	6209	5/9/2011	5/13/2011	N.D.	2	23.97	47.94	23.97
	6310	6/14/2011	6/21/2011	N.D.	2	23.97	47.94	23.97
	6425	7/18/2011	7/22/2011	N.D.	2	23.97	47.94	23.97
	6493	8/15/2011	8/22/2011	N.D.	2	23.97	47.94	23.97
	6572	9/19/2011	9/27/2011	N.D.	2	23.97	47.94	23.97
	6655	10/18/2011	10/25/2011	N.D.	2	23.97	47.94	23.97
	6717	11/7/2011	11/11/2011	N.D.	2	23.97	47.94	23.97
	6772	12/5/2011	12/9/2011	N.D.	2	17.45	34.9	17.45
	6856	1/9/2012	1/13/2012	N.D.	2	17.45	34.9	17.45
	6960	2/16/2012	2/22/2012	N.D.	2	17.45	34.9	17.45
	7010	3/6/2012	3/9/2012	N.D.	2	17.45	34.9	17.45
	7082	4/2/2012	4/9/2012	N.D.	2	17.45	34.9	17.45
	7160	5/1/2012	5/4/2012	N.D.	2	17.45	34.9	17.45
	7233	6/4/2012	6/8/2012	N.D.	2	17.45	34.9	17.45
	7360	7/16/2012	7/23/2012	N.D.	2	17.45	34.9	17.45
	7418	8/6/2012	8/10/2012	N.D.	2	17.45	34.9	17.45
	7503	9/4/2012	9/7/2012	N.D.	2	17.45	34.9	17.45
	7614	10/8/2012	10/16/2012	N.D.	2	17.45	34.9	17.45
	7685	11/5/2012	11/9/2012	N.D.	2	15.71	31.42	15.71
	7771	12/3/2012	12/7/2012	N.D.	2	15.71	31.42	15.71

Appendix D

Panel 4 Methane Data

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 7e	4032	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4069	6/9/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4139	7/21/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4200	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4274	9/15/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4315	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4404	11/9/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4531	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4595	1/20/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4680	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4833	3/17/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4915	4/13/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5050	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5175	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5310	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5396	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5450	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5569	10/20/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5661	11/16/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5718	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5816	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5892	2/7/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5980	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6083	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6182	5/3/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6333	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6409	7/12/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6477	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6553	9/14/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6627	10/11/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6700	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6804	12/12/2011	12/16/2011	N.D.	2	17.45	34.9	17.45
	6890	1/17/2012	1/23/2012	N.D.	2	17.45	34.9	17.45
	6942	2/7/2012	2/10/2012	N.D.	2	17.45	34.9	17.45
	7043	3/13/2012	3/16/2012	N.D.	2	17.45	34.9	17.45
	7113	4/10/2012	4/13/2012	N.D.	2	17.45	34.9	17.45
	7191	5/9/2012	5/15/2012	N.D.	2	17.45	34.9	17.45
	7270	6/11/2012	6/18/2012	N.D.	2	17.45	34.9	17.45
	7341	7/10/2012	7/13/2012	N.D.	2	17.45	34.9	17.45
	7457	8/13/2012	8/17/2012	N.D.	2	17.45	34.9	17.45
	7535	9/10/2012	9/14/2012	N.D.	2	17.45	34.9	17.45
	7581	10/2/2012	10/5/2012	N.D.	2	17.45	34.9	17.45
	7721	11/13/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7809	12/11/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 7i	4028	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4073	6/9/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4130	7/20/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4191	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4265	9/14/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4306	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4413	11/11/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4522	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4586	1/19/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4671	2/9/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4824	3/16/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4925	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5041	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5166	6/14/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5301	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5387	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5441	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5560	10/19/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5652	11/15/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5709	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5807	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5881	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5971	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6074	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6173	5/2/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6324	6/15/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6400	7/11/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6461	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6544	9/13/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6618	10/10/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6691	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6795	12/12/2011	12/16/2011	N.D.	2	17.45	34.9	17.45
	6881	1/17/2012	1/23/2012	N.D.	2	17.45	34.9	17.45
	6933	2/7/2012	2/10/2012	N.D.	2	17.45	34.9	17.45
	7034	3/13/2012	3/16/2012	N.D.	2	17.45	34.9	17.45
	7104	4/10/2012	4/13/2012	N.D.	2	17.45	34.9	17.45
	7182	5/8/2012	5/15/2012	N.D.	2	17.45	34.9	17.45
	7261	6/11/2012	6/18/2012	N.D.	2	17.45	34.9	17.45
	7332	7/10/2012	7/13/2012	N.D.	2	17.45	34.9	17.45
	7448	8/13/2012	8/17/2012	N.D.	2	17.45	34.9	17.45
	7526	9/10/2012	9/14/2012	N.D.	2	17.45	34.9	17.45
	7572	10/1/2012	10/5/2012	N.D.	2	17.45	34.9	17.45
	7712	11/12/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7800	12/10/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 6e	4031	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4068	6/8/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4140	7/21/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4201	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4275	9/15/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4316	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4403	11/9/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4532	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4596	1/20/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4681	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4834	3/17/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4916	4/13/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5051	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5176	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5311	7/27/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5397	8/25/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5451	9/14/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5570	10/20/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5662	11/16/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5719	12/8/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5817	1/12/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5893	2/7/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5981	3/2/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6084	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6183	5/3/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6334	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6410	7/12/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6478	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6554	9/14/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6628	10/11/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6701	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 6i	4027	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4072	6/9/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4131	7/20/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4192	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4266	9/14/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4307	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4412	11/11/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4523	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4587	1/19/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4672	2/9/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4825	3/16/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4926	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5042	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5167	6/14/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5302	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5388	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5442	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5561	10/19/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5653	11/15/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5710	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5808	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5882	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5972	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6075	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6174	5/2/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6325	6/15/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6401	7/11/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6469	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6545	9/13/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6619	10/10/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6692	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6796	12/12/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6882	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6934	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7035	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7105	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7183	5/8/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7262	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7333	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7449	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7527	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7573	10/1/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7713	11/12/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7801	12/10/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 5e	4030	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4067	6/8/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4141	7/21/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4202	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4276	9/15/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4317	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4402	11/9/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4533	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4597	1/20/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4682	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4835	3/17/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4917	4/13/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5052	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5177	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5312	7/27/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5398	8/25/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5452	9/14/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5571	10/20/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5663	11/16/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5720	12/8/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5818	1/12/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5894	2/7/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5982	3/2/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6085	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6184	5/3/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6335	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6411	7/12/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6479	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6557	9/14/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6629	10/11/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6702	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6806	12/13/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6892	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6943	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7044	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7114	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7192	5/9/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7271	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7342	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 5i	4026	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4071	6/9/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4132	7/20/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4193	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4267	9/14/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4308	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4411	11/11/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4524	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4588	1/19/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4673	2/9/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4826	3/16/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4927	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5043	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5168	6/14/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5303	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5389	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5443	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5562	10/19/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5654	11/15/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5711	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5809	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5883	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5973	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6076	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6175	5/2/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6326	6/15/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6402	7/11/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6470	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6546	9/13/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6620	10/10/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6693	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6797	12/12/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6883	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6935	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7036	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7106	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7184	5/8/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7263	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7334	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7450	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7528	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7574	10/1/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7714	11/12/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7802	12/10/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 4e	4029	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4066	6/8/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4142	7/21/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4203	8/13/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4277	9/15/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4318	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4401	11/9/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4534	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4598	1/20/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4683	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4836	3/17/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4918	4/13/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5053	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5178	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5313	7/27/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5399	8/25/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5453	9/14/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5572	10/20/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5664	11/16/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5721	12/8/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5819	1/12/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5895	2/7/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5983	3/2/2011	3/4/2011	N.D.	2	23.97	47.94	23.97

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 4i	4025	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4070	6/9/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4133	7/20/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4194	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4268	9/14/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4309	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4410	11/11/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4525	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4589	1/19/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4674	2/9/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4827	3/16/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4928	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5044	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5169	6/14/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5304	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5390	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5444	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5563	10/19/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5655	11/15/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5712	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5810	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5884	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5974	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6077	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6176	5/2/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6327	6/15/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6403	7/11/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6471	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6547	9/13/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6621	10/10/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6694	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6798	12/12/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6884	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6936	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7037	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7107	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7185	5/8/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7264	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7335	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7451	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7529	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7575	10/1/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7715	11/12/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7803	12/10/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 3e	4019	5/26/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4077	6/10/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4143	7/21/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4204	8/13/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4278	9/15/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4319	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4400	11/9/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4535	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4599	1/20/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4684	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4837	3/17/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4919	4/13/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5054	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5179	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5314	7/27/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5400	8/25/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5454	9/14/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5573	10/20/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5665	11/16/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5722	12/8/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5820	1/12/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5896	2/7/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5984	3/2/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6087	4/6/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6185	5/3/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6336	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6412	7/12/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6480	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6558	9/14/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6630	10/11/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6703	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6807	12/13/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6893	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6944	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7045	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7115	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7193	5/9/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7272	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7343	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7459	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7536	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7582	10/2/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7722	11/13/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7810	12/11/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 3i	4024	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4079	6/10/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4134	7/20/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4195	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4269	9/14/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4310	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4409	11/11/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4526	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4590	1/19/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4675	2/9/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4828	3/16/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4929	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5045	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5170	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5305	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5391	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5445	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5564	10/19/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5656	11/15/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5713	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5811	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5885	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5975	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6078	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6177	5/2/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6328	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6404	7/11/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6472	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6548	9/13/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6622	10/10/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6695	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6799	12/12/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6885	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6937	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7038	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7108	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7186	5/8/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7265	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7336	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7452	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7530	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7576	10/1/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7716	11/12/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7804	12/10/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 2e	4018	5/26/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4076	6/10/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4144	7/22/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4205	8/13/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4279	9/15/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4320	10/6/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4399	11/9/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4536	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4600	1/20/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4685	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4838	3/17/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4920	4/13/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5055	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5180	6/16/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5315	7/27/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5401	8/25/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5455	9/14/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5574	10/20/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5666	11/16/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5723	12/8/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5821	1/12/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5897	2/7/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5985	3/2/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6088	4/6/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6186	5/3/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6337	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6413	7/12/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6481	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6559	9/14/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6631	10/11/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6704	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6808	12/13/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6894	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6945	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7046	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7116	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7194	5/9/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7273	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7344	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7460	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7537	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7583	10/2/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7723	11/13/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7811	12/11/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 2i	4023	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4078	6/10/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4135	7/20/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4196	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4270	9/14/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4311	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4408	11/11/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4527	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4591	1/19/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4676	2/9/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4829	3/16/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4930	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5046	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5171	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5306	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5392	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5446	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5565	10/19/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5657	11/15/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5714	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5812	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5886	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5976	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6079	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6178	5/2/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6329	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6405	7/11/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6473	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6549	9/13/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6623	10/10/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6696	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6800	12/12/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6886	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6938	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7039	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7109	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7187	5/8/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7266	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7337	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7453	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7531	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7577	10/1/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7717	11/12/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7805	12/10/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 1e	4016	5/26/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4074	6/9/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4145	7/22/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4206	8/13/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4280	9/15/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4321	10/6/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4397	11/9/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4537	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4601	1/20/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4686	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4839	3/17/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4923	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5056	5/18/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5181	6/16/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5316	7/27/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5402	8/25/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5456	9/14/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5575	10/20/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5667	11/16/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5724	12/8/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5822	1/12/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5890	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5986	3/2/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6089	4/6/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6187	5/4/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6338	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6414	7/12/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6482	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6560	9/14/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6634	10/11/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6707	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6811	12/13/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6897	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6948	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7049	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7119	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7197	5/9/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7276	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7347	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7463	8/14/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7540	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7586	10/2/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7726	11/13/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7814	12/11/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Room 1i	4020	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4061	6/8/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4136	7/20/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4197	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4271	9/14/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4312	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4407	11/11/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4528	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4592	1/19/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4677	2/9/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4830	3/16/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4931	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5047	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5172	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5307	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5393	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5447	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5566	10/19/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5658	11/15/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5715	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5813	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5887	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5977	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6080	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6179	5/2/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6330	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6406	7/11/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6474	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6550	9/13/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6624	10/10/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6697	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6801	12/12/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6887	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6939	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7040	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7110	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7188	5/8/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7267	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7338	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7454	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7532	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7578	10/1/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7718	11/13/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7806	12/10/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Location EBW	4015	5/26/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4065	6/8/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4147	7/22/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4208	8/13/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4282	9/15/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4323	10/6/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4396	11/9/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4539	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4603	1/20/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4688	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4841	3/17/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4921	4/13/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5058	5/18/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5183	6/16/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5318	7/27/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5404	8/25/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5458	9/14/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5577	10/20/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5669	11/16/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5726	12/8/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5824	1/12/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5898	2/7/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5988	3/2/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6091	4/6/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6189	5/4/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6340	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6416	7/12/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6484	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6562	9/14/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6632	10/11/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6705	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6809	12/13/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6895	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6946	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7047	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7117	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7195	5/9/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7274	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7345	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7461	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7538	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7584	10/2/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7724	11/13/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7812	12/11/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Location EBA	4014	5/26/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4064	6/8/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4148	7/22/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4209	8/13/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4283	9/15/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4324	10/6/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4395	11/9/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4540	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4604	1/20/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4689	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4842	3/17/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4922	4/13/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5059	5/18/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5184	6/16/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5319	7/27/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5405	8/25/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5459	9/14/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5578	10/20/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5670	11/16/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5727	12/8/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5825	1/12/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5899	2/7/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5989	3/2/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6092	4/6/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6190	5/4/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6341	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6417	7/12/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6485	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6563	9/14/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6633	10/11/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6706	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6810	12/13/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6896	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6947	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7048	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7118	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7196	5/9/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7275	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7346	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7462	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7539	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7585	10/2/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7725	11/13/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7813	12/11/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Location IBW	4022	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4063	6/8/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4137	7/20/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4198	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4272	9/14/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4313	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4406	11/11/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4529	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4593	1/19/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4678	2/9/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4831	3/16/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4932	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5048	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5173	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5308	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5394	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5448	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5567	10/19/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5659	11/15/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5716	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5814	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5888	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5978	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6081	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6180	5/3/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6331	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6407	7/11/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6475	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6551	9/13/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6625	10/10/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6698	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6802	12/12/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6888	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6940	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7041	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7111	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7189	5/8/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7268	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7339	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7455	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7533	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7579	10/2/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7719	11/13/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7807	12/10/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Methane (CH_4)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution Corrected MDL (ppmv)	Concentration for Statistical Analysis (ppmv)
Panel 4 Location IBA	4021	5/27/2009	5/29/2009	N.D.	2	23.74	47.48	23.74
	4062	6/8/2009	6/12/2009	N.D.	2	23.74	47.48	23.74
	4138	7/20/2009	7/24/2009	N.D.	2	22.21	44.42	22.21
	4199	8/11/2009	8/17/2009	N.D.	2	22.21	44.42	22.21
	4273	9/14/2009	9/18/2009	N.D.	2	22.21	44.42	22.21
	4314	10/5/2009	10/12/2009	N.D.	2	22.21	44.42	22.21
	4405	11/11/2009	11/16/2009	N.D.	2	22.21	44.42	22.21
	4530	12/30/2009	1/12/2010	N.D.	2	22.21	44.42	22.21
	4594	1/19/2010	1/22/2010	N.D.	2	22.21	44.42	22.21
	4679	2/10/2010	2/12/2010	N.D.	2	22.21	44.42	22.21
	4832	3/16/2010	3/29/2010	N.D.	2	22.21	44.42	22.21
	4933	4/14/2010	4/20/2010	N.D.	2	22.21	44.42	22.21
	5049	5/17/2010	5/24/2010	N.D.	2	22.21	44.42	22.21
	5174	6/15/2010	6/21/2010	N.D.	2	21.39	42.78	21.39
	5309	7/26/2010	8/2/2010	N.D.	2	21.39	42.78	21.39
	5395	8/24/2010	8/30/2010	N.D.	2	21.39	42.78	21.39
	5449	9/13/2010	9/20/2010	N.D.	2	21.39	42.78	21.39
	5568	10/19/2010	10/25/2010	N.D.	2	21.39	42.78	21.39
	5660	11/15/2010	11/22/2010	N.D.	2	21.39	42.78	21.39
	5717	12/7/2010	12/13/2010	N.D.	2	21.39	42.78	21.39
	5815	1/11/2011	1/18/2011	N.D.	2	23.97	47.94	23.97
	5889	2/1/2011	2/10/2011	N.D.	2	23.97	47.94	23.97
	5979	3/1/2011	3/4/2011	N.D.	2	23.97	47.94	23.97
	6082	4/5/2011	4/20/2011	N.D.	2	23.97	47.94	23.97
	6181	5/3/2011	5/6/2011	N.D.	2	23.97	47.94	23.97
	6332	6/16/2011	6/24/2011	N.D.	2	23.97	47.94	23.97
	6408	7/12/2011	7/15/2011	N.D.	2	23.97	47.94	23.97
	6476	8/9/2011	8/19/2011	N.D.	2	23.97	47.94	23.97
	6552	9/14/2011	9/16/2011	N.D.	2	23.97	47.94	23.97
	6626	10/10/2011	10/14/2011	N.D.	2	23.97	47.94	23.97
	6699	11/1/2011	11/4/2011	N.D.	2	23.97	47.94	23.97
	6803	12/12/2011	12/16/2011	N.D.	2	17.45	34.90	17.45
	6889	1/17/2012	1/23/2012	N.D.	2	17.45	34.90	17.45
	6941	2/7/2012	2/10/2012	N.D.	2	17.45	34.90	17.45
	7042	3/13/2012	3/16/2012	N.D.	2	17.45	34.90	17.45
	7112	4/10/2012	4/13/2012	N.D.	2	17.45	34.90	17.45
	7190	5/8/2012	5/15/2012	N.D.	2	17.45	34.90	17.45
	7269	6/11/2012	6/18/2012	N.D.	2	17.45	34.90	17.45
	7340	7/10/2012	7/13/2012	N.D.	2	17.45	34.90	17.45
	7456	8/13/2012	8/17/2012	N.D.	2	17.45	34.90	17.45
	7534	9/10/2012	9/14/2012	N.D.	2	17.45	34.90	17.45
	7580	10/2/2012	10/5/2012	N.D.	2	17.45	34.90	17.45
	7720	11/13/2012	11/16/2012	N.D.	2	15.71	31.42	15.71
	7808	12/11/2012	12/14/2012	N.D.	2	15.71	31.42	15.71

Appendix E

Panel 3 Hydrogen Data

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 7e	3176	4/24/2008	4/30/2008	59.74	2	10.79	21.58	59.74
	3213	5/15/2008	5/23/2008	86.52	2	10.79	21.58	86.52
	3281	6/19/2008	6/25/2008	103.78	2	10.79	21.58	103.78
	3340	7/16/2008	7/22/2008	178.92	2	10.79	21.58	178.92
	3405	8/19/2008	8/22/2008	353.02	2	14.93	29.86	353.02
	3453	9/10/2008	9/12/2008	209.46	2	14.93	29.86	209.46
	3509	10/8/2008	10/10/2008	352.68	2	14.93	29.86	352.68
	3582	11/13/2008	11/18/2008	146.54	2	14.93	29.86	146.54
	3621	12/3/2008	12/6/2008	89.50	2	14.93	29.86	89.50
	3720	1/13/2009	1/21/2009	83.18	2	14.93	29.86	83.18
	3777	2/10/2009	2/13/2009	53.76	2	14.93	29.86	53.76
	3844	3/11/2009	3/27/2009	53.88	2	14.93	29.86	53.88
	3919	4/14/2009	4/22/2009	51.82	2	14.93	29.86	51.82
	3990	5/12/2009	5/15/2009	88.94	2	14.93	29.86	88.94
	4048	6/2/2009	6/8/2009	68.52	2	14.93	29.86	68.52
	4106	7/7/2009	7/10/2009	123.32	2	15.17	30.34	123.32
	4165	8/5/2009	8/13/2009	84.52	2	15.17	30.34	84.52
	4236	9/1/2009	9/4/2009	130.44	2	15.17	30.34	130.44
	4333	10/12/2009	10/15/2009	95.60	2	15.17	30.34	95.60
	4375	11/2/2009	11/12/2009	90.80	2	15.17	30.34	90.80
	4465	12/8/2009	12/15/2009	23.62	2	15.17	30.34	15.17
	4626	1/26/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4724	2/17/2010	2/23/2010	84.12	2	15.17	30.34	84.12
	4790	3/9/2010	3/12/2010	64.72	2	15.17	30.34	64.72
	4958	4/20/2010	4/28/2010	57.18	2	15.17	30.34	57.18
	5082	5/25/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5117	6/1/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5255	7/13/2010	7/19/2010	127.94	2	7.00	14.00	127.94

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 7i	3175	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3222	5/19/2008	5/23/2008	10.40	2	10.79	21.58	10.79

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 6e	3178	4/24/2008	4/30/2008	27.34	2	10.79	21.58	27.34
	3212	5/14/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3280	6/19/2008	6/25/2008	69.22	2	10.79	21.58	69.22
	3339	7/16/2008	7/22/2008	145.62	2	10.79	21.58	145.62
	3426	8/20/2008	8/22/2008	228.66	2	14.93	29.86	228.66
	3452	9/10/2008	9/12/2008	136.30	2	14.93	29.86	136.30
	3508	10/8/2008	10/10/2008	12.42	2	14.93	29.86	14.93
	3581	11/13/2008	11/18/2008	35.30	2	14.93	29.86	35.30
	3620	12/3/2008	12/6/2008	76.10	2	14.93	29.86	76.10
	3719	1/13/2009	1/21/2009	64.12	2	14.93	29.86	64.12
	3776	2/10/2009	2/13/2009	43.60	2	14.93	29.86	43.60
	3843	3/10/2009	3/27/2009	67.46	2	14.93	29.86	67.46
	3918	4/14/2009	4/22/2009	53.12	2	14.93	29.86	53.12
	3989	5/12/2009	5/15/2009	76.46	2	14.93	29.86	76.46
	4047	6/2/2009	6/8/2009	39.94	2	14.93	29.86	39.94
	4107	7/7/2009	7/10/2009	110.02	2	15.17	30.34	110.02
	4166	8/5/2009	8/13/2009	79.50	2	15.17	30.34	79.50
	4237	9/1/2009	9/4/2009	106.26	2	15.17	30.34	106.26
	4334	10/12/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4376	11/2/2009	11/12/2009	51.54	2	15.17	30.34	51.54
	4466	12/8/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4627	1/26/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4725	2/17/2010	2/23/2010	49.20	2	15.17	30.34	49.20
	4791	3/9/2010	3/12/2010	77.26	2	15.17	30.34	77.26
	4959	4/20/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5083	5/25/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5118	6/1/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5256	7/13/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5349	8/9/2010	8/17/2010	97.04	2	7.00	14.00	97.04
	5475	9/21/2010	9/27/2010	114.26	2	7.00	14.00	114.26
	5534	10/11/2010	10/18/2010	98.94	2	7.00	14.00	98.94
	5627	11/8/2010	11/15/2010	93.20	2	7.00	14.00	93.20
	5746	12/14/2010	12/20/2010	92.60	2	7.00	14.00	92.60
	5844	1/18/2011	1/24/2011	140.32	2	14.03	28.06	140.32
	5930	2/15/2011	2/21/2011	62.32	2	14.03	28.06	62.32
	6018	3/8/2011	3/11/2011	87.88	2	14.03	28.06	87.88
	6131	4/19/2011	4/26/2011	N.D.	2	14.03	28.06	14.03
	6213	5/9/2011	5/13/2011	48.58	2	14.03	28.06	48.58
	6313	6/14/2011	6/21/2011	53.46	2	14.03	28.06	53.46
	6427	7/18/2011	7/28/2011	36.06	2	14.03	28.06	36.06
	6495	8/15/2011	8/22/2011	76.68	2	14.03	28.06	76.68
	6573	9/19/2011	9/27/2011	46.88	2	14.03	28.06	46.88
	6646	10/17/2011	10/25/2011	38.82	2	14.03	28.06	38.82
	6718	11/7/2011	11/11/2011	32.08	2	14.03	28.06	32.08
	6773	12/5/2011	12/9/2011	27.48	2	14.40	28.80	14.40
	6858	1/9/2012	1/13/2012	52.82	2	14.40	28.80	52.82
	6961	2/16/2012	2/22/2012	34.02	2	14.40	28.80	34.02
	7011	3/6/2012	3/9/2012	45.38	2	14.40	28.80	45.38
	7084	4/2/2012	4/9/2012	29.00	2	14.40	28.80	29.00
	7162	5/1/2012	5/4/2012	32.72	2	14.40	28.80	32.72
	7235	6/4/2012	6/8/2012	34.30	2	14.40	28.80	34.30
	7362	7/16/2012	7/23/2012	37.86	2	14.40	28.80	37.86
	7420	8/6/2012	8/10/2012	29.30	2	14.40	28.80	29.30
	7505	9/4/2012	9/7/2012	31.18	2	14.40	28.80	31.18

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 6i	3166	4/24/2008	4/30/2008	21.80	2	10.79	21.58	21.80
	3221	5/15/2008	5/23/2008	23.28	2	10.79	21.58	23.28
	3289	6/19/2008	6/25/2008	78.90	2	10.79	21.58	78.90
	3348	7/16/2008	7/22/2008	126.18	2	10.79	21.58	126.18
	3412	8/20/2008	8/22/2008	185.26	2	14.93	29.86	185.26
	3460	9/10/2008	9/12/2008	311.62	2	14.93	29.86	311.62
	3516	10/8/2008	10/10/2008	19.46	2	14.93	29.86	14.93
	3589	11/13/2008	11/18/2008	N.D.	2	14.93	29.86	14.93
	3628	12/3/2008	12/6/2008	N.D.	2	14.93	29.86	14.93
	3723	1/14/2009	1/21/2009	25.66	2	14.93	29.86	14.93
	3784	2/11/2009	2/13/2009	22.22	2	14.93	29.86	14.93
	3847	3/11/2009	3/27/2009	27.96	2	14.93	29.86	14.93
	3922	4/14/2009	4/22/2009	32.58	2	14.93	29.86	32.58
	3986	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4055	6/2/2009	6/8/2009	28.90	2	14.93	29.86	14.93
	4114	7/8/2009	7/10/2009	71.36	2	15.17	30.34	71.36
	4171	8/5/2009	8/13/2009	44.14	2	15.17	30.34	44.14
	4244	9/2/2009	9/4/2009	60.60	2	15.17	30.34	60.60
	4341	10/13/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4383	11/3/2009	11/12/2009	36.66	2	15.17	30.34	36.66
	4473	12/9/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4634	1/27/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4732	2/18/2010	2/23/2010	31.48	2	15.17	30.34	31.48
	4800	3/10/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4966	4/21/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5090	5/26/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5125	6/2/2010	6/7/2010	50.92	2	15.17	30.34	50.92
	5263	7/14/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5356	8/10/2010	8/17/2010	96.30	2	7.00	14.00	96.30

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 5e	3179	4/24/2008	4/30/2008	45.70	2	10.79	21.58	45.70
	3211	5/14/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3279	6/17/2008	6/25/2008	91.62	2	10.79	21.58	91.62
	3338	7/16/2008	7/22/2008	156.04	2	10.79	21.58	156.04
	3403	8/19/2008	8/22/2008	221.24	2	14.93	29.86	221.24
	3451	9/10/2008	9/12/2008	207.98	2	14.93	29.86	207.98
	3507	10/8/2008	10/10/2008	187.98	2	14.93	29.86	187.98
	3580	11/13/2008	11/18/2008	101.64	2	14.93	29.86	101.64
	3619	12/3/2008	12/6/2008	66.24	2	14.93	29.86	66.24
	3718	1/13/2009	1/21/2009	61.18	2	14.93	29.86	61.18
	3775	2/10/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3842	3/10/2009	3/27/2009	63.18	2	14.93	29.86	63.18
	3917	4/14/2009	4/22/2009	51.28	2	14.93	29.86	51.28
	3988	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4046	6/1/2009	6/8/2009	42.80	2	14.93	29.86	42.80
	4108	7/7/2009	7/10/2009	102.20	2	15.17	30.34	102.20
	4167	8/5/2009	8/13/2009	57.74	2	15.17	30.34	57.74
	4238	9/1/2009	9/4/2009	59.18	2	15.17	30.34	59.18
	4335	10/12/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4377	11/2/2009	11/12/2009	65.18	2	15.17	30.34	65.18
	4467	12/8/2009	12/15/2009	12.40	2	15.17	30.34	15.17
	4628	1/26/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4726	2/17/2010	2/23/2010	76.68	2	15.17	30.34	76.68
	4792	3/9/2010	3/12/2010	61.28	2	15.17	30.34	61.28
	4960	4/20/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5084	5/25/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5119	6/1/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5257	7/13/2010	7/19/2010	49.72	2	7.00	14.00	49.72
	5350	8/9/2010	8/17/2010	101.44	2	7.00	14.00	101.44
	5476	9/21/2010	9/27/2010	100.80	2	7.00	14.00	100.80
	5535	10/11/2010	10/18/2010	80.42	2	7.00	14.00	80.42
	5628	11/8/2010	11/15/2010	50.66	2	7.00	14.00	50.66
	5747	12/14/2010	12/20/2010	89.50	2	7.00	14.00	89.50
	5845	1/18/2011	1/24/2011	125.50	2	14.03	28.06	125.50
	5931	2/15/2011	2/21/2011	69.84	2	14.03	28.06	69.84
	6019	3/8/2011	3/11/2011	88.68	2	14.03	28.06	88.68
	6132	4/19/2011	4/26/2011	47.86	2	14.03	28.06	47.86
	6214	5/9/2011	5/13/2011	51.18	2	14.03	28.06	51.18
	6314	6/14/2011	6/21/2011	56.52	2	14.03	28.06	56.52
	6428	7/18/2011	7/22/2011	50.44	2	14.03	28.06	50.44
	6496	8/15/2011	8/22/2011	59.04	2	14.03	28.06	59.04
	6574	9/19/2011	9/27/2011	41.84	2	14.03	28.06	41.84
	6647	10/17/2011	10/25/2011	25.74	2	14.03	28.06	25.74
	6719	11/7/2011	11/11/2011	32.00	2	14.03	28.06	32.00
	6774	12/5/2011	12/9/2011	44.44	2	14.40	28.80	44.44
	6859	1/9/2012	1/13/2012	51.44	2	14.40	28.80	51.44
	6962	2/16/2012	2/22/2012	22.48	2	14.40	28.80	14.40
	7012	3/6/2012	3/9/2012	52.86	2	14.40	28.80	52.86
	7085	4/2/2012	4/9/2012	43.68	2	14.40	28.80	43.68
	7163	5/1/2012	5/4/2012	48.28	2	14.40	28.80	48.28
	7236	6/4/2012	6/8/2012	N.D.	2	14.40	28.80	14.40
	7363	7/16/2012	7/23/2012	29.78	2	14.40	28.80	29.78
	7421	8/6/2012	8/10/2012	44.24	2	14.40	28.80	44.24
	7506	9/4/2012	9/7/2012	37.76	2	14.40	28.80	37.76
	7617	10/8/2012	10/16/2012	32.84	2	14.40	28.80	32.84
	7687	11/5/2012	11/9/2012	37.16	2	17.29	34.58	37.16
	7773	12/3/2012	12/7/2012	42.52	2	17.29	34.58	42.52

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 5i	3177	4/24/2008	4/30/2008	24.18	2	10.79	21.58	24.18
	3220	5/15/2008	5/23/2008	17.68	2	10.79	21.58	10.79
	3288	6/19/2008	6/25/2008	60.62	2	10.79	21.58	60.62
	3347	7/16/2008	7/22/2008	166.08	2	10.79	21.58	166.08
	3411	8/19/2008	8/22/2008	247.14	2	14.93	29.86	247.14
	3459	9/10/2008	9/12/2008	220.32	2	14.93	29.86	220.32
	3515	10/8/2008	10/10/2008	57.40	2	14.93	29.86	57.40
	3588	11/13/2008	11/18/2008	N.D.	2	14.93	29.86	14.93
	3627	12/3/2008	12/6/2008	N.D.	2	14.93	29.86	14.93
	3722	1/13/2009	1/21/2009	26.62	2	14.93	29.86	14.93
	3783	2/11/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3846	3/11/2009	3/27/2009	16.56	2	14.93	29.86	14.93
	3921	4/14/2009	4/22/2009	18.66	2	14.93	29.86	14.93
	3985	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4054	6/2/2009	6/8/2009	32.80	2	14.93	29.86	32.80
	4115	7/8/2009	7/10/2009	99.70	2	15.17	30.34	99.70
	4176	8/6/2009	8/13/2009	81.66	2	15.17	30.34	81.66
	4245	9/2/2009	9/4/2009	62.66	2	15.17	30.34	62.66
	4342	10/13/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4384	11/3/2009	11/12/2009	32.30	2	15.17	30.34	32.30
	4474	12/9/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4635	1/27/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4733	2/18/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4801	3/10/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4967	4/21/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5091	5/26/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5126	6/2/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5264	7/14/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5357	8/10/2010	8/17/2010	93.94	2	7.00	14.00	93.94
	5483	9/22/2010	9/27/2010	96.22	2	7.00	14.00	96.22
	5541	10/12/2010	10/18/2010	46.98	2	7.00	14.00	46.98
	5634	11/9/2010	11/15/2010	54.98	2	7.00	14.00	54.98
	5753	12/15/2010	12/20/2010	76.98	2	7.00	14.00	76.98
	5851	1/19/2011	1/24/2011	N.D.	2	14.03	28.06	14.03
	5937	2/15/2011	2/21/2011	31.10	2	14.03	28.06	31.10
	6025	3/9/2011	3/11/2011	39.10	2	14.03	28.06	39.10
	6138	4/19/2011	4/26/2011	N.D.	2	14.03	28.06	14.03
	6220	5/10/2011	5/13/2011	30.62	2	14.03	28.06	30.62
	6320	6/15/2011	6/21/2011	18.64	2	14.03	28.06	14.03
	6436	7/19/2011	7/22/2011	N.D.	2	14.03	28.06	14.03
	6502	8/16/2011	8/22/2011	49.46	2	14.03	28.06	49.46
	6580	9/20/2011	9/27/2011	27.16	2	14.03	28.06	14.03
	6651	10/17/2011	10/25/2011	15.38	2	14.03	28.06	14.03
	6725	11/7/2011	11/11/2011	N.D.	2	14.03	28.06	14.03
	6780	12/5/2011	12/9/2011	N.D.	2	14.40	28.80	14.40
	6865	1/10/2012	1/13/2012	N.D.	2	14.40	28.80	14.40
	6968	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7018	3/6/2012	3/9/2012	N.D.	2	14.40	28.80	14.40
	7091	4/3/2012	4/9/2012	12.68	2	14.40	28.80	14.40
	7169	5/1/2012	5/4/2012	N.D.	2	14.40	28.80	14.40
	7242	6/5/2012	6/8/2012	N.D.	2	14.40	28.80	14.40
	7369	7/17/2012	7/23/2012	N.D.	2	14.40	28.80	14.40
	7427	8/6/2012	8/10/2012	N.D.	2	14.40	28.80	14.40
	7512	9/4/2012	9/7/2012	N.D.	2	14.40	28.80	14.40
	7623	10/9/2012	10/16/2012	N.D.	2	14.40	28.80	14.40
	7693	11/6/2012	11/9/2012	N.D.	2	17.29	34.58	17.29
	7779	12/4/2012	12/7/2012	29.86	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 4e	3174	4/24/2008	4/30/2008	56.32	2	10.79	21.58	56.32
	3210	5/14/2008	5/23/2008	48.84	2	10.79	21.58	48.84
	3278	6/17/2008	6/25/2008	20.00	2	10.79	21.58	10.79
	3337	7/16/2008	7/22/2008	54.12	2	10.79	21.58	54.12
	3402	8/19/2008	8/22/2008	120.12	2	14.93	29.86	120.12
	3450	9/10/2008	9/12/2008	136.06	2	14.93	29.86	136.06
	3506	10/8/2008	10/10/2008	N.D.	2	14.93	29.86	14.93
	3579	11/13/2008	11/18/2008	N.D.	2	14.93	29.86	14.93
	3618	12/3/2008	12/6/2008	49.22	2	14.93	29.86	49.22
	3717	1/13/2009	1/21/2009	55.40	2	14.93	29.86	55.40
	3774	2/10/2009	2/13/2009	35.76	2	14.93	29.86	35.76
	3841	3/10/2009	3/27/2009	47.92	2	14.93	29.86	47.92
	3916	4/14/2009	4/22/2009	35.76	2	14.93	29.86	35.76
	3987	5/12/2009	5/15/2009	15.26	2	14.93	29.86	14.93
	4045	6/1/2009	6/8/2009	41.08	2	14.93	29.86	41.08
	4109	7/7/2009	7/10/2009	91.98	2	15.17	30.34	91.98
	4168	8/5/2009	8/13/2009	52.92	2	15.17	30.34	52.92
	4239	9/1/2009	9/4/2009	45.46	2	15.17	30.34	45.46
	4336	10/12/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4378	11/2/2009	11/12/2009	54.43	2.1	15.17	31.86	54.43
	4468	12/8/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4629	1/26/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4727	2/17/2010	2/23/2010	63.46	2	15.17	30.34	63.46
	4793	3/9/2010	3/12/2010	43.46	2	15.17	30.34	43.46
	4961	4/20/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5085	5/25/2010	5/28/2010	58.64	2	15.17	30.34	58.64
	5120	6/1/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5258	7/13/2010	7/19/2010	39.14	2	7.00	14.00	39.14
	5351	8/9/2010	8/17/2010	99.22	2	7.00	14.00	99.22
	5477	9/21/2010	9/27/2010	90.04	2	7.00	14.00	90.04
	5536	10/11/2010	10/18/2010	85.22	2	7.00	14.00	85.22
	5629	11/8/2010	11/15/2010	68.10	2	7.00	14.00	68.10
	5748	12/14/2010	12/20/2010	89.98	2	7.00	14.00	89.98
	5846	1/18/2011	1/24/2011	132.24	2	14.03	28.06	132.24
	5932	2/15/2011	2/21/2011	66.56	2	14.03	28.06	66.56
	6020	3/8/2011	3/11/2011	58.04	2	14.03	28.06	58.04
	6133	4/19/2011	4/26/2011	43.64	2	14.03	28.06	43.64
	6215	5/9/2011	5/13/2011	55.34	2	14.03	28.06	55.34
	6315	6/14/2011	6/21/2011	43.96	2	14.03	28.06	43.96
	6429	7/18/2011	7/22/2011	55.78	2	14.03	28.06	55.78
	6497	8/15/2011	8/22/2011	66.62	2	14.03	28.06	66.62
	6575	9/19/2011	9/27/2011	51.62	2	14.03	28.06	51.62
	6648	10/17/2011	10/25/2011	34.04	2	14.03	28.06	34.04
	6720	11/7/2011	11/11/2011	30.00	2	14.03	28.06	30.00
	6775	12/5/2011	12/9/2011	29.26	2	14.40	28.80	29.26
	6860	1/9/2012	1/13/2012	58.28	2	14.40	28.80	58.28
	6963	2/16/2012	2/22/2012	14.74	2	14.40	28.80	14.40
	7013	3/6/2012	3/9/2012	42.20	2	14.40	28.80	42.20
	7086	4/2/2012	4/9/2012	33.40	2	14.40	28.80	33.40
	7164	5/1/2012	5/4/2012	N.D.	2	14.40	28.80	14.40
	7237	6/4/2012	6/8/2012	41.10	2	14.40	28.80	41.10
	7364	7/16/2012	7/23/2012	49.44	2	14.40	28.80	49.44
	7422	8/6/2012	8/10/2012	27.22	2	14.40	28.80	14.40
	7507	9/4/2012	9/7/2012	37.36	2	14.40	28.80	37.36
	7618	10/9/2012	10/16/2012	38.28	2	14.40	28.80	38.28
	7688	11/5/2012	11/9/2012	23.10	2	17.29	34.58	17.29
	7774	12/3/2012	12/7/2012	34.96	2	17.29	34.58	34.96

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 4i	3170	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3219	5/15/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3287	6/19/2008	6/25/2008	43.70	2	10.79	21.58	43.70
	3346	7/16/2008	7/22/2008	94.38	2	10.79	21.58	94.38
	3410	8/19/2008	8/22/2008	122.86	2	14.93	29.86	122.86
	3458	9/10/2008	9/12/2008	55.78	2	14.93	29.86	55.78
	3514	10/8/2008	10/10/2008	14.80	2	14.93	29.86	14.93
	3587	11/13/2008	11/18/2008	21.26	2	14.93	29.86	14.93
	3626	12/3/2008	12/6/2008	N.D.	2	14.93	29.86	14.93
	3721	1/13/2009	1/21/2009	14.98	2	14.93	29.86	14.93
	3782	2/10/2009	2/13/2009	19.84	2	14.93	29.86	14.93
	3845	3/11/2009	3/27/2009	5.50	2	14.93	29.86	14.93
	3920	4/14/2009	4/22/2009	18.42	2	14.93	29.86	14.93
	3984	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4053	6/2/2009	6/8/2009	N.D.	2	14.93	29.86	14.93
	4116	7/8/2009	7/10/2009	70.10	2	15.17	30.34	70.10
	4177	8/6/2009	8/13/2009	69.88	2	15.17	30.34	69.88
	4246	9/2/2009	9/4/2009	19.66	2	15.17	30.34	15.17
	4343	10/13/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4385	11/3/2009	11/12/2009	N.D.	2	15.17	30.34	15.17
	4475	12/9/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4636	1/27/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4734	2/18/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4802	3/10/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4968	4/21/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5092	5/26/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5127	6/2/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5265	7/14/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5358	8/10/2010	8/17/2010	78.80	2	7.00	14.00	78.80
	5484	9/22/2010	9/27/2010	N.D.	2	7.00	14.00	7.00
	5542	10/12/2010	10/18/2010	49.60	2	7.00	14.00	49.60
	5635	11/9/2010	11/15/2010	30.22	2	7.00	14.00	30.22
	5754	12/15/2010	12/20/2010	85.24	2	7.00	14.00	85.24
	5852	1/19/2011	1/24/2011	58.84	2	14.03	28.06	58.84
	5938	2/15/2011	2/21/2011	28.12	2	14.03	28.06	28.12
	6026	3/9/2011	3/11/2011	N.D.	2	14.03	28.06	14.03
	6139	4/19/2011	4/26/2011	N.D.	2	14.03	28.06	14.03
	6221	5/10/2011	5/13/2011	24.72	2	14.03	28.06	14.03
	6321	6/15/2011	6/21/2011	N.D.	2	14.03	28.06	14.03
	6437	7/19/2011	7/22/2011	N.D.	2	14.03	28.06	14.03
	6503	8/16/2011	8/22/2011	42.26	2	14.03	28.06	42.26
	6581	9/20/2011	9/27/2011	N.D.	2	14.03	28.06	14.03
	6656	10/18/2011	10/25/2011	N.D.	2	14.03	28.06	14.03
	6726	11/7/2011	11/11/2011	N.D.	2	14.03	28.06	14.03
	6781	12/6/2011	12/9/2011	N.D.	2	14.40	28.80	14.40
	6866	1/10/2012	1/13/2012	N.D.	2	14.40	28.80	14.40
	6969	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7019	3/6/2012	3/9/2012	N.D.	2	14.40	28.80	14.40
	7092	4/3/2012	4/9/2012	15.68	2	14.40	28.80	14.40
	7170	5/1/2012	5/4/2012	N.D.	2	14.40	28.80	14.40
	7243	6/5/2012	6/8/2012	N.D.	2	14.40	28.80	14.40
	7370	7/17/2012	7/23/2012	N.D.	2	14.40	28.80	14.40
	7428	8/6/2012	8/10/2012	N.D.	2	14.40	28.80	14.40
	7513	9/4/2012	9/7/2012	N.D.	2	14.40	28.80	14.40
	7624	10/9/2012	10/16/2012	N.D.	2	14.40	28.80	14.40
	7694	11/6/2012	11/9/2012	N.D.	2	17.29	34.58	17.29
	7780	12/4/2012	12/7/2012	N.D.	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 3e	3172	4/24/2008	4/30/2008	38.24	2	10.79	21.58	38.24
	3209	5/14/2008	5/23/2008	45.78	2	10.79	21.58	45.78
	3277	6/17/2008	6/25/2008	N.D.	2	10.79	21.58	10.79
	3336	7/15/2008	7/22/2008	49.56	2	10.79	21.58	49.56
	3401	8/20/2008	8/22/2008	46.38	2	14.93	29.86	46.38
	3449	9/8/2008	9/12/2008	76.02	2	14.93	29.86	76.02
	3505	10/6/2008	10/10/2008	91.54	2	14.93	29.86	91.54
	3578	11/10/2008	11/18/2008	76.38	2	14.93	29.86	76.38
	3617	12/3/2008	12/6/2008	51.44	2	14.93	29.86	51.44
	3712	1/12/2009	1/21/2009	46.52	2	14.93	29.86	46.52
	3773	2/9/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3834	3/12/2009	3/27/2009	49.78	2	14.93	29.86	49.78
	3911	4/13/2009	4/22/2009	36.44	2	14.93	29.86	36.44
	3979	5/12/2009	5/15/2009	40.06	2	14.93	29.86	40.06
	4044	6/1/2009	6/8/2009	44.98	2	14.93	29.86	44.98
	4110	7/7/2009	7/10/2009	88.52	2	15.17	30.34	88.52
	4169	8/5/2009	8/13/2009	62.82	2	15.17	30.34	62.82
	4240	9/1/2009	9/4/2009	54.22	2	15.17	30.34	54.22
	4337	10/12/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4379	11/3/2009	11/12/2009	N.D.	2	15.17	30.34	15.17
	4469	12/8/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4630	1/26/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4728	2/17/2010	2/23/2010	55.36	2	15.17	30.34	55.36
	4796	3/10/2010	3/12/2010	41.42	2	15.17	30.34	41.42
	4962	4/21/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5086	5/26/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5121	6/2/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5259	7/13/2010	7/19/2010	88.48	2	7.00	14.00	88.48
	5352	8/9/2010	8/17/2010	105.14	2	7.00	14.00	105.14
	5478	9/21/2010	9/27/2010	58.68	2	7.00	14.00	58.68
	5537	10/11/2010	10/18/2010	59.18	2	7.00	14.00	59.18
	5630	11/8/2010	11/15/2010	66.94	2	7.00	14.00	66.94
	5749	12/14/2010	12/20/2010	80.20	2	7.00	14.00	80.20
	5847	1/18/2011	1/24/2011	136.16	2	14.03	28.06	136.16
	5933	2/15/2011	2/21/2011	53.02	2	14.03	28.06	53.02
	6021	3/8/2011	3/11/2011	84.28	2	14.03	28.06	84.28
	6134	4/19/2011	4/26/2011	47.04	2	14.03	28.06	47.04
	6216	5/9/2011	5/13/2011	39.22	2	14.03	28.06	39.22
	6316	6/14/2011	6/21/2011	34.02	2	14.03	28.06	34.02
	6430	7/18/2011	7/22/2011	53.20	2	14.03	28.06	53.20
	6498	8/15/2011	8/22/2011	50.46	2	14.03	28.06	50.46
	6576	9/19/2011	9/27/2011	38.60	2	14.03	28.06	38.60
	6649	10/17/2011	10/25/2011	28.86	2	14.03	28.06	28.86
	6721	11/7/2011	11/11/2011	26.00	2	14.03	28.06	14.03
	6776	12/5/2011	12/9/2011	38.26	2	14.40	28.80	38.26
	6861	1/9/2012	1/13/2012	53.60	2	14.40	28.80	53.60
	6964	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7014	3/6/2012	3/9/2012	32.26	2	14.40	28.80	32.26
	7087	4/2/2012	4/9/2012	23.00	2	14.40	28.80	14.40
	7165	5/1/2012	5/4/2012	27.48	2	14.40	28.80	14.40
	7238	6/4/2012	6/8/2012	19.22	2	14.40	28.80	14.40
	7365	7/16/2012	7/23/2012	34.56	2	14.40	28.80	34.56
	7423	8/6/2012	8/10/2012	43.44	2	14.40	28.80	43.44
	7508	9/4/2012	9/7/2012	30.22	2	14.40	28.80	30.22
	7619	10/9/2012	10/16/2012	30.90	2	14.40	28.80	30.90
	7689	11/5/2012	11/9/2012	39.38	2	17.29	34.58	39.38
	7775	12/3/2012	12/7/2012	31.02	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 3i	3171	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3218	5/14/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3286	6/17/2008	6/25/2008	N.D.	2	10.79	21.58	10.79
	3345	7/15/2008	7/22/2008	N.D.	2	10.79	21.58	10.79
	3409	8/20/2008	8/22/2008	N.D.	2	14.93	29.86	14.93
	3457	9/8/2008	9/12/2008	N.D.	2	14.93	29.86	14.93
	3513	10/6/2008	10/10/2008	48.84	2	14.93	29.86	48.84
	3586	11/13/2008	11/18/2008	N.D.	2	14.93	29.86	14.93
	3625	12/3/2008	12/6/2008	N.D.	2	14.93	29.86	14.93
	3714	1/12/2009	1/21/2009	N.D.	2	14.93	29.86	14.93
	3781	2/10/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3836	3/12/2009	3/27/2009	N.D.	2	14.93	29.86	14.93
	3913	4/13/2009	4/22/2009	N.D.	2	14.93	29.86	14.93
	3981	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4052	6/2/2009	6/8/2009	N.D.	2	14.93	29.86	14.93
	4117	7/8/2009	7/10/2009	36.74	2	15.17	30.34	36.74
	4178	8/6/2009	8/13/2009	N.D.	2	15.17	30.34	15.17
	4247	9/2/2009	9/4/2009	N.D.	2	15.17	30.34	15.17
	4344	10/13/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4386	11/3/2009	11/12/2009	N.D.	2	15.17	30.34	15.17
	4476	12/9/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4637	1/27/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4735	2/18/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4803	3/10/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4969	4/21/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5093	5/26/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5128	6/2/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5266	7/14/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5359	8/10/2010	8/17/2010	69.66	2	7.00	14.00	69.66
	5485	9/22/2010	9/27/2010	N.D.	2	7.00	14.00	7.00
	5543	10/12/2010	10/18/2010	34.78	2	7.00	14.00	34.78
	5636	11/9/2010	11/15/2010	N.D.	2	7.00	14.00	7.00
	5755	12/15/2010	12/20/2010	70.66	2	7.00	14.00	70.66
	5853	1/19/2011	1/24/2011	79.18	2	14.03	28.06	79.18
	5939	2/15/2011	2/21/2011	N.D.	2	14.03	28.06	14.03
	6027	3/9/2011	3/11/2011	N.D.	2	14.03	28.06	14.03
	6140	4/19/2011	4/26/2011	N.D.	2	14.03	28.06	14.03
	6222	5/10/2011	5/13/2011	N.D.	2	14.03	28.06	14.03
	6322	6/15/2011	6/21/2011	N.D.	2	14.03	28.06	14.03
	6438	7/19/2011	7/22/2011	N.D.	2	14.03	28.06	14.03
	6504	8/16/2011	8/22/2011	N.D.	2	14.03	28.06	14.03
	6582	9/20/2011	9/27/2011	N.D.	2	14.03	28.06	14.03
	6657	10/18/2011	10/25/2011	N.D.	2	14.03	28.06	14.03
	6727	11/8/2011	11/11/2011	N.D.	2	14.03	28.06	14.03
	6782	12/6/2011	12/9/2011	N.D.	2	14.40	28.80	14.40
	6867	1/10/2012	1/13/2012	N.D.	2	14.40	28.80	14.40
	6970	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7020	3/6/2012	3/9/2012	N.D.	2	14.40	28.80	14.40
	7093	4/3/2012	4/9/2012	N.D.	2	14.40	28.80	14.40
	7171	5/1/2012	5/4/2012	N.D.	2	14.40	28.80	14.40
	7244	6/5/2012	6/8/2012	N.D.	2	14.40	28.80	14.40
	7371	7/17/2012	7/23/2012	N.D.	2	14.40	28.80	14.40
	7429	8/6/2012	8/10/2012	N.D.	2	14.40	28.80	14.40
	7514	9/4/2012	9/7/2012	N.D.	2	14.40	28.80	14.40
	7625	10/9/2012	10/16/2012	N.D.	2	14.40	28.80	14.40
	7695	11/6/2012	11/9/2012	N.D.	2	17.29	34.58	17.29
	7781	12/4/2012	12/7/2012	N.D.	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 2e	3164	4/24/2008	4/30/2008	32.02	2	10.79	21.58	32.02
	3208	5/14/2008	5/23/2008	31.20	2	10.79	21.58	31.20
	3276	6/17/2008	6/25/2008	22.78	2	10.79	21.58	22.78
	3335	7/15/2008	7/22/2008	32.36	2	10.79	21.58	32.36
	3400	8/20/2008	8/22/2008	37.30	2	14.93	29.86	37.30
	3448	9/8/2008	9/12/2008	35.04	2	14.93	29.86	35.04
	3504	10/6/2008	10/10/2008	36.14	2	14.93	29.86	36.14
	3577	11/10/2008	11/18/2008	36.90	2	14.93	29.86	36.90
	3616	12/3/2008	12/6/2008	33.86	2	14.93	29.86	33.86
	3711	1/12/2009	1/21/2009	36.68	2	14.93	29.86	36.68
	3772	2/9/2009	2/13/2009	24.04	2	14.93	29.86	14.93
	3833	3/12/2009	3/27/2009	16.42	2	14.93	29.86	14.93
	3910	4/13/2009	4/22/2009	23.94	2	14.93	29.86	14.93
	3978	5/12/2009	5/15/2009	35.24	2	14.93	29.86	35.24
	4043	6/1/2009	6/8/2009	14.40	2	14.93	29.86	14.93
	4111	7/7/2009	7/10/2009	37.48	2	15.17	30.34	37.48
	4170	8/5/2009	8/13/2009	18.32	2	15.17	30.34	15.17
	4241	9/1/2009	9/4/2009	21.32	2	15.17	30.34	15.17
	4338	10/13/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4380	11/3/2009	11/12/2009	22.38	2	15.17	30.34	15.17
	4470	12/8/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4631	1/26/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4729	2/17/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4797	3/10/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4963	4/21/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5087	5/26/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5122	6/2/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5260	7/13/2010	7/19/2010	105.46	2	7.00	14.00	105.46
	5353	8/9/2010	8/17/2010	N.D.	2	7.00	14.00	7.00
	5479	9/21/2010	9/27/2010	52.60	2	7.00	14.00	52.60
	5538	10/12/2010	10/18/2010	66.54	2	7.00	14.00	66.54
	5631	11/8/2010	11/15/2010	50.14	2	7.00	14.00	50.14
	5750	12/14/2010	12/20/2010	75.48	2	7.00	14.00	75.48
	5848	1/18/2011	1/24/2011	123.08	2	14.03	28.06	123.08
	5934	2/15/2011	2/21/2011	48.58	2	14.03	28.06	48.58
	6022	3/8/2011	3/11/2011	54.10	2	14.03	28.06	54.10
	6135	4/19/2011	4/26/2011	49.12	2	14.03	28.06	49.12
	6217	5/10/2011	5/13/2011	42.72	2	14.03	28.06	42.72
	6317	6/14/2011	6/21/2011	31.62	2	14.03	28.06	31.62
	6431	7/18/2011	7/22/2011	37.94	2	14.03	28.06	37.94
	6499	8/15/2011	8/22/2011	55.18	2	14.03	28.06	55.18
	6577	9/19/2011	9/27/2011	33.10	2	14.03	28.06	33.10
	6650	10/17/2011	10/25/2011	22.14	2	14.03	28.06	14.03
	6722	11/7/2011	11/11/2011	20.36	2	14.03	28.06	14.03
	6777	12/5/2011	12/9/2011	31.18	2	14.40	28.80	31.18
	6862	1/9/2012	1/13/2012	60.96	2	14.40	28.80	60.96
	6965	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7015	3/6/2012	3/9/2012	40.78	2	14.40	28.80	40.78
	7088	4/2/2012	4/9/2012	35.32	2	14.40	28.80	35.32
	7166	5/1/2012	5/4/2012	25.76	2	14.40	28.80	14.40
	7239	6/4/2012	6/8/2012	36.96	2	14.40	28.80	36.96
	7366	7/16/2012	7/23/2012	28.50	2	14.40	28.80	14.40
	7424	8/6/2012	8/10/2012	34.66	2	14.40	28.80	34.66
	7509	9/4/2012	9/7/2012	46.42	2	14.40	28.80	46.42
	7620	10/9/2012	10/16/2012	37.68	2	14.40	28.80	37.68
	7690	11/6/2012	11/9/2012	26.16	2	17.29	34.58	17.29
	7776	12/3/2012	12/7/2012	46.82	2	17.29	34.58	46.82

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 2i	3162	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3217	5/14/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3285	6/17/2008	6/25/2008	N.D.	2	10.79	21.58	10.79
	3344	7/15/2008	7/22/2008	N.D.	2	10.79	21.58	10.79
	3408	8/20/2008	8/22/2008	N.D.	2	14.93	29.86	14.93
	3456	9/8/2008	9/12/2008	N.D.	2	14.93	29.86	14.93
	3512	10/6/2008	10/10/2008	13.24	2	14.93	29.86	14.93
	3585	11/13/2008	11/18/2008	N.D.	2	14.93	29.86	14.93
	3624	12/3/2008	12/6/2008	N.D.	2	14.93	29.86	14.93
	3713	1/12/2009	1/21/2009	N.D.	2	14.93	29.86	14.93
	3780	2/10/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3835	3/12/2009	3/27/2009	N.D.	2	14.93	29.86	14.93
	3912	4/13/2009	4/22/2009	N.D.	2	14.93	29.86	14.93
	3980	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4051	6/2/2009	6/8/2009	N.D.	2	14.93	29.86	14.93
	4118	7/8/2009	7/10/2009	N.D.	2	15.17	30.34	15.17
	4179	8/6/2009	8/13/2009	N.D.	2	15.17	30.34	15.17
	4248	9/2/2009	9/4/2009	N.D.	2	15.17	30.34	15.17
	4345	10/13/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4387	11/3/2009	11/12/2009	N.D.	2	15.17	30.34	15.17
	4477	12/9/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4638	1/27/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4736	2/18/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4804	3/10/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4970	4/21/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5094	5/26/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5129	6/2/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5267	7/14/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5360	8/10/2010	8/17/2010	N.D.	2	7.00	14.00	7.00
	5486	9/22/2010	9/27/2010	N.D.	2	7.00	14.00	7.00
	5544	10/12/2010	10/18/2010	19.24	2	7.00	14.00	19.24
	5637	11/9/2010	11/15/2010	N.D.	2	7.00	14.00	7.00
	5756	12/15/2010	12/20/2010	68.86	2	7.00	14.00	68.86
	5854	1/19/2011	1/24/2011	55.84	2	14.03	28.06	55.84
	5940	2/15/2011	2/21/2011	N.D.	2	14.03	28.06	14.03
	6028	3/9/2011	3/11/2011	N.D.	2	14.03	28.06	14.03
	6141	4/19/2011	4/26/2011	N.D.	2	14.03	28.06	14.03
	6223	5/10/2011	5/13/2011	N.D.	2	14.03	28.06	14.03
	6323	6/15/2011	6/21/2011	N.D.	2	14.03	28.06	14.03
	6439	7/19/2011	7/22/2011	N.D.	2	14.03	28.06	14.03
	6505	8/16/2011	8/22/2011	N.D.	2	14.03	28.06	14.03
	6583	9/20/2011	9/27/2011	N.D.	2	14.03	28.06	14.03
	6658	10/18/2011	10/25/2011	N.D.	2	14.03	28.06	14.03
	6728	11/8/2011	11/11/2011	N.D.	2	14.03	28.06	14.03
	6783	12/6/2011	12/9/2011	N.D.	2	14.40	28.80	14.40
	6868	1/10/2012	1/13/2012	N.D.	2	14.40	28.80	14.40
	6971	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7021	3/6/2012	3/9/2012	N.D.	2	14.40	28.80	14.40
	7094	4/3/2012	4/9/2012	N.D.	2	14.40	28.80	14.40
	7172	5/1/2012	5/4/2012	N.D.	2	14.40	28.80	14.40
	7245	6/5/2012	6/8/2012	N.D.	2	14.40	28.80	14.40
	7372	7/17/2012	7/23/2012	N.D.	2	14.40	28.80	14.40
	7430	8/6/2012	8/10/2012	N.D.	2	14.40	28.80	14.40
	7515	9/4/2012	9/7/2012	N.D.	2	14.40	28.80	14.40
	7626	10/9/2012	10/16/2012	N.D.	2	14.40	28.80	14.40
	7696	11/6/2012	11/9/2012	N.D.	2	17.29	34.58	17.29
	7782	12/4/2012	12/7/2012	N.D.	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 1e	3163	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3207	5/14/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3293	6/17/2008	6/25/2008	N.D.	2	10.79	21.58	10.79
	3334	7/15/2008	7/22/2008	58.36	2	10.79	21.58	58.36
	3399	8/20/2008	8/22/2008	N.D.	2	14.93	29.86	14.93
	3447	9/8/2008	9/12/2008	19.46	2	14.93	29.86	14.93
	3503	10/6/2008	10/10/2008	21.18	2	14.93	29.86	14.93
	3575	11/10/2008	11/18/2008	14.10	2	14.93	29.86	14.93
	3614	12/3/2008	12/6/2008	23.54	2	14.93	29.86	14.93
	3709	1/12/2009	1/21/2009	N.D.	2	14.93	29.86	14.93
	3770	2/9/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3831	3/11/2009	3/27/2009	8.86	2	14.93	29.86	14.93
	3908	4/13/2009	4/22/2009	8.00	2	14.93	29.86	14.93
	3976	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4041	6/1/2009	6/8/2009	N.D.	2	14.93	29.86	14.93
	4112	7/7/2009	7/10/2009	N.D.	2	15.17	30.34	15.17
	4172	8/6/2009	8/13/2009	N.D.	2	15.17	30.34	15.17
	4242	9/1/2009	9/4/2009	N.D.	2	15.17	30.34	15.17
	4339	10/13/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4381	11/3/2009	11/12/2009	N.D.	2	15.17	30.34	15.17
	4471	12/9/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4632	1/26/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4730	2/17/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4798	3/10/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4964	4/21/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5088	5/26/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5123	6/2/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5261	7/13/2010	7/19/2010	54.82	2	7.00	14.00	54.82
	5354	8/10/2010	8/17/2010	43.64	2	7.00	14.00	43.64
	5480	9/21/2010	9/27/2010	34.86	2	7.00	14.00	34.86
	5539	10/12/2010	10/18/2010	58.30	2	7.00	14.00	58.30
	5632	11/9/2010	11/15/2010	26.00	2	7.00	14.00	26.00
	5751	12/15/2010	12/20/2010	75.32	2	7.00	14.00	75.32
	5849	1/18/2011	1/24/2011	84.54	2	14.03	28.06	84.54
	5935	2/15/2011	2/21/2011	58.96	2	14.03	28.06	58.96
	6023	3/9/2011	3/11/2011	67.98	2	14.03	28.06	67.98
	6136	4/19/2011	4/26/2011	32.52	2	14.03	28.06	32.52
	6218	5/10/2011	5/13/2011	N.D.	2	14.03	28.06	14.03
	6318	6/15/2011	6/21/2011	N.D.	2	14.03	28.06	14.03
	6433	7/19/2011	7/22/2011	N.D.	2	14.03	28.06	14.03
	6506	8/16/2011	8/22/2011	34.00	2	14.03	28.06	34.00
	6584	9/20/2011	9/27/2011	N.D.	2	14.03	28.06	14.03
	6659	10/18/2011	10/25/2011	N.D.	2	14.03	28.06	14.03
	6729	11/8/2011	11/11/2011	N.D.	2	14.03	28.06	14.03
	6784	12/6/2011	12/9/2011	N.D.	2	14.40	28.80	14.40
	6869	1/10/2012	1/13/2012	50.88	2	14.40	28.80	50.88
	6972	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7022	3/6/2012	3/9/2012	32.80	2	14.40	28.80	32.80
	7095	4/3/2012	4/9/2012	16.56	2	14.40	28.80	14.40
	7173	5/1/2012	5/4/2012	31.26	2	14.40	28.80	31.26
	7246	6/5/2012	6/8/2012	16.54	2	14.40	28.80	14.40
	7373	7/17/2012	7/23/2012	33.04	2	14.40	28.80	33.04
	7431	8/6/2012	8/10/2012	N.D.	2	14.40	28.80	14.40
	7516	9/4/2012	9/7/2012	N.D.	2	14.40	28.80	14.40
	7627	10/9/2012	10/16/2012	32.06	2	14.40	28.80	32.06
	7697	11/6/2012	11/9/2012	21.14	2	17.29	34.58	17.29
	7783	12/4/2012	12/7/2012	32.90	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Room 1i	3169	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3216	5/19/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3284	6/19/2008	6/25/2008	N.D.	2	10.79	21.58	10.79

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Location EBW	3165	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3215	5/15/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3283	6/17/2008	6/25/2008	N.D.	2	10.79	21.58	10.79
	3342	7/15/2008	7/22/2008	N.D.	2	10.79	21.58	10.79
	3407	8/20/2008	8/22/2008	N.D.	2	14.93	29.86	14.93
	3455	9/8/2008	9/12/2008	N.D.	2	14.93	29.86	14.93
	3511	10/6/2008	10/10/2008	32.88	2	14.93	29.86	32.88
	3584	11/10/2008	11/18/2008	N.D.	2	14.93	29.86	14.93
	3623	12/3/2008	12/6/2008	N.D.	2	14.93	29.86	14.93
	3716	1/12/2009	1/21/2009	N.D.	2	14.93	29.86	14.93
	3779	2/9/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3838	3/12/2009	3/27/2009	N.D.	2	14.93	29.86	14.93
	3915	4/13/2009	4/22/2009	N.D.	2	14.93	29.86	14.93
	3983	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4049	6/2/2009	6/8/2009	N.D.	2	14.93	29.86	14.93
	4105	7/7/2009	7/10/2009	N.D.	2	15.17	30.34	15.17
	4164	8/5/2009	8/13/2009	N.D.	2	15.17	30.34	15.17
	4235	9/1/2009	9/4/2009	N.D.	2	15.17	30.34	15.17
	4332	10/12/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4374	11/2/2009	11/12/2009	N.D.	2	15.17	30.34	15.17
	4464	12/8/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4625	1/26/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4723	2/17/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4789	3/9/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4957	4/20/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5081	5/25/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5116	6/1/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5254	7/13/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5347	8/9/2010	8/17/2010	47.32	2	7.00	14.00	47.32
	5474	9/21/2010	9/27/2010	35.28	2	7.00	14.00	35.28
	5533	10/11/2010	10/18/2010	60.22	2	7.00	14.00	60.22
	5626	11/8/2010	11/15/2010	36.90	2	7.00	14.00	36.90
	5745	12/14/2010	12/20/2010	71.48	2	7.00	14.00	71.48
	5843	1/18/2011	1/24/2011	95.56	2	14.03	28.06	95.56
	5929	2/15/2011	2/21/2011	53.14	2	14.03	28.06	53.14
	6017	3/8/2011	3/11/2011	73.22	2	14.03	28.06	73.22
	6130	4/18/2011	4/26/2011	31.08	2	14.03	28.06	31.08
	6212	5/9/2011	5/13/2011	40.20	2	14.03	28.06	40.20
	6312	6/14/2011	6/21/2011	N.D.	2	14.03	28.06	14.03
	6432	7/18/2011	7/22/2011	N.D.	2	14.03	28.06	14.03
	6500	8/15/2011	8/22/2011	N.D.	2	14.03	28.06	14.03
	6578	9/19/2011	9/27/2011	N.D.	2	14.03	28.06	14.03
	6652	10/17/2011	10/25/2011	N.D.	2	14.03	28.06	14.03
	6723	11/7/2011	11/11/2011	N.D.	2	14.03	28.06	14.03
	6778	12/5/2011	12/9/2011	29.60	2	14.40	28.80	29.60
	6863	1/9/2012	1/13/2012	51.46	2	14.40	28.80	51.46
	6966	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7016	3/6/2012	3/9/2012	23.10	2	14.40	28.80	14.40
	7089	4/2/2012	4/9/2012	27.82	2	14.40	28.80	14.40
	7167	5/1/2012	5/4/2012	N.D.	2	14.40	28.80	14.40
	7240	6/4/2012	6/8/2012	N.D.	2	14.40	28.80	14.40
	7367	7/16/2012	7/23/2012	31.38	2	14.40	28.80	31.38
	7425	8/6/2012	8/10/2012	N.D.	2	14.40	28.80	14.40
	7510	9/4/2012	9/7/2012	N.D.	2	14.40	28.80	14.40
	7621	10/9/2012	10/16/2012	26.92	2	14.40	28.80	14.40
	7691	11/6/2012	11/9/2012	28.84	2	17.29	34.58	17.29
	7777	12/4/2012	12/7/2012	22.64	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Location EBA	3167	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3214	5/15/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3282	6/19/2008	6/25/2008	N.D.	2	10.79	21.58	10.79
	3341	7/15/2008	7/22/2008	N.D.	2	10.79	21.58	10.79
	3406	8/20/2008	8/22/2008	N.D.	2	14.93	29.86	14.93
	3454	9/8/2008	9/12/2008	N.D.	2	14.93	29.86	14.93
	3510	10/6/2008	10/10/2008	15.14	2	14.93	29.86	14.93
	3583	11/10/2008	11/18/2008	N.D.	2	14.93	29.86	14.93
	3622	12/3/2008	12/6/2008	N.D.	2	14.93	29.86	14.93
	3715	1/12/2009	1/21/2009	N.D.	2	14.93	29.86	14.93
	3778	2/9/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3837	3/12/2009	3/27/2009	N.D.	2	14.93	29.86	14.93
	3914	4/13/2009	4/22/2009	N.D.	2	14.93	29.86	14.93
	3982	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4050	6/2/2009	6/8/2009	N.D.	2	14.93	29.86	14.93
	4104	7/7/2009	7/10/2009	N.D.	2	15.17	30.34	15.17
	4163	8/5/2009	8/13/2009	N.D.	2	15.17	30.34	15.17
	4234	9/1/2009	9/4/2009	N.D.	2	15.17	30.34	15.17
	4331	10/12/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4373	11/2/2009	11/12/2009	N.D.	2	15.17	30.34	15.17
	4463	12/8/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4624	1/26/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4722	2/17/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4788	3/9/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4956	4/20/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5080	5/25/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5115	6/1/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5253	7/13/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5346	8/9/2010	8/17/2010	N.D.	2	7.00	14.00	7.00
	5473	9/21/2010	9/27/2010	N.D.	2	7.00	14.00	7.00
	5532	10/11/2010	10/18/2010	41.80	2	7.00	14.00	41.80
	5625	11/8/2010	11/15/2010	N.D.	2	7.00	14.00	7.00
	5744	12/14/2010	12/20/2010	N.D.	2	7.00	14.00	7.00
	5842	1/18/2011	1/24/2011	N.D.	2	14.03	28.06	14.03
	5928	2/15/2011	2/21/2011	N.D.	2	14.03	28.06	14.03
	6016	3/8/2011	3/11/2011	N.D.	2	14.03	28.06	14.03
	6129	4/18/2011	4/26/2011	N.D.	2	14.03	28.06	14.03
	6211	5/9/2011	5/13/2011	N.D.	2	14.03	28.06	14.03
	6311	6/14/2011	6/21/2011	N.D.	2	14.03	28.06	14.03
	6435	7/19/2011	7/22/2011	N.D.	2	14.03	28.06	14.03
	6501	8/16/2011	8/22/2011	N.D.	2	14.03	28.06	14.03
	6579	9/20/2011	9/27/2011	N.D.	2	14.03	28.06	14.03
	6653	10/17/2011	10/25/2011	N.D.	2	14.03	28.06	14.03
	6724	11/7/2011	11/11/2011	N.D.	2	14.03	28.06	14.03
	6779	12/5/2011	12/9/2011	N.D.	2	14.40	28.80	14.40
	6864	1/10/2012	1/13/2012	N.D.	2	14.40	28.80	14.40
	6967	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7017	3/6/2012	3/9/2012	N.D.	2	14.40	28.80	14.40
	7090	4/3/2012	4/9/2012	N.D.	2	14.40	28.80	14.40
	7168	5/1/2012	5/4/2012	N.D.	2	14.40	28.80	14.40
	7241	6/5/2012	6/8/2012	N.D.	2	14.40	28.80	14.40
	7368	7/16/2012	7/23/2012	N.D.	2	14.40	28.80	14.40
	7426	8/6/2012	8/10/2012	N.D.	2	14.40	28.80	14.40
	7511	9/4/2012	9/7/2012	N.D.	2	14.40	28.80	14.40
	7622	10/9/2012	10/16/2012	N.D.	2	14.40	28.80	14.40
	7692	11/6/2012	11/9/2012	N.D.	2	17.29	34.58	17.29
	7778	12/4/2012	12/7/2012	N.D.	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Location IBW	3173	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3224	5/15/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3292	6/19/2008	6/25/2008	N.D.	2	10.79	21.58	10.79
	3350	7/16/2008	7/22/2008	N.D.	2	10.79	21.58	10.79
	3414	8/20/2008	8/22/2008	N.D.	2	14.93	29.86	14.93
	3462	9/10/2008	9/12/2008	N.D.	2	14.93	29.86	14.93
	3518	10/8/2008	10/10/2008	N.D.	2	14.93	29.86	14.93
	3591	11/13/2008	11/18/2008	N.D.	2	14.93	29.86	14.93
	3630	12/3/2008	12/6/2008	N.D.	2	14.93	29.86	14.93
	3725	1/14/2009	1/21/2009	N.D.	2	14.93	29.86	14.93
	3786	2/11/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3840	3/10/2009	3/27/2009	N.D.	2	14.93	29.86	14.93
	3924	4/15/2009	4/22/2009	N.D.	2	14.93	29.86	14.93
	3992	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4040	6/1/2009	6/8/2009	N.D.	2	14.93	29.86	14.93
	4103	7/7/2009	7/10/2009	N.D.	2	15.17	30.34	15.17
	4181	8/6/2009	8/13/2009	N.D.	2	15.17	30.34	15.17
	4250	9/2/2009	9/4/2009	N.D.	2	15.17	30.34	15.17
	4347	10/13/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4372	11/2/2009	11/12/2009	N.D.	2	15.17	30.34	15.17
	4479	12/9/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4640	1/27/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4738	2/18/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4795	3/9/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	5078	5/25/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5130	6/2/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5252	7/13/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5362	8/10/2010	8/17/2010	N.D.	2	7.00	14.00	7.00
	5487	9/22/2010	9/27/2010	N.D.	2	7.00	14.00	7.00
	5531	10/11/2010	10/18/2010	N.D.	2	7.00	14.00	7.00
	5624	11/8/2010	11/15/2010	N.D.	2	7.00	14.00	7.00
	5743	12/14/2010	12/20/2010	51.16	2	7.00	14.00	51.16
	5841	1/18/2011	1/24/2011	N.D.	2	14.03	28.06	14.03
	5927	2/15/2011	2/21/2011	N.D.	2	14.03	28.06	14.03
	6015	3/8/2011	3/11/2011	N.D.	2	14.03	28.06	14.03
	6128	4/18/2011	4/26/2011	N.D.	2	14.03	28.06	14.03
	6210	5/9/2011	5/13/2011	N.D.	2	14.03	28.06	14.03
	6309	6/14/2011	6/21/2011	N.D.	2	14.03	28.06	14.03
	6426	7/18/2011	7/22/2011	N.D.	2	14.03	28.06	14.03
	6494	8/15/2011	8/22/2011	N.D.	2	14.03	28.06	14.03
	6571	9/19/2011	9/27/2011	N.D.	2	14.03	28.06	14.03
	6654	10/18/2011	10/25/2011	N.D.	2	14.03	28.06	14.03
	6716	11/7/2011	11/11/2011	38.82	2	14.03	28.06	38.82
	6771	12/5/2011	12/9/2011	N.D.	2	14.40	28.80	14.40
	6857	1/9/2012	1/13/2012	N.D.	2	14.40	28.80	14.40
	6959	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7009	3/6/2012	3/9/2012	N.D.	2	14.40	28.80	14.40
	7083	4/2/2012	4/9/2012	N.D.	2	14.40	28.80	14.40
	7161	5/1/2012	5/4/2012	N.D.	2	14.40	28.80	14.40
	7234	6/4/2012	6/8/2012	N.D.	2	14.40	28.80	14.40
	7361	7/16/2012	7/23/2012	N.D.	2	14.40	28.80	14.40
	7419	8/6/2012	8/10/2012	N.D.	2	14.40	28.80	14.40
	7504	9/4/2012	9/7/2012	N.D.	2	14.40	28.80	14.40
	7615	10/8/2012	10/16/2012	N.D.	2	14.40	28.80	14.40
	7686	11/5/2012	11/9/2012	N.D.	2	17.29	34.58	17.29
	7772	12/3/2012	12/7/2012	N.D.	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 3 Location IBA	3168	4/24/2008	4/30/2008	N.D.	2	10.79	21.58	10.79
	3223	5/15/2008	5/23/2008	N.D.	2	10.79	21.58	10.79
	3291	6/19/2008	6/25/2008	N.D.	2	10.79	21.58	10.79
	3349	7/16/2008	7/22/2008	N.D.	2	10.79	21.58	10.79
	3413	8/20/2008	8/22/2008	N.D.	2	14.93	29.86	14.93
	3461	9/10/2008	9/12/2008	N.D.	2	14.93	29.86	14.93
	3517	10/8/2008	10/10/2008	N.D.	2	14.93	29.86	14.93
	3590	11/13/2008	11/18/2008	N.D.	2	14.93	29.86	14.93
	3629	12/3/2008	12/6/2008	N.D.	2	14.93	29.86	14.93
	3724	1/14/2009	1/21/2009	N.D.	2	14.93	29.86	14.93
	3785	2/11/2009	2/13/2009	N.D.	2	14.93	29.86	14.93
	3839	3/10/2009	3/27/2009	N.D.	2	14.93	29.86	14.93
	3923	4/15/2009	4/22/2009	N.D.	2	14.93	29.86	14.93
	3991	5/12/2009	5/15/2009	N.D.	2	14.93	29.86	14.93
	4039	6/1/2009	6/8/2009	N.D.	2	14.93	29.86	14.93
	4102	7/7/2009	7/10/2009	N.D.	2	15.17	30.34	15.17
	4180	8/6/2009	8/13/2009	N.D.	2	15.17	30.34	15.17
	4249	9/2/2009	9/4/2009	N.D.	2	15.17	30.34	15.17
	4346	10/13/2009	10/15/2009	N.D.	2	15.17	30.34	15.17
	4371	11/2/2009	11/12/2009	N.D.	2	15.17	30.34	15.17
	4478	12/9/2009	12/15/2009	N.D.	2	15.17	30.34	15.17
	4639	1/27/2010	2/2/2010	N.D.	2	15.17	30.34	15.17
	4737	2/18/2010	2/23/2010	N.D.	2	15.17	30.34	15.17
	4794	3/9/2010	3/12/2010	N.D.	2	15.17	30.34	15.17
	4954	4/20/2010	4/28/2010	N.D.	2	15.17	30.34	15.17
	5079	5/25/2010	5/28/2010	N.D.	2	15.17	30.34	15.17
	5131	6/2/2010	6/7/2010	N.D.	2	15.17	30.34	15.17
	5251	7/13/2010	7/19/2010	N.D.	2	7.00	14.00	7.00
	5361	8/10/2010	8/17/2010	N.D.	2	7.00	14.00	7.00
	5488	9/22/2010	9/27/2010	N.D.	2	7.00	14.00	7.00
	5530	10/11/2010	10/18/2010	N.D.	2	7.00	14.00	7.00
	5623	11/8/2010	11/15/2010	N.D.	2	7.00	14.00	7.00
	5742	12/14/2010	12/20/2010	N.D.	2	7.00	14.00	7.00
	5840	1/18/2011	1/24/2011	N.D.	2	14.03	28.06	14.03
	5926	2/15/2011	2/21/2011	N.D.	2	14.03	28.06	14.03
	6014	3/8/2011	3/11/2011	N.D.	2	14.03	28.06	14.03
	6127	4/18/2011	4/26/2011	N.D.	2	14.03	28.06	14.03
	6209	5/9/2011	5/13/2011	N.D.	2	14.03	28.06	14.03
	6310	6/14/2011	6/21/2011	N.D.	2	14.03	28.06	14.03
	6425	7/18/2011	7/22/2011	N.D.	2	14.03	28.06	14.03
	6493	8/15/2011	8/22/2011	N.D.	2	14.03	28.06	14.03
	6572	9/19/2011	9/27/2011	N.D.	2	14.03	28.06	14.03
	6655	10/18/2011	10/25/2011	N.D.	2	14.03	28.06	14.03
	6717	11/7/2011	11/11/2011	N.D.	2	14.03	28.06	14.03
	6772	12/5/2011	12/9/2011	N.D.	2	14.40	28.80	14.40
	6856	1/9/2012	1/13/2012	N.D.	2	14.40	28.80	14.40
	6960	2/16/2012	2/22/2012	N.D.	2	14.40	28.80	14.40
	7010	3/6/2012	3/9/2012	N.D.	2	14.40	28.80	14.40
	7082	4/2/2012	4/9/2012	N.D.	2	14.40	28.80	14.40
	7160	5/1/2012	5/4/2012	N.D.	2	14.40	28.80	14.40
	7233	6/4/2012	6/8/2012	N.D.	2	14.40	28.80	14.40
	7360	7/16/2012	7/23/2012	N.D.	2	14.40	28.80	14.40
	7418	8/6/2012	8/10/2012	N.D.	2	14.40	28.80	14.40
	7503	9/4/2012	9/7/2012	N.D.	2	14.40	28.80	14.40
	7614	10/8/2012	10/16/2012	N.D.	2	14.40	28.80	14.40
	7685	11/5/2012	11/9/2012	N.D.	2	17.29	34.58	17.29
	7771	12/3/2012	12/7/2012	N.D.	2	17.29	34.58	17.29

Appendix F

Panel 4 Hydrogen Data

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 7e	4032	5/27/2009	5/29/2009	214.50	2	14.93	29.86	214.50
	4069	6/9/2009	6/12/2009	81.40	2	14.93	29.86	81.40
	4139	7/21/2009	7/24/2009	N.D.	2	15.17	30.34	15.17
	4200	8/11/2009	8/17/2009	N.D.	2	15.17	30.34	15.17
	4274	9/15/2009	9/18/2009	52.08	2	15.17	30.34	52.08
	4315	10/5/2009	10/12/2009	29.58	2	15.17	30.34	15.17
	4404	11/9/2009	11/16/2009	376.32	2	15.17	30.34	376.32
	4531	12/30/2009	1/12/2010	732.38	2	15.17	30.34	732.38
	4595	1/20/2010	1/22/2010	230.68	2	15.17	30.34	230.68
	4680	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4833	3/17/2010	3/29/2010	538.04	2	15.17	30.34	538.04
	4915	4/13/2010	4/20/2010	470.54	2	15.17	30.34	470.54
	5050	5/17/2010	5/24/2010	432.10	2	15.17	30.34	432.10
	5175	6/15/2010	6/21/2010	923.52	2	7.00	14.00	923.52
	5310	7/26/2010	8/2/2010	291.14	2	7.00	14.00	291.14
	5396	8/24/2010	8/30/2010	257.50	2	7.00	14.00	257.50
	5450	9/13/2010	9/20/2010	867.36	2	7.00	14.00	867.36
	5569	10/20/2010	10/25/2010	873.20	2	7.00	14.00	873.20
	5661	11/16/2010	11/22/2010	868.52	2	7.00	14.00	868.52
	5718	12/7/2010	12/13/2010	983.72	2	7.00	14.00	983.72
	5816	1/11/2011	1/18/2011	938.74	2	14.03	28.06	938.74
	5892	2/7/2011	2/10/2011	785.90	2	14.03	28.06	785.90
	5980	3/1/2011	3/4/2011	841.20	2	14.03	28.06	841.20
	6083	4/5/2011	4/20/2011	739.96	2	14.03	28.06	739.96
	6182	5/3/2011	5/6/2011	920.04	2	14.03	28.06	920.04
	6333	6/16/2011	6/24/2011	854.28	2	14.03	28.06	854.28
	6409	7/12/2011	7/15/2011	775.72	2	14.03	28.06	775.72
	6477	8/9/2011	8/19/2011	837.04	2	14.03	28.06	837.04
	6553	9/14/2011	9/16/2011	823.62	2	14.03	28.06	823.62
	6627	10/11/2011	10/14/2011	856.32	2	14.03	28.06	856.32
	6700	11/1/2011	11/4/2011	793.36	2	14.03	28.06	793.36
	6804	12/12/2011	12/16/2011	737.98	2	14.40	28.80	737.98
	6890	1/17/2012	1/23/2012	759.70	2	14.40	28.80	759.70
	6942	2/7/2012	2/10/2012	735.92	2	14.40	28.80	735.92
	7043	3/13/2012	3/16/2012	669.68	2	14.40	28.80	669.68
	7113	4/10/2012	4/13/2012	635.18	2	14.40	28.80	635.18
	7191	5/9/2012	5/15/2012	530.68	2	14.40	28.80	530.68
	7270	6/11/2012	6/18/2012	466.46	2	14.40	28.80	466.46
	7341	7/10/2012	7/13/2012	409.74	2	14.40	28.80	409.74
	7457	8/13/2012	8/17/2012	288.84	2	14.40	28.80	288.84
	7535	9/10/2012	9/14/2012	344.36	2	14.40	28.80	344.36
	7581	10/2/2012	10/5/2012	399.12	2	14.40	28.80	399.12
	7721	11/13/2012	11/16/2012	389.44	2	17.29	34.58	389.44
	7809	12/11/2012	12/14/2012	421.08	2	17.29	34.58	421.08

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 7i	4028	5/27/2009	5/29/2009	77.78	2	14.93	29.86	77.78
	4073	6/9/2009	6/12/2009	100.20	2	14.93	29.86	100.20
	4130	7/20/2009	7/24/2009	226.46	2	15.17	30.34	226.46
	4191	8/11/2009	8/17/2009	235.94	2	15.17	30.34	235.94
	4265	9/14/2009	9/18/2009	242.14	2	15.17	30.34	242.14
	4306	10/5/2009	10/12/2009	48.62	2	15.17	30.34	48.62
	4413	11/11/2009	11/16/2009	179.38	2	15.17	30.34	179.38
	4522	12/30/2009	1/12/2010	N.D.	2	15.17	30.34	15.17
	4586	1/19/2010	1/22/2010	242.94	2	15.17	30.34	242.94
	4671	2/9/2010	2/12/2010	341.44	2	15.17	30.34	341.44
	4824	3/16/2010	3/29/2010	652.14	2	15.17	30.34	652.14
	4925	4/14/2010	4/20/2010	453.88	2	15.17	30.34	453.88
	5041	5/17/2010	5/24/2010	879.08	2	15.17	30.34	879.08
	5166	6/14/2010	6/21/2010	823.70	2	7.00	14.00	823.70
	5301	7/26/2010	8/2/2010	45.56	2	7.00	14.00	45.56
	5387	8/24/2010	8/30/2010	686.82	2	7.00	14.00	686.82
	5441	9/13/2010	9/20/2010	758.66	2	7.00	14.00	758.66
	5560	10/19/2010	10/25/2010	761.02	2	7.00	14.00	761.02
	5652	11/15/2010	11/22/2010	849.62	2	7.00	14.00	849.62
	5709	12/7/2010	12/13/2010	828.18	2	7.00	14.00	828.18
	5807	1/11/2011	1/18/2011	708.12	2	14.03	28.06	708.12
	5881	2/1/2011	2/10/2011	707.46	2	14.03	28.06	707.46
	5971	3/1/2011	3/4/2011	902.20	2	14.03	28.06	902.20
	6074	4/5/2011	4/20/2011	831.04	2	14.03	28.06	831.04
	6173	5/2/2011	5/6/2011	729.88	2	14.03	28.06	729.88
	6324	6/15/2011	6/24/2011	687.94	2	14.03	28.06	687.94
	6400	7/11/2011	7/15/2011	674.94	2	14.03	28.06	674.94
	6461	8/9/2011	8/19/2011	507.68	2	14.03	28.06	507.68
	6544	9/13/2011	9/16/2011	500.24	2	14.03	28.06	500.24
	6618	10/10/2011	10/14/2011	388.58	2	14.03	28.06	388.58
	6691	11/1/2011	11/4/2011	425.88	2	14.03	28.06	425.88
	6795	12/12/2011	12/16/2011	557.70	2	14.40	28.80	557.70
	6881	1/17/2012	1/23/2012	529.76	2	14.40	28.80	529.76
	6933	2/7/2012	2/10/2012	435.94	2	14.40	28.80	435.94
	7034	3/13/2012	3/16/2012	378.74	2	14.40	28.80	378.74
	7104	4/10/2012	4/13/2012	168.24	2	14.40	28.80	168.24
	7182	5/8/2012	5/15/2012	217.16	2	14.40	28.80	217.16
	7261	6/11/2012	6/18/2012	141.74	2	14.40	28.80	141.74
	7332	7/10/2012	7/13/2012	135.10	2	14.40	28.80	135.10
	7448	8/13/2012	8/17/2012	102.58	2	14.40	28.80	102.58
	7526	9/10/2012	9/14/2012	358.82	2	14.40	28.80	358.82
	7572	10/1/2012	10/5/2012	357.82	2	14.40	28.80	357.82
	7712	11/12/2012	11/16/2012	323.84	2	17.29	34.58	323.84
	7800	12/10/2012	12/14/2012	348.26	2	17.29	34.58	348.26

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 6e	4031	5/27/2009	5/29/2009	190.82	2	14.93	29.86	190.82
	4068	6/8/2009	6/12/2009	114.46	2	14.93	29.86	114.46
	4140	7/21/2009	7/24/2009	177.58	2	15.17	30.34	177.58
	4201	8/11/2009	8/17/2009	247.88	2	15.17	30.34	247.88
	4275	9/15/2009	9/18/2009	159.46	2	15.17	30.34	159.46
	4316	10/5/2009	10/12/2009	117.88	2	15.17	30.34	117.88
	4403	11/9/2009	11/16/2009	341.80	2	15.17	30.34	341.80
	4532	12/30/2009	1/12/2010	466.88	2	15.17	30.34	466.88
	4596	1/20/2010	1/22/2010	576.72	2	15.17	30.34	576.72
	4681	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4834	3/17/2010	3/29/2010	599.50	2	15.17	30.34	599.50
	4916	4/13/2010	4/20/2010	741.36	2	15.17	30.34	741.36
	5051	5/17/2010	5/24/2010	234.98	2	15.17	30.34	234.98
	5176	6/15/2010	6/21/2010	207.18	2	7.00	14.00	207.18
	5311	7/27/2010	8/2/2010	N.D.	2	7.00	14.00	7.00
	5397	8/25/2010	8/30/2010	880.34	2	7.00	14.00	880.34
	5451	9/14/2010	9/20/2010	902.54	2	7.00	14.00	902.54
	5570	10/20/2010	10/25/2010	1012.68	2	7.00	14.00	1012.68
	5662	11/16/2010	11/22/2010	991.58	2	7.00	14.00	991.58
	5719	12/8/2010	12/13/2010	768.08	2	7.00	14.00	768.08
	5817	1/12/2011	1/18/2011	619.40	2	14.03	28.06	619.40
	5893	2/7/2011	2/10/2011	911.52	2	14.03	28.06	911.52
	5981	3/2/2011	3/4/2011	946.96	2	14.03	28.06	946.96
	6084	4/5/2011	4/20/2011	616.24	2	14.03	28.06	616.24
	6183	5/3/2011	5/6/2011	720.54	2	14.03	28.06	720.54
	6334	6/16/2011	6/24/2011	543.56	2	14.03	28.06	543.56
	6410	7/12/2011	7/15/2011	648.56	2	14.03	28.06	648.56
	6478	8/9/2011	8/19/2011	692.68	2	14.03	28.06	692.68
	6554	9/14/2011	9/16/2011	656.56	2	14.03	28.06	656.56
	6628	10/11/2011	10/14/2011	679.30	2	14.03	28.06	679.30
	6701	11/1/2011	11/4/2011	661.62	2	14.03	28.06	661.62

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 6i	4027	5/27/2009	5/29/2009	67.96	2	14.93	29.86	67.96
	4072	6/9/2009	6/12/2009	N.D.	2	14.93	29.86	14.93
	4131	7/20/2009	7/24/2009	247.58	2	15.17	30.34	247.58
	4192	8/11/2009	8/17/2009	230.00	2	15.17	30.34	230.00
	4266	9/14/2009	9/18/2009	247.62	2	15.17	30.34	247.62
	4307	10/5/2009	10/12/2009	324.08	2	15.17	30.34	324.08
	4412	11/11/2009	11/16/2009	N.D.	2	15.17	30.34	15.17
	4523	12/30/2009	1/12/2010	419.66	2	15.17	30.34	419.66
	4587	1/19/2010	1/22/2010	199.04	2	15.17	30.34	199.04
	4672	2/9/2010	2/12/2010	85.18	2	15.17	30.34	85.18
	4825	3/16/2010	3/29/2010	647.86	2	15.17	30.34	647.86
	4926	4/14/2010	4/20/2010	528.88	2	15.17	30.34	528.88
	5042	5/17/2010	5/24/2010	613.98	2	15.17	30.34	613.98
	5167	6/14/2010	6/21/2010	613.10	2	7.00	14.00	613.10
	5302	7/26/2010	8/2/2010	555.22	2	7.00	14.00	555.22
	5388	8/24/2010	8/30/2010	750.22	2	7.00	14.00	750.22
	5442	9/13/2010	9/20/2010	713.28	2	7.00	14.00	713.28
	5561	10/19/2010	10/25/2010	902.74	2	7.00	14.00	902.74
	5653	11/15/2010	11/22/2010	760.56	2	7.00	14.00	760.56
	5710	12/7/2010	12/13/2010	740.56	2	7.00	14.00	740.56
	5808	1/11/2011	1/18/2011	740.30	2	14.03	28.06	740.30
	5882	2/1/2011	2/10/2011	704.76	2	14.03	28.06	704.76
	5972	3/1/2011	3/4/2011	736.38	2	14.03	28.06	736.38
	6075	4/5/2011	4/20/2011	648.88	2	14.03	28.06	648.88
	6174	5/2/2011	5/6/2011	512.20	2	14.03	28.06	512.20
	6325	6/15/2011	6/24/2011	531.00	2	14.03	28.06	531.00
	6401	7/11/2011	7/15/2011	494.48	2	14.03	28.06	494.48
	6469	8/9/2011	8/19/2011	397.04	2	14.03	28.06	397.04
	6545	9/13/2011	9/16/2011	461.88	2	14.03	28.06	461.88
	6619	10/10/2011	10/14/2011	323.52	2	14.03	28.06	323.52
	6692	11/1/2011	11/4/2011	370.18	2	14.03	28.06	370.18
	6796	12/12/2011	12/16/2011	459.02	2	14.40	28.80	459.02
	6882	1/17/2012	1/23/2012	496.08	2	14.40	28.80	496.08
	6934	2/7/2012	2/10/2012	382.54	2	14.40	28.80	382.54
	7035	3/13/2012	3/16/2012	376.90	2	14.40	28.80	376.90
	7105	4/10/2012	4/13/2012	143.80	2	14.40	28.80	143.80
	7183	5/8/2012	5/15/2012	239.76	2	14.40	28.80	239.76
	7262	6/11/2012	6/18/2012	131.74	2	14.40	28.80	131.74
	7333	7/10/2012	7/13/2012	125.18	2	14.40	28.80	125.18
	7449	8/13/2012	8/17/2012	103.14	2	14.40	28.80	103.14
	7527	9/10/2012	9/14/2012	337.64	2	14.40	28.80	337.64
	7573	10/1/2012	10/5/2012	358.46	2	14.40	28.80	358.46
	7713	11/12/2012	11/16/2012	318.78	2	17.29	34.58	318.78
	7801	12/10/2012	12/14/2012	352.86	2	17.29	34.58	352.86

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 5e	4030	5/27/2009	5/29/2009	143.28	2	14.93	29.86	143.28
	4067	6/8/2009	6/12/2009	65.66	2	14.93	29.86	65.66
	4141	7/21/2009	7/24/2009	175.06	2	15.17	30.34	175.06
	4202	8/11/2009	8/17/2009	33.02	2	15.17	30.34	33.02
	4276	9/15/2009	9/18/2009	172.86	2	15.17	30.34	172.86
	4317	10/5/2009	10/12/2009	129.82	2	15.17	30.34	129.82
	4402	11/9/2009	11/16/2009	406.36	2	15.17	30.34	406.36
	4533	12/30/2009	1/12/2010	468.60	2	15.17	30.34	468.60
	4597	1/20/2010	1/22/2010	408.40	2	15.17	30.34	408.40
	4682	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4835	3/17/2010	3/29/2010	575.58	2	15.17	30.34	575.58
	4917	4/13/2010	4/20/2010	510.30	2	15.17	30.34	510.30
	5052	5/17/2010	5/24/2010	747.14	2	15.17	30.34	747.14
	5177	6/15/2010	6/21/2010	N.D.	2	7.00	14.00	7.00
	5312	7/27/2010	8/2/2010	601.06	2	7.00	14.00	601.06
	5398	8/25/2010	8/30/2010	688.94	2	7.00	14.00	688.94
	5452	9/14/2010	9/20/2010	792.94	2	7.00	14.00	792.94
	5571	10/20/2010	10/25/2010	655.86	2	7.00	14.00	655.86
	5663	11/16/2010	11/22/2010	756.48	2	7.00	14.00	756.48
	5720	12/8/2010	12/13/2010	583.38	2	7.00	14.00	583.38
	5818	1/12/2011	1/18/2011	709.40	2	14.03	28.06	709.40
	5894	2/7/2011	2/10/2011	677.24	2	14.03	28.06	677.24
	5982	3/2/2011	3/4/2011	683.92	2	14.03	28.06	683.92
	6085	4/5/2011	4/20/2011	608.70	2	14.03	28.06	608.70
	6184	5/3/2011	5/6/2011	731.70	2	14.03	28.06	731.70
	6335	6/16/2011	6/24/2011	689.48	2	14.03	28.06	689.48
	6411	7/12/2011	7/15/2011	640.36	2	14.03	28.06	640.36
	6479	8/9/2011	8/19/2011	646.18	2	14.03	28.06	646.18
	6557	9/14/2011	9/16/2011	671.18	2	14.03	28.06	671.18
	6629	10/11/2011	10/14/2011	673.00	2	14.03	28.06	673.00
	6702	11/1/2011	11/4/2011	604.10	2	14.03	28.06	604.10
	6806	12/13/2011	12/16/2011	558.76	2	14.40	28.80	558.76
	6892	1/17/2012	1/23/2012	648.78	2	14.40	28.80	648.78
	6943	2/7/2012	2/10/2012	606.14	2	14.40	28.80	606.14
	7044	3/13/2012	3/16/2012	533.38	2	14.40	28.80	533.38
	7114	4/10/2012	4/13/2012	484.22	2	14.40	28.80	484.22
	7192	5/9/2012	5/15/2012	425.66	2	14.40	28.80	425.66
	7271	6/11/2012	6/18/2012	337.64	2	14.40	28.80	337.64
	7342	7/10/2012	7/13/2012	381.12	2	14.40	28.80	381.12

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 5i	4026	5/27/2009	5/29/2009	68.62	2	14.93	29.86	68.62
	4071	6/9/2009	6/12/2009	95.90	2	14.93	29.86	95.90
	4132	7/20/2009	7/24/2009	198.24	2	15.17	30.34	198.24
	4193	8/11/2009	8/17/2009	250.44	2	15.17	30.34	250.44
	4267	9/14/2009	9/18/2009	N.D.	2	15.17	30.34	15.17
	4308	10/5/2009	10/12/2009	371.50	2	15.17	30.34	371.50
	4411	11/11/2009	11/16/2009	429.94	2	15.17	30.34	429.94
	4524	12/30/2009	1/12/2010	576.48	2	15.17	30.34	576.48
	4588	1/19/2010	1/22/2010	312.66	2	15.17	30.34	312.66
	4673	2/9/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4826	3/16/2010	3/29/2010	649.22	2	15.17	30.34	649.22
	4927	4/14/2010	4/20/2010	480.98	2	15.17	30.34	480.98
	5043	5/17/2010	5/24/2010	386.14	2	15.17	30.34	386.14
	5168	6/14/2010	6/21/2010	N.D.	2	7.00	14.00	7.00
	5303	7/26/2010	8/2/2010	593.42	2	7.00	14.00	593.42
	5389	8/24/2010	8/30/2010	606.30	2	7.00	14.00	606.30
	5443	9/13/2010	9/20/2010	790.44	2	7.00	14.00	790.44
	5562	10/19/2010	10/25/2010	764.12	2	7.00	14.00	764.12
	5654	11/15/2010	11/22/2010	686.16	2	7.00	14.00	686.16
	5711	12/7/2010	12/13/2010	636.06	2	7.00	14.00	636.06
	5809	1/11/2011	1/18/2011	647.44	2	14.03	28.06	647.44
	5883	2/1/2011	2/10/2011	580.90	2	14.03	28.06	580.90
	5973	3/1/2011	3/4/2011	636.12	2	14.03	28.06	636.12
	6076	4/5/2011	4/20/2011	698.90	2	14.03	28.06	698.90
	6175	5/2/2011	5/6/2011	695.86	2	14.03	28.06	695.86
	6326	6/15/2011	6/24/2011	608.70	2	14.03	28.06	608.70
	6402	7/11/2011	7/15/2011	715.64	2	14.03	28.06	715.64
	6470	8/9/2011	8/19/2011	631.96	2	14.03	28.06	631.96
	6546	9/13/2011	9/16/2011	564.12	2	14.03	28.06	564.12
	6620	10/10/2011	10/14/2011	449.38	2	14.03	28.06	449.38
	6693	11/1/2011	11/4/2011	421.78	2	14.03	28.06	421.78
	6797	12/12/2011	12/16/2011	502.48	2	14.40	28.80	502.48
	6883	1/17/2012	1/23/2012	517.00	2	14.40	28.80	517.00
	6935	2/7/2012	2/10/2012	442.04	2	14.40	28.80	442.04
	7036	3/13/2012	3/16/2012	421.60	2	14.40	28.80	421.60
	7106	4/10/2012	4/13/2012	312.30	2	14.40	28.80	312.30
	7184	5/8/2012	5/15/2012	279.52	2	14.40	28.80	279.52
	7263	6/11/2012	6/18/2012	258.10	2	14.40	28.80	258.10
	7334	7/10/2012	7/13/2012	325.82	2	14.40	28.80	325.82
	7450	8/13/2012	8/17/2012	223.98	2	14.40	28.80	223.98
	7528	9/10/2012	9/14/2012	364.56	2	14.40	28.80	364.56
	7574	10/1/2012	10/5/2012	387.78	2	14.40	28.80	387.78
	7714	11/12/2012	11/16/2012	354.74	2	17.29	34.58	354.74
	7802	12/10/2012	12/14/2012	362.94	2	17.29	34.58	362.94

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 4e	4029	5/27/2009	5/29/2009	52.26	2	14.93	29.86	52.26
	4066	6/8/2009	6/12/2009	29.26	2	14.93	29.86	14.93
	4142	7/21/2009	7/24/2009	145.02	2	15.17	30.34	145.02
	4203	8/13/2009	8/17/2009	256.40	2	15.17	30.34	256.40
	4277	9/15/2009	9/18/2009	239.74	2	15.17	30.34	239.74
	4318	10/5/2009	10/12/2009	107.02	2	15.17	30.34	107.02
	4401	11/9/2009	11/16/2009	293.96	2	15.17	30.34	293.96
	4534	12/30/2009	1/12/2010	525.70	2	15.17	30.34	525.70
	4598	1/20/2010	1/22/2010	298.72	2	15.17	30.34	298.72
	4683	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4836	3/17/2010	3/29/2010	512.92	2	15.17	30.34	512.92
	4918	4/13/2010	4/20/2010	516.80	2	15.17	30.34	516.80
	5053	5/17/2010	5/24/2010	479.40	2	15.17	30.34	479.40
	5178	6/15/2010	6/21/2010	144.16	2	7.00	14.00	144.16
	5313	7/27/2010	8/2/2010	597.18	2	7.00	14.00	597.18
	5399	8/25/2010	8/30/2010	779.30	2	7.00	14.00	779.30
	5453	9/14/2010	9/20/2010	561.66	2	7.00	14.00	561.66
	5572	10/20/2010	10/25/2010	643.42	2	7.00	14.00	643.42
	5664	11/16/2010	11/22/2010	640.36	2	7.00	14.00	640.36
	5721	12/8/2010	12/13/2010	570.10	2	7.00	14.00	570.10
	5819	1/12/2011	1/18/2011	656.70	2	14.03	28.06	656.70
	5895	2/7/2011	2/10/2011	479.42	2	14.03	28.06	479.42
	5983	3/2/2011	3/4/2011	561.46	2	14.03	28.06	561.46

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 4i	4025	5/27/2009	5/29/2009	46.62	2	14.93	29.86	46.62
	4070	6/9/2009	6/12/2009	66.00	2	14.93	29.86	66.00
	4133	7/20/2009	7/24/2009	162.30	2	15.17	30.34	162.30
	4194	8/11/2009	8/17/2009	184.72	2	15.17	30.34	184.72
	4268	9/14/2009	9/18/2009	N.D.	2	15.17	30.34	15.17
	4309	10/5/2009	10/12/2009	167.38	2	15.17	30.34	167.38
	4410	11/11/2009	11/16/2009	390.88	2	15.17	30.34	390.88
	4525	12/30/2009	1/12/2010	476.76	2	15.17	30.34	476.76
	4589	1/19/2010	1/22/2010	302.16	2	15.17	30.34	302.16
	4674	2/9/2010	2/12/2010	73.90	2	15.17	30.34	73.90
	4827	3/16/2010	3/29/2010	532.06	2	15.17	30.34	532.06
	4928	4/14/2010	4/20/2010	91.48	2	15.17	30.34	91.48
	5044	5/17/2010	5/24/2010	537.96	2	15.17	30.34	537.96
	5169	6/14/2010	6/21/2010	111.78	2	7.00	14.00	111.78
	5304	7/26/2010	8/2/2010	275.10	2	7.00	14.00	275.10
	5390	8/24/2010	8/30/2010	709.50	2	7.00	14.00	709.50
	5444	9/13/2010	9/20/2010	728.04	2	7.00	14.00	728.04
	5563	10/19/2010	10/25/2010	670.12	2	7.00	14.00	670.12
	5655	11/15/2010	11/22/2010	672.26	2	7.00	14.00	672.26
	5712	12/7/2010	12/13/2010	610.84	2	7.00	14.00	610.84
	5810	1/11/2011	1/18/2011	597.58	2	14.03	28.06	597.58
	5884	2/1/2011	2/10/2011	N.D.	2	14.03	28.06	14.03
	5974	3/1/2011	3/4/2011	622.32	2	14.03	28.06	622.32
	6077	4/5/2011	4/20/2011	734.34	2	14.03	28.06	734.34
	6176	5/2/2011	5/6/2011	663.88	2	14.03	28.06	663.88
	6327	6/15/2011	6/24/2011	583.40	2	14.03	28.06	583.40
	6403	7/11/2011	7/15/2011	629.18	2	14.03	28.06	629.18
	6471	8/9/2011	8/19/2011	445.40	2	14.03	28.06	445.40
	6547	9/13/2011	9/16/2011	428.76	2	14.03	28.06	428.76
	6621	10/10/2011	10/14/2011	357.76	2	14.03	28.06	357.76
	6694	11/1/2011	11/4/2011	381.34	2	14.03	28.06	381.34
	6798	12/12/2011	12/16/2011	552.18	2	14.40	28.80	552.18
	6884	1/17/2012	1/23/2012	550.82	2	14.40	28.80	550.82
	6936	2/7/2012	2/10/2012	457.42	2	14.40	28.80	457.42
	7037	3/13/2012	3/16/2012	389.74	2	14.40	28.80	389.74
	7107	4/10/2012	4/13/2012	312.08	2	14.40	28.80	312.08
	7185	5/8/2012	5/15/2012	290.96	2	14.40	28.80	290.96
	7264	6/11/2012	6/18/2012	282.70	2	14.40	28.80	282.70
	7335	7/10/2012	7/13/2012	327.42	2	14.40	28.80	327.42
	7451	8/13/2012	8/17/2012	266.40	2	14.40	28.80	266.40
	7529	9/10/2012	9/14/2012	370.90	2	14.40	28.80	370.90
	7575	10/1/2012	10/5/2012	398.82	2	14.40	28.80	398.82
	7715	11/12/2012	11/16/2012	371.26	2	17.29	34.58	371.26
	7803	12/10/2012	12/14/2012	383.66	2	17.29	34.58	383.66

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 3e	4019	5/26/2009	5/29/2009	135.72	2	14.93	29.86	135.72
	4077	6/10/2009	6/12/2009	46.60	2	14.93	29.86	46.60
	4143	7/21/2009	7/24/2009	137.72	2	15.17	30.34	137.72
	4204	8/13/2009	8/17/2009	160.64	2	15.17	30.34	160.64
	4278	9/15/2009	9/18/2009	166.84	2	15.17	30.34	166.84
	4319	10/5/2009	10/12/2009	33.06	2	15.17	30.34	33.06
	4400	11/9/2009	11/16/2009	391.36	2	15.17	30.34	391.36
	4535	12/30/2009	1/12/2010	538.14	2	15.17	30.34	538.14
	4599	1/20/2010	1/22/2010	407.96	2	15.17	30.34	407.96
	4684	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4837	3/17/2010	3/29/2010	554.86	2	15.17	30.34	554.86
	4919	4/13/2010	4/20/2010	458.06	2	15.17	30.34	458.06
	5054	5/17/2010	5/24/2010	377.58	2	15.17	30.34	377.58
	5179	6/15/2010	6/21/2010	N.D.	2	7.00	14.00	7.00
	5314	7/27/2010	8/2/2010	647.24	2	7.00	14.00	647.24
	5400	8/25/2010	8/30/2010	241.08	2	7.00	14.00	241.08
	5454	9/14/2010	9/20/2010	622.18	2	7.00	14.00	622.18
	5573	10/20/2010	10/25/2010	533.98	2	7.00	14.00	533.98
	5665	11/16/2010	11/22/2010	691.12	2	7.00	14.00	691.12
	5722	12/8/2010	12/13/2010	620.50	2	7.00	14.00	620.50
	5820	1/12/2011	1/18/2011	656.18	2	14.03	28.06	656.18
	5896	2/7/2011	2/10/2011	661.56	2	14.03	28.06	661.56
	5984	3/2/2011	3/4/2011	573.94	2	14.03	28.06	573.94
	6087	4/6/2011	4/20/2011	676.52	2	14.03	28.06	676.52
	6185	5/3/2011	5/6/2011	662.62	2	14.03	28.06	662.62
	6336	6/16/2011	6/24/2011	674.22	2	14.03	28.06	674.22
	6412	7/12/2011	7/15/2011	635.28	2	14.03	28.06	635.28
	6480	8/9/2011	8/19/2011	663.40	2	14.03	28.06	663.40
	6558	9/14/2011	9/16/2011	626.82	2	14.03	28.06	626.82
	6630	10/11/2011	10/14/2011	628.78	2	14.03	28.06	628.78
	6703	11/1/2011	11/4/2011	605.58	2	14.03	28.06	605.58
	6807	12/13/2011	12/16/2011	552.70	2	14.40	28.80	552.70
	6893	1/17/2012	1/23/2012	590.80	2	14.40	28.80	590.80
	6944	2/7/2012	2/10/2012	533.58	2	14.40	28.80	533.58
	7045	3/13/2012	3/16/2012	524.88	2	14.40	28.80	524.88
	7115	4/10/2012	4/13/2012	407.36	2	14.40	28.80	407.36
	7193	5/9/2012	5/15/2012	353.58	2	14.40	28.80	353.58
	7272	6/11/2012	6/18/2012	322.22	2	14.40	28.80	322.22
	7343	7/10/2012	7/13/2012	298.32	2	14.40	28.80	298.32
	7459	8/13/2012	8/17/2012	188.78	2	14.40	28.80	188.78
	7536	9/10/2012	9/14/2012	351.60	2	14.40	28.80	351.60
	7582	10/2/2012	10/5/2012	408.14	2	14.40	28.80	408.14
	7722	11/13/2012	11/16/2012	395.10	2	17.29	34.58	395.10
	7810	12/11/2012	12/14/2012	415.32	2	17.29	34.58	415.32

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 3i	4024	5/27/2009	5/29/2009	15.48	2	14.93	29.86	14.93
	4079	6/10/2009	6/12/2009	40.10	2	14.93	29.86	40.10
	4134	7/20/2009	7/24/2009	65.92	2	15.17	30.34	65.92
	4195	8/11/2009	8/17/2009	120.62	2	15.17	30.34	120.62
	4269	9/14/2009	9/18/2009	130.34	2	15.17	30.34	130.34
	4310	10/5/2009	10/12/2009	23.22	2	15.17	30.34	15.17
	4409	11/11/2009	11/16/2009	317.70	2	15.17	30.34	317.70
	4526	12/30/2009	1/12/2010	410.20	2	15.17	30.34	410.20
	4590	1/19/2010	1/22/2010	N.D.	2	15.17	30.34	15.17
	4675	2/9/2010	2/12/2010	92.42	2	15.17	30.34	92.42
	4828	3/16/2010	3/29/2010	484.76	2	15.17	30.34	484.76
	4929	4/14/2010	4/20/2010	331.22	2	15.17	30.34	331.22
	5045	5/17/2010	5/24/2010	408.70	2	15.17	30.34	408.70
	5170	6/15/2010	6/21/2010	491.76	2	7.00	14.00	491.76
	5305	7/26/2010	8/2/2010	N.D.	2	7.00	14.00	7.00
	5391	8/24/2010	8/30/2010	824.28	2	7.00	14.00	824.28
	5445	9/13/2010	9/20/2010	177.42	2	7.00	14.00	177.42
	5564	10/19/2010	10/25/2010	658.14	2	7.00	14.00	658.14
	5656	11/15/2010	11/22/2010	693.76	2	7.00	14.00	693.76
	5713	12/7/2010	12/13/2010	653.24	2	7.00	14.00	653.24
	5811	1/11/2011	1/18/2011	539.18	2	14.03	28.06	539.18
	5885	2/1/2011	2/10/2011	610.30	2	14.03	28.06	610.30
	5975	3/1/2011	3/4/2011	567.88	2	14.03	28.06	567.88
	6078	4/5/2011	4/20/2011	647.26	2	14.03	28.06	647.26
	6177	5/2/2011	5/6/2011	579.32	2	14.03	28.06	579.32
	6328	6/16/2011	6/24/2011	604.84	2	14.03	28.06	604.84
	6404	7/11/2011	7/15/2011	592.78	2	14.03	28.06	592.78
	6472	8/9/2011	8/19/2011	589.06	2	14.03	28.06	589.06
	6548	9/13/2011	9/16/2011	586.56	2	14.03	28.06	586.56
	6622	10/10/2011	10/14/2011	543.54	2	14.03	28.06	543.54
	6695	11/1/2011	11/4/2011	476.68	2	14.03	28.06	476.68
	6799	12/12/2011	12/16/2011	538.20	2	14.40	28.80	538.20
	6885	1/17/2012	1/23/2012	557.32	2	14.40	28.80	557.32
	6937	2/7/2012	2/10/2012	489.38	2	14.40	28.80	489.38
	7038	3/13/2012	3/16/2012	446.26	2	14.40	28.80	446.26
	7108	4/10/2012	4/13/2012	403.18	2	14.40	28.80	403.18
	7186	5/8/2012	5/15/2012	322.48	2	14.40	28.80	322.48
	7265	6/11/2012	6/18/2012	251.78	2	14.40	28.80	251.78
	7336	7/10/2012	7/13/2012	195.46	2	14.40	28.80	195.46
	7452	8/13/2012	8/17/2012	141.14	2	14.40	28.80	141.14
	7530	9/10/2012	9/14/2012	324.08	2	14.40	28.80	324.08
	7576	10/1/2012	10/5/2012	344.38	2	14.40	28.80	344.38
	7716	11/12/2012	11/16/2012	351.76	2	17.29	34.58	351.76
	7804	12/10/2012	12/14/2012	381.98	2	17.29	34.58	381.98

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 2e	4018	5/26/2009	5/29/2009	119.42	2	14.93	29.86	119.42
	4076	6/10/2009	6/12/2009	40.70	2	14.93	29.86	40.70
	4144	7/22/2009	7/24/2009	21.58	2	15.17	30.34	15.17
	4205	8/13/2009	8/17/2009	41.80	2	15.17	30.34	41.80
	4279	9/15/2009	9/18/2009	33.74	2	15.17	30.34	33.74
	4320	10/6/2009	10/12/2009	N.D.	2	15.17	30.34	15.17
	4399	11/9/2009	11/16/2009	360.32	2	15.17	30.34	360.32
	4536	12/30/2009	1/12/2010	447.06	2	15.17	30.34	447.06
	4600	1/20/2010	1/22/2010	412.04	2	15.17	30.34	412.04
	4685	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4838	3/17/2010	3/29/2010	401.50	2	15.17	30.34	401.50
	4920	4/13/2010	4/20/2010	384.86	2	15.17	30.34	384.86
	5055	5/17/2010	5/24/2010	450.50	2	15.17	30.34	450.50
	5180	6/16/2010	6/21/2010	N.D.	2	7.00	14.00	7.00
	5315	7/27/2010	8/2/2010	252.22	2	7.00	14.00	252.22
	5401	8/25/2010	8/30/2010	453.70	2	7.00	14.00	453.70
	5455	9/14/2010	9/20/2010	505.30	2	7.00	14.00	505.30
	5574	10/20/2010	10/25/2010	164.70	2	7.00	14.00	164.70
	5666	11/16/2010	11/22/2010	478.96	2	7.00	14.00	478.96
	5723	12/8/2010	12/13/2010	477.24	2	7.00	14.00	477.24
	5821	1/12/2011	1/18/2011	530.64	2	14.03	28.06	530.64
	5897	2/7/2011	2/10/2011	498.90	2	14.03	28.06	498.90
	5985	3/2/2011	3/4/2011	456.92	2	14.03	28.06	456.92
	6088	4/6/2011	4/20/2011	573.66	2	14.03	28.06	573.66
	6186	5/3/2011	5/6/2011	435.26	2	14.03	28.06	435.26
	6337	6/16/2011	6/24/2011	549.10	2	14.03	28.06	549.10
	6413	7/12/2011	7/15/2011	472.86	2	14.03	28.06	472.86
	6481	8/9/2011	8/19/2011	416.32	2	14.03	28.06	416.32
	6559	9/14/2011	9/16/2011	465.28	2	14.03	28.06	465.28
	6631	10/11/2011	10/14/2011	327.84	2	14.03	28.06	327.84
	6704	11/1/2011	11/4/2011	426.68	2	14.03	28.06	426.68
	6808	12/13/2011	12/16/2011	506.18	2	14.40	28.80	506.18
	6894	1/17/2012	1/23/2012	552.66	2	14.40	28.80	552.66
	6945	2/7/2012	2/10/2012	432.98	2	14.40	28.80	432.98
	7046	3/13/2012	3/16/2012	424.60	2	14.40	28.80	424.60
	7116	4/10/2012	4/13/2012	348.22	2	14.40	28.80	348.22
	7194	5/9/2012	5/15/2012	259.10	2	14.40	28.80	259.10
	7273	6/11/2012	6/18/2012	249.62	2	14.40	28.80	249.62
	7344	7/10/2012	7/13/2012	269.48	2	14.40	28.80	269.48
	7460	8/13/2012	8/17/2012	274.92	2	14.40	28.80	274.92
	7537	9/10/2012	9/14/2012	319.26	2	14.40	28.80	319.26
	7583	10/2/2012	10/5/2012	382.74	2	14.40	28.80	382.74
	7723	11/13/2012	11/16/2012	363.98	2	17.29	34.58	363.98
	7811	12/11/2012	12/14/2012	386.38	2	17.29	34.58	386.38

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 2i	4023	5/27/2009	5/29/2009	N.D.	2	14.93	29.86	14.93
	4078	6/10/2009	6/12/2009	9.74	2	14.93	29.86	14.93
	4135	7/20/2009	7/24/2009	18.58	2	15.17	30.34	15.17
	4196	8/11/2009	8/17/2009	39.14	2	15.17	30.34	39.14
	4270	9/14/2009	9/18/2009	27.80	2	15.17	30.34	15.17
	4311	10/5/2009	10/12/2009	123.80	2	15.17	30.34	123.80
	4408	11/11/2009	11/16/2009	360.98	2	15.17	30.34	360.98
	4527	12/30/2009	1/12/2010	345.20	2	15.17	30.34	345.20
	4591	1/19/2010	1/22/2010	212.78	2	15.17	30.34	212.78
	4676	2/9/2010	2/12/2010	100.50	2	15.17	30.34	100.50
	4829	3/16/2010	3/29/2010	315.38	2	15.17	30.34	315.38
	4930	4/14/2010	4/20/2010	465.72	2	15.17	30.34	465.72
	5046	5/17/2010	5/24/2010	359.90	2	15.17	30.34	359.90
	5171	6/15/2010	6/21/2010	297.24	2	7.00	14.00	297.24
	5306	7/26/2010	8/2/2010	106.64	2	7.00	14.00	106.64
	5392	8/24/2010	8/30/2010	484.80	2	7.00	14.00	484.80
	5446	9/13/2010	9/20/2010	525.82	2	7.00	14.00	525.82
	5565	10/19/2010	10/25/2010	466.74	2	7.00	14.00	466.74
	5657	11/15/2010	11/22/2010	516.38	2	7.00	14.00	516.38
	5714	12/7/2010	12/13/2010	479.42	2	7.00	14.00	479.42
	5812	1/11/2011	1/18/2011	445.86	2	14.03	28.06	445.86
	5886	2/1/2011	2/10/2011	479.84	2	14.03	28.06	479.84
	5976	3/1/2011	3/4/2011	417.06	2	14.03	28.06	417.06
	6079	4/5/2011	4/20/2011	501.76	2	14.03	28.06	501.76
	6178	5/2/2011	5/6/2011	373.08	2	14.03	28.06	373.08
	6329	6/16/2011	6/24/2011	505.80	2	14.03	28.06	505.80
	6405	7/11/2011	7/15/2011	460.76	2	14.03	28.06	460.76
	6473	8/9/2011	8/19/2011	353.70	2	14.03	28.06	353.70
	6549	9/13/2011	9/16/2011	468.10	2	14.03	28.06	468.10
	6623	10/10/2011	10/14/2011	332.94	2	14.03	28.06	332.94
	6696	11/1/2011	11/4/2011	399.78	2	14.03	28.06	399.78
	6800	12/12/2011	12/16/2011	494.62	2	14.40	28.80	494.62
	6886	1/17/2012	1/23/2012	486.72	2	14.40	28.80	486.72
	6938	2/7/2012	2/10/2012	375.26	2	14.40	28.80	375.26
	7039	3/13/2012	3/16/2012	344.34	2	14.40	28.80	344.34
	7109	4/10/2012	4/13/2012	209.40	2	14.40	28.80	209.40
	7187	5/8/2012	5/15/2012	217.40	2	14.40	28.80	217.40
	7266	6/11/2012	6/18/2012	146.80	2	14.40	28.80	146.80
	7337	7/10/2012	7/13/2012	142.92	2	14.40	28.80	142.92
	7453	8/13/2012	8/17/2012	114.18	2	14.40	28.80	114.18
	7531	9/10/2012	9/14/2012	357.32	2	14.40	28.80	357.32
	7577	10/1/2012	10/5/2012	384.32	2	14.40	28.80	384.32
	7717	11/12/2012	11/16/2012	317.22	2	17.29	34.58	317.22
	7805	12/10/2012	12/14/2012	356.80	2	17.29	34.58	356.80

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 1e	4016	5/26/2009	5/29/2009	N.D.	2	14.93	29.86	14.93
	4074	6/9/2009	6/12/2009	N.D.	2	14.93	29.86	14.93
	4145	7/22/2009	7/24/2009	N.D.	2	15.17	30.34	15.17
	4206	8/13/2009	8/17/2009	N.D.	2	15.17	30.34	15.17
	4280	9/15/2009	9/18/2009	N.D.	2	15.17	30.34	15.17
	4321	10/6/2009	10/12/2009	239.96	2	15.17	30.34	239.96
	4397	11/9/2009	11/16/2009	350.24	2	15.17	30.34	350.24
	4537	12/30/2009	1/12/2010	390.52	2	15.17	30.34	390.52
	4601	1/20/2010	1/22/2010	267.72	2	15.17	30.34	267.72
	4686	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4839	3/17/2010	3/29/2010	319.58	2	15.17	30.34	319.58
	4923	4/14/2010	4/20/2010	384.86	2	15.17	30.34	384.86
	5056	5/18/2010	5/24/2010	N.D.	2	15.17	30.34	15.17
	5181	6/16/2010	6/21/2010	N.D.	2	7.00	14.00	7.00
	5316	7/27/2010	8/2/2010	307.08	2	7.00	14.00	307.08
	5402	8/25/2010	8/30/2010	223.64	2	7.00	14.00	223.64
	5456	9/14/2010	9/20/2010	270.82	2	7.00	14.00	270.82
	5575	10/20/2010	10/25/2010	355.54	2	7.00	14.00	355.54
	5667	11/16/2010	11/22/2010	451.70	2	7.00	14.00	451.70
	5724	12/8/2010	12/13/2010	347.96	2	7.00	14.00	347.96
	5822	1/12/2011	1/18/2011	460.36	2	14.03	28.06	460.36
	5890	2/1/2011	2/10/2011	371.40	2	14.03	28.06	371.40
	5986	3/2/2011	3/4/2011	391.48	2	14.03	28.06	391.48
	6089	4/6/2011	4/20/2011	480.62	2	14.03	28.06	480.62
	6187	5/4/2011	5/6/2011	345.60	2	14.03	28.06	345.60
	6338	6/16/2011	6/24/2011	488.10	2	14.03	28.06	488.10
	6414	7/12/2011	7/15/2011	283.24	2	14.03	28.06	283.24
	6482	8/9/2011	8/19/2011	143.48	2	14.03	28.06	143.48
	6560	9/14/2011	9/16/2011	410.04	2	14.03	28.06	410.04
	6634	10/11/2011	10/14/2011	305.92	2	14.03	28.06	305.92
	6707	11/1/2011	11/4/2011	388.88	2	14.03	28.06	388.88
	6811	12/13/2011	12/16/2011	494.32	2	14.40	28.80	494.32
	6897	1/17/2012	1/23/2012	501.80	2	14.40	28.80	501.80
	6948	2/7/2012	2/10/2012	414.88	2	14.40	28.80	414.88
	7049	3/13/2012	3/16/2012	376.52	2	14.40	28.80	376.52
	7119	4/10/2012	4/13/2012	322.28	2	14.40	28.80	322.28
	7197	5/9/2012	5/15/2012	278.46	2	14.40	28.80	278.46
	7276	6/11/2012	6/18/2012	219.08	2	14.40	28.80	219.08
	7347	7/10/2012	7/13/2012	79.50	2	14.40	28.80	79.50
	7463	8/14/2012	8/17/2012	203.66	2	14.40	28.80	203.66
	7540	9/10/2012	9/14/2012	281.34	2	14.40	28.80	281.34
	7586	10/2/2012	10/5/2012	329.02	2	14.40	28.80	329.02
	7726	11/13/2012	11/16/2012	356.44	2	17.29	34.58	356.44
	7814	12/11/2012	12/14/2012	424.38	2	17.29	34.58	424.38

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Room 1i	4020	5/27/2009	5/29/2009	N.D.	2	14.93	29.86	14.93
	4061	6/8/2009	6/12/2009	N.D.	2	14.93	29.86	14.93
	4136	7/20/2009	7/24/2009	N.D.	2	15.17	30.34	15.17
	4197	8/11/2009	8/17/2009	N.D.	2	15.17	30.34	15.17
	4271	9/14/2009	9/18/2009	N.D.	2	15.17	30.34	15.17
	4312	10/5/2009	10/12/2009	197.06	2	15.17	30.34	197.06
	4407	11/11/2009	11/16/2009	173.66	2	15.17	30.34	173.66
	4528	12/30/2009	1/12/2010	340.76	2	15.17	30.34	340.76
	4592	1/19/2010	1/22/2010	231.74	2	15.17	30.34	231.74
	4677	2/9/2010	2/12/2010	93.12	2	15.17	30.34	93.12
	4830	3/16/2010	3/29/2010	163.52	2	15.17	30.34	163.52
	4931	4/14/2010	4/20/2010	408.26	2	15.17	30.34	408.26
	5047	5/17/2010	5/24/2010	342.24	2	15.17	30.34	342.24
	5172	6/15/2010	6/21/2010	218.42	2	7.00	14.00	218.42
	5307	7/26/2010	8/2/2010	125.26	2	7.00	14.00	125.26
	5393	8/24/2010	8/30/2010	333.46	2	7.00	14.00	333.46
	5447	9/13/2010	9/20/2010	328.02	2	7.00	14.00	328.02
	5566	10/19/2010	10/25/2010	427.46	2	7.00	14.00	427.46
	5658	11/15/2010	11/22/2010	443.82	2	7.00	14.00	443.82
	5715	12/7/2010	12/13/2010	455.58	2	7.00	14.00	455.58
	5813	1/11/2011	1/18/2011	362.94	2	14.03	28.06	362.94
	5887	2/1/2011	2/10/2011	353.66	2	14.03	28.06	353.66
	5977	3/1/2011	3/4/2011	370.72	2	14.03	28.06	370.72
	6080	4/5/2011	4/20/2011	414.54	2	14.03	28.06	414.54
	6179	5/2/2011	5/6/2011	252.54	2	14.03	28.06	252.54
	6330	6/16/2011	6/24/2011	519.66	2	14.03	28.06	519.66
	6406	7/11/2011	7/15/2011	411.26	2	14.03	28.06	411.26
	6474	8/9/2011	8/19/2011	300.02	2	14.03	28.06	300.02
	6550	9/13/2011	9/16/2011	429.54	2	14.03	28.06	429.54
	6624	10/10/2011	10/14/2011	294.66	2	14.03	28.06	294.66
	6697	11/1/2011	11/4/2011	365.72	2	14.03	28.06	365.72
	6801	12/12/2011	12/16/2011	483.68	2	14.40	28.80	483.68
	6887	1/17/2012	1/23/2012	505.60	2	14.40	28.80	505.60
	6939	2/7/2012	2/10/2012	412.76	2	14.40	28.80	412.76
	7040	3/13/2012	3/16/2012	362.80	2	14.40	28.80	362.80
	7110	4/10/2012	4/13/2012	192.06	2	14.40	28.80	192.06
	7188	5/8/2012	5/15/2012	191.24	2	14.40	28.80	191.24
	7267	6/11/2012	6/18/2012	134.02	2	14.40	28.80	134.02
	7338	7/10/2012	7/13/2012	151.34	2	14.40	28.80	151.34
	7454	8/13/2012	8/17/2012	114.52	2	14.40	28.80	114.52
	7532	9/10/2012	9/14/2012	334.94	2	14.40	28.80	334.94
	7578	10/1/2012	10/5/2012	332.66	2	14.40	28.80	332.66
	7718	11/13/2012	11/16/2012	364.88	2	17.29	34.58	364.88
	7806	12/10/2012	12/14/2012	376.58	2	17.29	34.58	376.58

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Location EBW	4015	5/26/2009	5/29/2009	N.D.	2	14.93	29.86	14.93
	4065	6/8/2009	6/12/2009	N.D.	2	14.93	29.86	14.93
	4147	7/22/2009	7/24/2009	N.D.	2	15.17	30.34	15.17
	4208	8/13/2009	8/17/2009	N.D.	2	15.17	30.34	15.17
	4282	9/15/2009	9/18/2009	N.D.	2	15.17	30.34	15.17
	4323	10/6/2009	10/12/2009	105.10	2	15.17	30.34	105.10
	4396	11/9/2009	11/16/2009	141.00	2	15.17	30.34	141.00
	4539	12/30/2009	1/12/2010	235.40	2	15.17	30.34	235.40
	4603	1/20/2010	1/22/2010	270.16	2	15.17	30.34	270.16
	4688	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4841	3/17/2010	3/29/2010	324.28	2	15.17	30.34	324.28
	4921	4/13/2010	4/20/2010	N.D.	2	15.17	30.34	15.17
	5058	5/18/2010	5/24/2010	64.70	2	15.17	30.34	64.70
	5183	6/16/2010	6/21/2010	N.D.	2	7.00	14.00	7.00
	5318	7/27/2010	8/2/2010	137.54	2	7.00	14.00	137.54
	5404	8/25/2010	8/30/2010	60.18	2	7.00	14.00	60.18
	5458	9/14/2010	9/20/2010	N.D.	2	7.00	14.00	7.00
	5577	10/20/2010	10/25/2010	N.D.	2	7.00	14.00	7.00
	5669	11/16/2010	11/22/2010	N.D.	2	7.00	14.00	7.00
	5726	12/8/2010	12/13/2010	149.84	2	7.00	14.00	149.84
	5824	1/12/2011	1/18/2011	268.54	2	14.03	28.06	268.54
	5898	2/7/2011	2/10/2011	316.50	2	14.03	28.06	316.50
	5988	3/2/2011	3/4/2011	281.32	2	14.03	28.06	281.32
	6091	4/6/2011	4/20/2011	182.90	2	14.03	28.06	182.90
	6189	5/4/2011	5/6/2011	42.48	2	14.03	28.06	42.48
	6340	6/16/2011	6/24/2011	206.20	2	14.03	28.06	206.20
	6416	7/12/2011	7/15/2011	68.52	2	14.03	28.06	68.52
	6484	8/9/2011	8/19/2011	45.78	2	14.03	28.06	45.78
	6562	9/14/2011	9/16/2011	109.38	2	14.03	28.06	109.38
	6632	10/11/2011	10/14/2011	51.88	2	14.03	28.06	51.88
	6705	11/1/2011	11/4/2011	183.10	2	14.03	28.06	183.10
	6809	12/13/2011	12/16/2011	214.68	2	14.40	28.80	214.68
	6895	1/17/2012	1/23/2012	152.46	2	14.40	28.80	152.46
	6946	2/7/2012	2/10/2012	126.92	2	14.40	28.80	126.92
	7047	3/13/2012	3/16/2012	169.86	2	14.40	28.80	169.86
	7117	4/10/2012	4/13/2012	158.14	2	14.40	28.80	158.14
	7195	5/9/2012	5/15/2012	274.44	2	14.40	28.80	274.44
	7274	6/11/2012	6/18/2012	181.18	2	14.40	28.80	181.18
	7345	7/10/2012	7/13/2012	93.14	2	14.40	28.80	93.14
	7461	8/13/2012	8/17/2012	274.60	2	14.40	28.80	274.60
	7538	9/10/2012	9/14/2012	105.10	2	14.40	28.80	105.10
	7584	10/2/2012	10/5/2012	110.02	2	14.40	28.80	110.02
	7724	11/13/2012	11/16/2012	157.24	2	17.29	34.58	157.24
	7812	12/11/2012	12/14/2012	312.46	2	17.29	34.58	312.46

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Location EBA	4014	5/26/2009	5/29/2009	N.D.	2	14.93	29.86	14.93
	4064	6/8/2009	6/12/2009	N.D.	2	14.93	29.86	14.93
	4148	7/22/2009	7/24/2009	N.D.	2	15.17	30.34	15.17
	4209	8/13/2009	8/17/2009	N.D.	2	15.17	30.34	15.17
	4283	9/15/2009	9/18/2009	N.D.	2	15.17	30.34	15.17
	4324	10/6/2009	10/12/2009	N.D.	2	15.17	30.34	15.17
	4395	11/9/2009	11/16/2009	N.D.	2	15.17	30.34	15.17
	4540	12/30/2009	1/12/2010	N.D.	2	15.17	30.34	15.17
	4604	1/20/2010	1/22/2010	N.D.	2	15.17	30.34	15.17
	4689	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4842	3/17/2010	3/29/2010	N.D.	2	15.17	30.34	15.17
	4922	4/13/2010	4/20/2010	N.D.	2	15.17	30.34	15.17
	5059	5/18/2010	5/24/2010	N.D.	2	15.17	30.34	15.17
	5184	6/16/2010	6/21/2010	N.D.	2	7.00	14.00	7.00
	5319	7/27/2010	8/2/2010	N.D.	2	7.00	14.00	7.00
	5405	8/25/2010	8/30/2010	N.D.	2	7.00	14.00	7.00
	5459	9/14/2010	9/20/2010	N.D.	2	7.00	14.00	7.00
	5578	10/20/2010	10/25/2010	N.D.	2	7.00	14.00	7.00
	5670	11/16/2010	11/22/2010	N.D.	2	7.00	14.00	7.00
	5727	12/8/2010	12/13/2010	N.D.	2	7.00	14.00	7.00
	5825	1/12/2011	1/18/2011	N.D.	2	14.03	28.06	14.03
	5899	2/7/2011	2/10/2011	N.D.	2	14.03	28.06	14.03
	5989	3/2/2011	3/4/2011	N.D.	2	14.03	28.06	14.03
	6092	4/6/2011	4/20/2011	N.D.	2	14.03	28.06	14.03
	6190	5/4/2011	5/6/2011	N.D.	2	14.03	28.06	14.03
	6341	6/16/2011	6/24/2011	N.D.	2	14.03	28.06	14.03
	6417	7/12/2011	7/15/2011	N.D.	2	14.03	28.06	14.03
	6485	8/9/2011	8/19/2011	N.D.	2	14.03	28.06	14.03
	6563	9/14/2011	9/16/2011	N.D.	2	14.03	28.06	14.03
	6633	10/11/2011	10/14/2011	N.D.	2	14.03	28.06	14.03
	6706	11/1/2011	11/4/2011	N.D.	2	14.03	28.06	14.03
	6810	12/13/2011	12/16/2011	N.D.	2	14.40	28.80	14.40
	6896	1/17/2012	1/23/2012	N.D.	2	14.40	28.80	14.40
	6947	2/7/2012	2/10/2012	N.D.	2	14.40	28.80	14.40
	7048	3/13/2012	3/16/2012	N.D.	2	14.40	28.80	14.40
	7118	4/10/2012	4/13/2012	N.D.	2	14.40	28.80	14.40
	7196	5/9/2012	5/15/2012	N.D.	2	14.40	28.80	14.40
	7275	6/11/2012	6/18/2012	N.D.	2	14.40	28.80	14.40
	7346	7/10/2012	7/13/2012	N.D.	2	14.40	28.80	14.40
	7462	8/13/2012	8/17/2012	N.D.	2	14.40	28.80	14.40
	7539	9/10/2012	9/14/2012	N.D.	2	14.40	28.80	14.40
	7585	10/2/2012	10/5/2012	N.D.	2	14.40	28.80	14.40
	7725	11/13/2012	11/16/2012	N.D.	2	17.29	34.58	17.29
	7813	12/11/2012	12/14/2012	31.60	2	17.29	34.58	17.29

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Location IBW	4022	5/27/2009	5/29/2009	N.D.	2	14.93	29.86	14.93
	4063	6/8/2009	6/12/2009	N.D.	2	14.93	29.86	14.93
	4137	7/20/2009	7/24/2009	N.D.	2	15.17	30.34	15.17
	4198	8/11/2009	8/17/2009	N.D.	2	15.17	30.34	15.17
	4272	9/14/2009	9/18/2009	N.D.	2	15.17	30.34	15.17
	4313	10/5/2009	10/12/2009	12.56	2	15.17	30.34	15.17
	4406	11/11/2009	11/16/2009	N.D.	2	15.17	30.34	15.17
	4529	12/30/2009	1/12/2010	166.08	2	15.17	30.34	166.08
	4593	1/19/2010	1/22/2010	129.08	2	15.17	30.34	129.08
	4678	2/9/2010	2/12/2010	50.74	2	15.17	30.34	50.74
	4831	3/16/2010	3/29/2010	N.D.	2	15.17	30.34	15.17
	4932	4/14/2010	4/20/2010	236.70	2	15.17	30.34	236.70
	5048	5/17/2010	5/24/2010	230.88	2	15.17	30.34	230.88
	5173	6/15/2010	6/21/2010	252.06	2	7.00	14.00	252.06
	5308	7/26/2010	8/2/2010	283.86	2	7.00	14.00	283.86
	5394	8/24/2010	8/30/2010	114.94	2	7.00	14.00	114.94
	5448	9/13/2010	9/20/2010	70.54	2	7.00	14.00	70.54
	5567	10/19/2010	10/25/2010	398.20	2	7.00	14.00	398.20
	5659	11/15/2010	11/22/2010	329.56	2	7.00	14.00	329.56
	5716	12/7/2010	12/13/2010	357.10	2	7.00	14.00	357.10
	5814	1/11/2011	1/18/2011	302.90	2	14.03	28.06	302.90
	5888	2/1/2011	2/10/2011	298.64	2	14.03	28.06	298.64
	5978	3/1/2011	3/4/2011	317.72	2	14.03	28.06	317.72
	6081	4/5/2011	4/20/2011	329.26	2	14.03	28.06	329.26
	6180	5/3/2011	5/6/2011	334.28	2	14.03	28.06	334.28
	6331	6/16/2011	6/24/2011	319.28	2	14.03	28.06	319.28
	6407	7/11/2011	7/15/2011	263.72	2	14.03	28.06	263.72
	6475	8/9/2011	8/19/2011	264.52	2	14.03	28.06	264.52
	6551	9/13/2011	9/16/2011	289.72	2	14.03	28.06	289.72
	6625	10/10/2011	10/14/2011	229.52	2	14.03	28.06	229.52
	6698	11/1/2011	11/4/2011	249.70	2	14.03	28.06	249.70
	6802	12/12/2011	12/16/2011	356.14	2	14.40	28.80	356.14
	6888	1/17/2012	1/23/2012	310.84	2	14.40	28.80	310.84
	6940	2/7/2012	2/10/2012	318.06	2	14.40	28.80	318.06
	7041	3/13/2012	3/16/2012	226.60	2	14.40	28.80	226.60
	7111	4/10/2012	4/13/2012	51.64	2	14.40	28.80	51.64
	7189	5/8/2012	5/15/2012	95.04	2	14.40	28.80	95.04
	7268	6/11/2012	6/18/2012	77.72	2	14.40	28.80	77.72
	7339	7/10/2012	7/13/2012	16.24	2	14.40	28.80	14.40
	7455	8/13/2012	8/17/2012	N.D.	2	14.40	28.80	14.40
	7533	9/10/2012	9/14/2012	230.78	2	14.40	28.80	230.78
	7579	10/2/2012	10/5/2012	227.70	2	14.40	28.80	227.70
	7719	11/13/2012	11/16/2012	220.86	2	17.29	34.58	220.86
	7807	12/10/2012	12/14/2012	296.50	2	17.29	34.58	296.50

Hydrogen (H_2)								
Location	Sample ID	Sample Date	Analysis Date	Reported Results (ppmv)	Dilution Factor	MDL (ppmv)	Dilution corrected MDL (ppmv)	Concentration for Statistical Evaluation (ppmv)
Panel 4 Location IBA	4021	5/27/2009	5/29/2009	N.D.	2	14.93	29.86	14.93
	4062	6/8/2009	6/12/2009	N.D.	2	14.93	29.86	14.93
	4138	7/20/2009	7/24/2009	N.D.	2	15.17	30.34	15.17
	4199	8/11/2009	8/17/2009	N.D.	2	15.17	30.34	15.17
	4273	9/14/2009	9/18/2009	N.D.	2	15.17	30.34	15.17
	4314	10/5/2009	10/12/2009	N.D.	2	15.17	30.34	15.17
	4405	11/11/2009	11/16/2009	130.72	2	15.17	30.34	130.72
	4530	12/30/2009	1/12/2010	N.D.	2	15.17	30.34	15.17
	4594	1/19/2010	1/22/2010	N.D.	2	15.17	30.34	15.17
	4679	2/10/2010	2/12/2010	N.D.	2	15.17	30.34	15.17
	4832	3/16/2010	3/29/2010	N.D.	2	15.17	30.34	15.17
	4933	4/14/2010	4/20/2010	N.D.	2	15.17	30.34	15.17
	5049	5/17/2010	5/24/2010	N.D.	2	15.17	30.34	15.17
	5174	6/15/2010	6/21/2010	N.D.	2	7.00	14.00	7.00
	5309	7/26/2010	8/2/2010	N.D.	2	7.00	14.00	7.00
	5395	8/24/2010	8/30/2010	N.D.	2	7.00	14.00	7.00
	5449	9/13/2010	9/20/2010	N.D.	2	7.00	14.00	7.00
	5568	10/19/2010	10/25/2010	N.D.	2	7.00	14.00	7.00
	5660	11/15/2010	11/22/2010	42.12	2	7.00	14.00	42.12
	5717	12/7/2010	12/13/2010	63.50	2	7.00	14.00	63.50
	5815	1/11/2011	1/18/2011	N.D.	2	14.03	28.06	14.03
	5889	2/1/2011	2/10/2011	N.D.	2	14.03	28.06	14.03
	5979	3/1/2011	3/4/2011	45.52	2	14.03	28.06	45.52
	6082	4/5/2011	4/20/2011	N.D.	2	14.03	28.06	14.03
	6181	5/3/2011	5/6/2011	67.86	2	14.03	28.06	67.86
	6332	6/16/2011	6/24/2011	N.D.	2	14.03	28.06	14.03
	6408	7/12/2011	7/15/2011	N.D.	2	14.03	28.06	14.03
	6476	8/9/2011	8/19/2011	N.D.	2	14.03	28.06	14.03
	6552	9/14/2011	9/16/2011	N.D.	2	14.03	28.06	14.03
	6626	10/10/2011	10/14/2011	N.D.	2	14.03	28.06	14.03
	6699	11/1/2011	11/4/2011	N.D.	2	14.03	28.06	14.03
	6803	12/12/2011	12/16/2011	N.D.	2	14.40	28.80	14.40
	6889	1/17/2012	1/23/2012	N.D.	2	14.40	28.80	14.40
	6941	2/7/2012	2/10/2012	N.D.	2	14.40	28.80	14.40
	7042	3/13/2012	3/16/2012	N.D.	2	14.40	28.80	14.40
	7112	4/10/2012	4/13/2012	N.D.	2	14.40	28.80	14.40
	7190	5/8/2012	5/15/2012	N.D.	2	14.40	28.80	14.40
	7269	6/11/2012	6/18/2012	N.D.	2	14.40	28.80	14.40
	7340	7/10/2012	7/13/2012	N.D.	2	14.40	28.80	14.40
	7456	8/13/2012	8/17/2012	N.D.	2	14.40	28.80	14.40
	7534	9/10/2012	9/14/2012	N.D.	2	14.40	28.80	14.40
	7580	10/2/2012	10/5/2012	20.80	2	14.40	28.80	14.40
	7720	11/13/2012	11/16/2012	N.D.	2	17.29	34.58	17.29
	7808	12/11/2012	12/14/2012	N.D.	2	17.29	34.58	17.29

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Item 2

Class 3 Permit Modification Request

Repository Reconfiguration of Panels 9 and 10

Waste Isolation Pilot Plant
Carlsbad, New Mexico

WIPP Permit Number - NM4890139088-TSDF

March 2013

Table of Contents

Acronyms and Abbreviations

CFR	Code of Federal Regulations
CH	contact-handled
DOE	U.S. Department of Energy
HWDU	Hazardous Waste Disposal Unit
LWA	Land Withdrawal Act
NMAC	New Mexico Administrative Code
NWP	Nuclear Waste Partnership, LLC
Permit	Hazardous Waste Facility Permit
PMR	Permit Modification Request
RH	remote-handled
SPDV	Site and Preliminary Design Validation
TRU	transuranic
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant

Overview of the Permit Modification Request

This document contains one Class 3 Permit Modification Request (**PMR**) for the Waste Isolation Pilot Plant (**WIPP**) Hazardous Waste Facility Permit (**Permit**) Number NM4890139088-TSDF.

This PMR is being submitted by the U.S. Department of Energy (**DOE**) Carlsbad Field Office and Nuclear Waste Partnership, LLC (**NWP**), collectively referred to as the Permittees, in accordance with the WIPP Permit Part 1, Section 1.3.1. (20.4.1.900 New Mexico Administrative Code (**NMAC**) incorporating Title 40 Code of Federal Regulations (**CFR**) §270.42(d)). The modification provides for the following changes:

- Reconfigure the location of Panels 9 and 10
- Designate new locations as Panels 9A and 10A
- Authorize disposal in Panels 9A and 10A

These changes do not reduce the ability of the Permittees to provide continued protection to human health and the environment.

The requested modification to the WIPP Permit and related supporting documents are provided in this PMR. The proposed modification to the text of the WIPP Permit has been identified using red text and a double underline for new text and ~~strikeout~~ font for deleted information. All direct quotations are indicated by italicized text. The following information specifically addresses how compliance has been achieved with the WIPP Permit Part 1, Section 1.3.1. for submission of this Class 3 PMR.

1. 20.4.1.900 NMAC (incorporating 40 CFR 270.42(c)(1)(i)) requires the applicant to describe the exact change to be made to the Permit conditions and supporting documents referenced by the Permit.

The Permittees are proposing a change to the configuration of the WIPP repository relative to the location of Panels 9 and 10. The proposal is to revise the location of two of the Hazardous Waste Disposal Units (**HWDUs**) or panels; one panel is proposed to be located south of Panel 4 and one located south of Panel 5 (Figure 1 Proposed Repository Design) and to remove the designation of HWDUs for the locations currently designated as Panels 9 and 10 (Figure 2 Current Repository Design). Ventilation and access drifts would be extended south of drift S-3650. The HWDUs would be the same nominal dimensions as the previous eight HWDUs. This PMR is to authorize the construction, certification, and use of those HWDUs. The new HWDUs will be designated as Panels 9A and 10A. The proposed changes are primarily associated with adding references to Panels 9A and 10A, deleting references to Panels 9 and 10, changing the location of the new proposed panels to south of the existing panels, revising figures to reflect the panel reconfiguration, changing the underground ventilation description, and changing in the underground traffic pattern to address the panel reconfiguration. Changes to Table 4.1.1 are proposed to include the capacities of the new HWDUs. The revised capacities do not authorize the Permittees to dispose more than 6.2 million cubic feet of transuranic (**TRU**) mixed waste, the total capacity of the WIPP facility listed in the Land Withdrawal Act (**LWA**). The changes are described below:

- Changed the references from Panels 9 and 10 to 9A and 10A respectively and made related changes throughout the Permit.
- Changed the location of Panels 9 and 10 to proposed Panels 9A and 10A, south of existing Panels 4 and 5 in the Permit text and in applicable figures.
- Modified Table 4.1.1, Underground HWDUs, to include Panels 9A and 10A and their Maximum Capacities and other editorial changes to provide clarification.
- Added 9A and 10A to the closure schedule and updated the closure schedule.
- Changed the Volatile Organic Compound (**VOC**) Monitoring Plan and the Hydrogen and Methane Monitoring Plan to accommodate Panels 9A and 10A.
- Changed the underground traffic flow pattern description and ventilation description to accommodate the new panels.
- Made some editorial changes such as deleting references to “the term of this permit.” The editorial changes are described more thoroughly in Item 3 below.

The Table of Changes and the redline/~~strikeout~~ in this modification describe each change that is being proposed.

2. 20.4.1.900 NMAC (incorporating 40 CFR 270.42(c)(1)(ii), requires the applicant to identify that the modification is a Class 3.

The proposed modification is classified as a Class 3 Permit Modification in accordance with 20.4.1.900 NMAC (incorporating 40 CFR 270.42(d)(1) which states:

> “(d) Other modifications. (1) *In the case of modifications not explicitly listed in appendix I of this section, the Permittee may submit a Class 3 modification request to the Agency…*”

The Permittees are requesting that this modification be managed under the Class 3 process since the Permittees were unable to identify a similar item justifying a different classification in Appendix I.

3. 20.4.1.900 NMAC (incorporating 40 CFR 270.42(c)(1)(iii)), requires the applicant to explain why the modification is needed.

The modification is needed for the reasons listed below:

1. Based on geomechanical considerations, it has been determined that locating new disposal Panels 9A and 10A south of the existing panels is geotechnically more advantageous than the location previously proposed for Panels 9 and 10, as discussed below.
2. Changes to the ventilation and underground traffic descriptions are required to support the panel reconfiguration to provide adequate separation of traffic and ventilation air during waste management activities.

Background

The original configuration of the WIPP repository has ten waste disposal panels, with four panels on each side of the four main access drifts and the four main access drifts constituting two panels. Each of the eight waste panels consists of seven rooms. The eight waste panels are separated from each other and the main access drifts by thick pillars of undisturbed salt. Each room has nominal dimensions of 300 ft (91 m) long, 33 ft (10 m) wide, and 13 ft (4.0 m) high. Pillars between rooms are 100 ft (30 m) wide. The eight waste panels are separated from each other and the main access drifts by nominally 200 ft (61 m) pillars. In addition to the eight panels, the main north-south and east-west access drifts in the waste regions are available for waste disposal, as described in the repository design in the Permit. The Permit specifies that the main access drifts used to transport waste to disposal panels and for ventilation would eventually be filled with waste. These areas are designated as waste Panels 9 and 10. These areas are defined by the north-south access drifts E-300, E-140, W-30, and W-170. The areas are bounded at the north by S-1600 (east-west cross drift) and at the south end by the S-3650 cross drift (Figure 2).

Preliminary designs of the WIPP repository were developed in the early 1970s, with validation efforts for the early designs starting in 1981 under the Site and Preliminary Design Validation (**SPDV**) program. The SPDV program was developed to further characterize the site, obtain geotechnical data, and validate early WIPP site geology and the preliminary repository design. The SPDV program confirmed that the site was suitable for disposal of the planned wastes and complied with established design criteria. For example, data obtained through this program and documented in the Design Validation Report (U.S. DOE, 1986, “Waste Isolation Pilot Plant Design Validation Final Report,” DOE-WIPP-86-010; Prepared by Bechtel National, Inc., for the U.S. Department of Energy, San Francisco, California) were used to confirm the design criteria and validate the design basis for underground disposal rooms. The current disposal area design is shown in Figure 2.

One of the geotechnical considerations in the design basis for this configuration was the visco-plastic (creep) properties of the rock salt formation in which the repository is located. When an opening (e.g., a waste disposal room or access drift) is excavated, it has a tendency to “heal” or close within a relatively short period of time. The advantage of this salt property is that after waste is emplaced in the repository the salt formation eventually entombs the waste containers, effectively sealing and isolating them from the accessible environment. The validated design for disposal rooms included a nominal five years for mining, emplacement, and closure with minimal maintenance. This design led to the “just-in-time” mining approach in which disposal areas are mined and outfitted for waste disposal shortly before they are needed. The areas designated as Panels 9 and 10, however, were mined with the intent that they would remain open and useable for the entire 25- to 30-year life of the repository. These areas are significantly narrower than the rooms in the disposal panels. The original intent was to re-mine these areas to make them suitable for TRU mixed waste disposal at the time when they are needed.

Engineering evaluations of Panels 9 and 10, discussed below, have led to the conclusion that the relocation of Panels 9 and 10 to an alternative location in the underground facility is preferred over widening the entries in Panels 9 and 10 to accommodate both contact-handled (**CH**) TRU and remote-handled (**RH**) TRU mixed waste.

Geotechnical Evaluation and Analyses

A geotechnical evaluation and analyses of historical and current ground conditions (U.S. DOE, 2011, "Geotechnical Analysis Report for July 2009 - June 2010," DOE/WIPP-11-3177, Volumes 1 and 2, Carlsbad, NM) indicate that convergence rates (the rate at which an opening closes after initial mining) and fractures are dependent on the age of the excavation and the proximity of nearby excavations.

As the repository ages the conditions of the excavations degrade and ground support systems need to be installed. Additional mining and scaling are needed to maintain safe access. The south access drifts can be maintained to support these activities. However, if these areas were enlarged for disposal of CH and RH TRU waste, the response to the removal of pillar volume and increasing the roof span would likely induce increased convergence rates and higher fracturing, leading to increased maintenance. Because this maintenance would be in areas being actively filled with waste, maintenance activities would interfere with waste disposal operations. Therefore, the Permittees propose to relocate disposal Panels 9 and 10 to the south of Panels 4 and 5 (south of S-3650 drift) as shown in Figure 1 instead of enlarging the access drifts for disposal.

The current long-term planning for the WIPP underground includes reconditioning Panels 9 and 10 for waste disposal. However, the evaluation of the geotechnical information collected regarding Panels 9 and 10 supports the option to mine new panels as opposed to attempting to recondition the existing panels. Because this is a design change to the permitted unit, this modification is necessary. Current anticipated schedules indicate that Panel 9A would be needed for operations in September 2020. Mining the access drifts (tunnels) south of S-3650 is planned to begin in calendar year 2016. Mining must be integrated with the schedule to perform final closure of Panels 1 through 6 and waste operations in Panels 7 and 8. Therefore, submittal of this modification at this time provides the Permittees sufficient time to process this change through the Class 3 process and, once approved, alter the underground long-term mining plan to assure the smooth integration of mining and waste emplacement activities and to provide the resources and manpower to complete the mining and outfitting in an efficient and timely manner.

Changes to Table 4.1.1 *Underground HWDUs,* and related text, are required to assure that there is no confusion with regard to the total capacity of the WIPP facility when the unit capacities for Panels 9A and 10A are added. Confusion is avoided by applying the total row in Table 4.1.1 only to the "Final Waste Volume" column rather than the "Maximum Capacity" column. The capacities listed for each HWDU including Panels 9A and 10A are appropriate and reflect the respective disposal unit capacities. The total amount of waste disposed at the WIPP facility cannot exceed the capacity listed in the LWA as referenced in a footnote to Table 4.1.1. The LWA capacity is compared to the total of the "Final Waste Volume" column of Table 4.1.1.

The changes to the underground traffic pattern description and ventilation description are required to accommodate the new panels. When mining operations are underway for Panels 9A and 10A, it will be necessary for the mining ventilation circuit and the waste ventilation circuit to cross. This is accomplished by using a structure referred to as an overcast. Overcasts allow one airstream to flow over another in a manner that prevents mixing and are common ventilation structures in the WIPP underground facility. There are instances when an intersection with an overcast is designated as a traffic route for both waste traffic and construction traffic. While these instances do not subject operators to any additional risk because ventilation practices to protect workers are unchanged, such ventilation overcasts represent an exception to the general rule of keeping both the traffic and the ventilation separate. Because there is no additional risk, it is being added to Attachment A4 as an exception to the general rule of separating traffic and ventilation. In addition, other changes to the text in Attachment A4 as well as Attachment A2 and Permit Part 4, Section 4.5.3.1. are being made to clarify the traffic and ventilation requirements.

Changes to the closure schedule are required to include Panels 9A and 10A in place of Panels 9 and 10. Note 1 is being deleted because this PMR authorizes disposal in all remaining panels so reference to past and future permits is unnecessary. Note 4 is being deleted because it specifically applied to Panels 9 and 10, which are old excavations. Other changes shown in the redline/strikeout of Table G-1 are proposed and discussed in the Panel Closure Redesign PMR.

Editorial Changes

In addition to the change described above, the Permittees are proposing to clarify text and make editorial changes. These clarifications and editorial changes are explained below:

- Part 4, Table 4.1.1 Underground HWDUs – Removed blank column from Table 4.1.1. This blank column is no longer needed.

- Attachment A2, Section A2-1 Description of the Geologic Repository – Combined paragraphs relating to waste emplaced in boreholes for clarity.

- Attachment A2, Section A2-2a(3) Subsurface Structures – Removed text referencing future permits.

- The editorial changes include removing text referring to “during the term of this permit.” This text is no longer relevant and it is unnecessary because all disposal areas in the underground will be authorized for construction and use.

The changes to Section 4.4.3 and Section N-3a(3) Ongoing Disposal Room VOC Monitoring in Panels 3 through 8 are required to accommodate Panels 9A and 10A. Changes proposed to this section are editorial and do not reduce the amount of monitoring.

4. 20.4.1.900 NMAC (incorporating 40 CFR 270.42 (c)(1)(iv)), requires the applicant to provide the applicable information required by 40 CFR 270.13 through 270.21, 270.62 and 270.63.

Regulatory citations in this modification reference 20.4.1.900 NMAC (incorporating 40 CFR §§270.13-15) revised March 2009. Title 40 CFR §§270.16 through 270.22, 270.62, 270.63 and 270.66 are not applicable at the WIPP. Consequently, they are not included. Title 40 CFR §270.23 is applicable to the WIPP HWDUs.

5. 20.4.1.900 NMAC (incorporating 40 CFR 270.11(d)(1) and 40 CFR 270.30(k)), requires that any person signing under paragraph a and b must certify the document in accordance with 20.4.1.900 NMAC.

The transmittal letter for this PMR contains the signed certification statement in accordance with Part 1, Section 1.9 of the Permit.

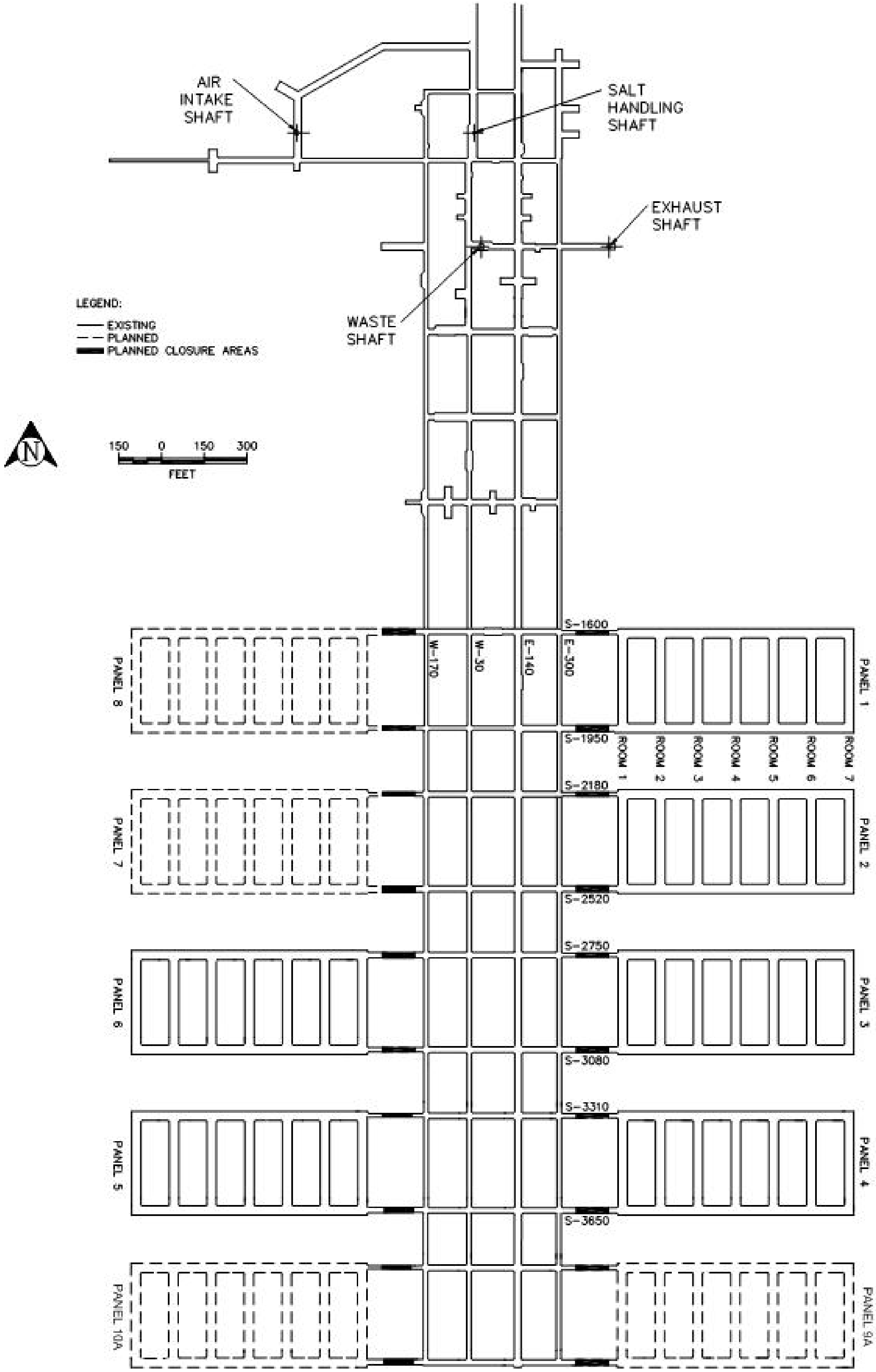


Figure 1
Proposed Repository Design

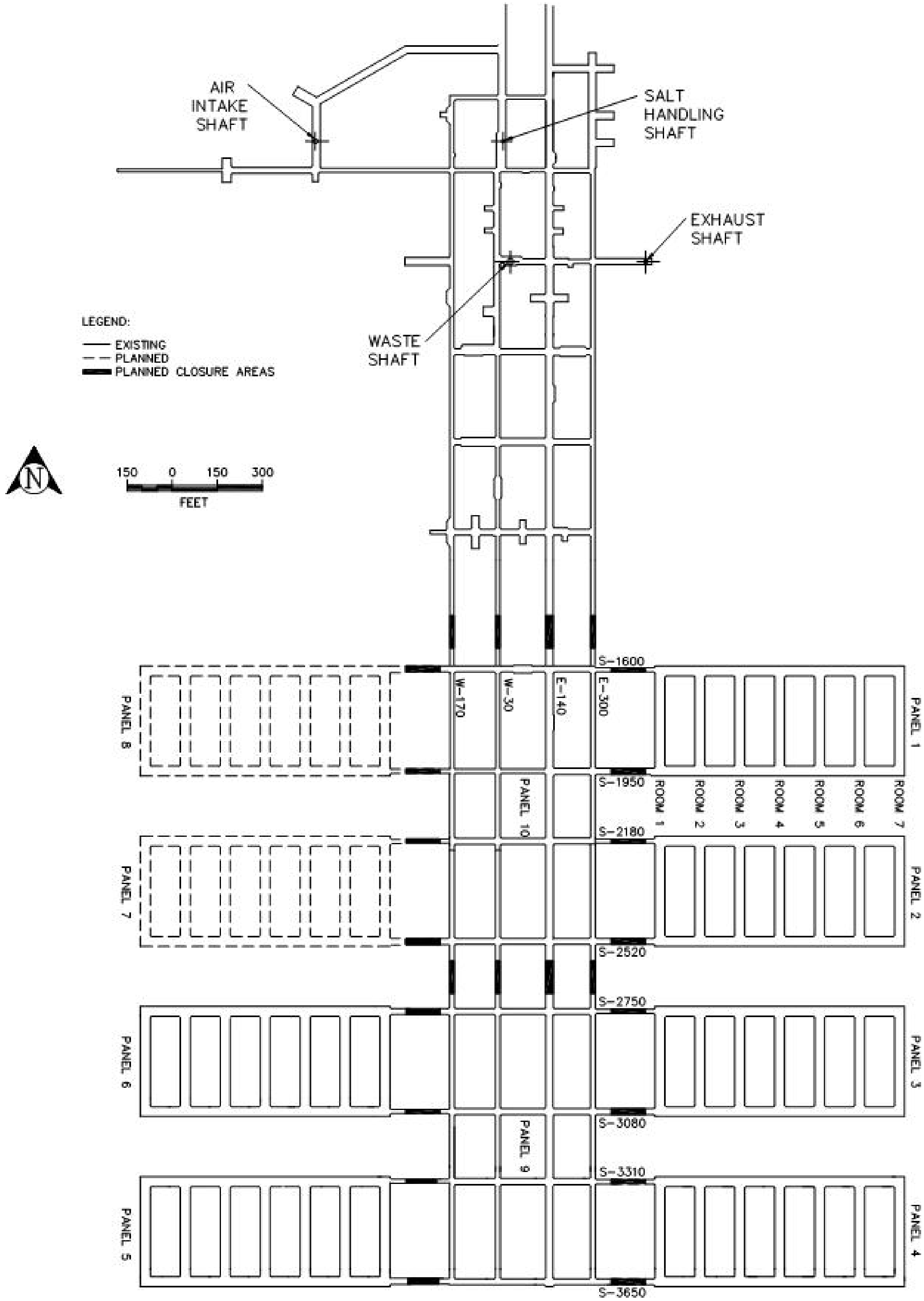


Figure 2
Current Repository Design

Regulatory Crosswalk

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
§270.13		Contents of Part A permit application	Attachment B Part A	✓	
§270.14(b)(1)		General facility description	Attachment A	✓	
§270.14(b)(2)	§264.13(a)	Chemical and physical analyses	Part 2.3.1 Attachment C		✓
§270.14(b)(3)	§264.13(b)	Development and implementation of waste analysis plan	Part 2.3.1.1 Attachment C		✓
	§264.13(c)	Off-site waste analysis requirements	Part 2.2.1 Attachment C		✓
§270.14(b)(5)	§264.15(a-d)	General inspection requirements	Part 2.7 Attachment E-1a		✓
	§264.174	Container inspections	Attachment E-1b(1)		✓
§270.23(a)(2)	§264.602	Miscellaneous units inspections	Attachment E-1b Attachment E-1b(1)		✓
§270.14(b)(6)		Request for waiver from preparedness and prevention requirements of Part 264 Subpart C	NA		✓
§270.14(b)(7)	264 Subpart D	Contingency plan requirements	Part 2.12 Attachment D		✓
	§264.51	Contingency plan design and implementation	Part 2.12.1 Attachment D		✓
	§264.52 (a) & (c-f)	Contingency plan content	Attachment D		✓
	§264.53	Contingency plan copies	Part 2.12.2 Attachment D		✓
	§264.54	Contingency plan amendment	Part 2.12.3 Attachment D		✓
	§264.55	Emergency coordinator	Part 2.12.4 Attachment D-4a(1)		✓
	§264.56	Emergency procedures	Attachment D-4		✓
§270.14(b)(8)		Description of procedures, structures or equipment for:	Attachment A Part 2.11		✓
§270.14(b)(8)(i)		Prevention of hazards in unloading operations (e.g., ramps and special forklifts)	Part 2.11		✓
§270.14(b)(8)(ii)		Runoff or flood prevention (e.g., berms, trenches, and dikes)	Attachment A1-1c(1) Part 2.11		✓
§270.14(b)(8)(iii)		Prevention of contamination of water supplies	Part 2.11		✓
§270.14(b)(8)(iv)		Mitigation of effects of equipment failure and power outages	Part 2.11		✓
§270.14(b)(8)(v)		Prevention of undue exposure of personnel (e.g., personal protective equipment)	Part 2.11		✓
§270.14(b)(8)(vi) §270.23(a)(2)	§264.601	Prevention of releases to the atmosphere	Part 2.11 Part 4.4 Attachment D-4e Attachment G-1a	✓	
	264 Subpart C	Preparedness and Prevention	Part 2.10		✓
	§264.31	Design and operation of facility	Part 2.1		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
	§264.32	Required equipment	Part 2.10.1 Attachment D		✓
	§264.33	Testing and maintenance of equipment	Part 2.10.2 Attachment E-1a		✓
	§264.34	Access to communication/alarm system	Attachment E-1a Part 2.10.3		✓
	§264.35	Required aisle space	Part 2.10.4		✓
	§264.37	Arrangements with local authorities	Attachment D-4a(3)		✓
§270.14(b)(9)	§264.17(a-c)	Prevention of accidental ignition or reaction of ignitable, reactive, or incompatible wastes	Part 2.9		✓
§270.14(b)(10)		Traffic pattern, volume, and controls, for example: Identification of turn lanes Identification of traffic/stacking lanes, if appropriate Description of access road surface Description of access road load-bearing capacity Identification of traffic controls	Attachment A4	✓	
§270.14(b) (11)(i) and (ii)	§264.18(a)	Seismic standard applicability and requirements	Attachment G2-2.2 Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(11)(iii-v)	§264.18(b)	100-year floodplain standard	Attachment A1-1c(1) Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b) (12)	§264.16(a-e)	Personnel training program	Part 2.8 Attachment F		✓
§270.14(b)(13)	264 Subpart G	Closure and post-closure plans	Part 6 & 7 Attachment G & H	✓	
§270.14(b)(13)	§264.111	Closure performance standard	Attachment G-1a		✓
§270.14(b)(13)	§264.112(a), (b)	Written content of closure plan	Attachment G-1	✓	
§270.14(b)(13)	§264.112(c)	Amendment of closure plan	Part 6.3 Attachment G-1d(4)		✓
§270.14(b)(13)	§264.112(d)	Notification of partial and final closure	Attachment G-2a		✓
§270.14(b)(13)	§264.112(e)	Removal of wastes and decontamination/dismantling of equipment	Attachment G-1e(2)		✓
§270.14(b)(13)	§264.113	Time allowed for closure	Part 6.5 Attachment G-1d		✓
§270.14(b)(13)	§264.114	Disposal/decontamination	Part 6.6 Attachment G-1e(2)		✓
§270.14(b)(13)	§264.115	Certification of closure	Part 6.7 Attachment G-2a		✓
§270.14(b)(13)	§264.116	Survey plat	Part 6.8 Attachment G-2b		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
§270.14(b)(13)	§264.117	Post-closure care and use of property	Part 7.3 Attachment H-1a		✓
§270.14(b)(13)	§264.118	Post-closure plan; amendment of plan	Part 7.5 Attachment H-1a (1)		✓
§270.14(b)(13)	§264.178	Closure/containers	Part 6.9 Attachment A1-1h Attachment G-1	✓	
§270.14(b)(13)	§264.601	Environmental performance standards-miscellaneous units	Attachment A-4 Attachment D-1 Attachment G-1a	✓	
§270.14(b)(13)	§264.603	Post-closure care	Part 7.3 Attachment G-1a(3)		✓
§270.14(b)(14)	§264.119	Post-closure notices	Part 7.4 Attachment H-2		✓
§270.14(b)(15)	§264.142	Closure cost estimate	NA		✓
	§264.143	Financial assurance	NA		✓
§270.14(b)(16)	§264.144	Post-closure cost estimate	NA		✓
	§264.145	Post-closure care financial assurance	NA		✓
§270.14(b)(17)	§264.147	Liability insurance	NA		✓
§270.14(b)(18)	§264.149-150	Proof of financial coverage	NA		✓
§270.14(b)(19)(i), (vi), (vii), and (x)		Topographic map requirements Map scale and date Map orientation Legal boundaries Buildings Treatment, storage, and disposal operations Run-on/run-off control systems Fire control facilities	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(ii)	§264.18(b)	100-year floodplain	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(iii)		Surface waters	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(iv)		Surrounding land use	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
§270.14(b)(19)(v)		Wind rose	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(viii)	§264.14(b)	Access controls	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(ix)		Injection and withdrawal wells	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(xi)		Drainage on flood control barriers	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(19)(xii)		Location of operational units	Attachment B2 Part A Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.14(b)(20)		Other federal laws Wild and Scenic Rivers Act National Historic Preservation Act Endangered Species Act Coastal Zone Management Act Fish and Wildlife Coordination Act Executive Orders	Attachment B Renewal App. Sep. 2009, 270.14 Contents of Part B: General Requirements		✓
§270.15	§264 Subpart I	Containers	Part 3 Part 4.3 Attachment A1		✓
	§264.171	Condition of containers	Part 3.3 Attachment A1		✓
	§264.172	Compatibility of waste with containers	Part 3.4 Attachment A1		✓
	§264.173	Management of containers	Part 3.5 Attachment A1		✓
	§264.174	Inspections	Part 3.7 Attachment E-1 Attachment A1-1e		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
§270.15(a)	§264.175	Containment systems	Part 3.6 Attachment A1		✓
§270.15(c)	§264.176	Special requirements for ignitable or reactive waste	Attachment A1-1g Permit Part 2.1		✓
§270.15(d)	§264.177	Special requirements for incompatible wastes	Attachment A1-1g Permit Part 2.3.3.4		✓
	§264.178	Closure	Part 6 Attachment G	✓	
§270.15(e)	§264.179	Air emission standards	Part 4.4.2 Attachment N		✓
§270.23	264 Subpart X	Miscellaneous units	Part 1.3.1 Attachment A2-1 Attachment G1.3.1		✓
§270.23(a)	§264.601	Detailed unit description	Part 4 Part 5 Attachment A2 Attachment L	✓	
§270.23(b)	§264.601	Hydrologic, geologic, and meteorologic assessments	Part 4 Part 5 Attachment A2 Attachment L	✓	
§270.23(c)	§264.601	Potential exposure pathways	Part 4 Part 5 Attachment A2 Attachment N Attachment L	✓	
§270.23(d)		Demonstration of treatment effectiveness	Part 4 Attachment A2 Attachment N		✓
	§264.602	Monitoring, analysis, inspection, response, reporting, and corrective action	Part 4 Part 5 Attachment A2 Attachment E-1 Attachment N Attachment L	✓	
	§264.603	Post-closure care	Attachment H Attachment H1	✓	
	264 Subpart E	Manifest system, record keeping, and reporting	Permit Part 1 Permit Part 2.13 & 2.14 Permit Part 4 Attachment C		✓
§270.30(j)(2)	§264.73(b)	Ground-water records	Part 1		✓
	264 Subpart F	Releases from solid waste management units	Part 5 & 7 Attachment G2 & L		✓
	§264.90	Applicability	Part 5 Attachment L		✓
	§264.91	Required programs	Attachment L		✓
	§264.92	Ground-water protection standard	Attachment L		✓
	§264.93	Hazardous constituents	Attachment L		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the WIPP Permit Application	Yes	No
	§264.94	Concentration limits	Part 5 Attachment L		✓
	§264.95	Point of compliance	Part 5 Attachment L		✓
	§264.96	Compliance period	Attachment L		✓
	§264.97	General ground-water monitoring requirements	Part 5 Attachment L		✓
	§264.98	Detection monitoring program	Part 5 Attachment L		✓
	§264.99	Compliance monitoring program	Part 5 Attachment L		✓
	§264.100	Corrective action program	Part 5 Attachment L		✓
	§264.101	Corrective action for solid waste management units	Part 8 Attachment L		✓
	264 Appendix IX	Ground-water Monitoring List	Part 5 Attachment L		✓

Appendix A
Table of Changes

Table of Changes

Affected Permit Section	Explanation of Change
Part 4, Table 4.1.1. Underground HWDUs	Deleted blank column Added “^{3}” after “Volume” in the last column of the heading row. Added rows for Panels 9A & 10A Added “Disposed in Filled Panels” to total row. Replaced the total rows for Maximum Capacity column for CH and RH with an asterisk Added “2,676,000 ft^3 (75,775 m^3)” to Final Waste Volume column for total row. Added “14,500 ft^3 (411 m^3)” to Final Waste Volume column for total row. Delete “The maximum repository capacity of “6.2 million cubic feet of transuranic waste” is specified in the WIPP Land Withdrawal Act (Pub. L. 102-579, as amended)” to note 2. Added “[3] The total final waste volume cannot exceed the maximum repository capacity (Final Waste Volume) of “6.2 million cubic feet of transuranic waste” is specified in the WIPP Land Withdrawal Act (Pub. L. 102-579, as amended)” as note 3 Added *Total only applies to the Final Waste Volume column.” to table notes
Part 4, Section 4.4.3. Ongoing Disposal Room VOC Monitoring in Panels 3 Through 8	Deleted “in Panels 3 Through 8” Changed “Panels 3 through 8 after completion of waste emplacement” to “a filled panel” Changed “the” to “an” Deleted “specified in Permit Attachment G1 (Detailed Design Report for an Operation Phase Panel Closure System)”
Part 4, Section 4.5.2.1 Construction Requirements	Deleted “● Panel 10 (Disposal area access drift)” Deleted “● Panel 9 (Disposal area access drift)” Added “● Panel 9A” Added “● Panel 10A”
Part 4, Section 4.5.3.1. Underground Traffic Flow	Replaced “The Permittees shall restrict and separate the ventilation and traffic flow areas in the underground TRU mixed waste handling and disposal areas from the ventilation and traffic flow areas for mining and construction equipment, except that during waste transport in W-30, ventilation need not be separated north of S-1600.” with “The Permittees will manage underground traffic in accordance with Permit Attachment A4, “Traffic Patterns,” Section A4-4, “Underground Traffic,” in order to provide adequate separation of traffic and ventilation air when waste is being transported in the underground.”
Part 7, Section 7.2 Unit Identification	Replaced “eight” with “10” Deleted “and two access drifts”
Attachment A, Section A-4 Facility Type	Replaced “10, although only Panels 1 through 8 will be used under the terms of this permit.” with “8, 9A, and 10A.”
Attachment A2, Section A2-1 Description of the Geologic Repository	Deleted “During the term of this permit, ” Replaced “D” with lowercase “d” in “Disposal” Replaced “5” with “1” Replaced “8 and in any currently active panel” with “10A” Deleted “The Permittees may also request in the future a Permit to allow disposal of containers of TRU mixed waste in the areas designated as Panels 9 and 10 in Figure A2-1.” Deleted “, during its 10-year term,” Added “and disposal of waste in”

Affected Permit Section	Explanation of Change
	Added "A" to "10" Deleted "and the disposal of waste in Panels 1 through 8" Replaced "8" with "10A" Delete "Panels 9 and 10 have yet to be designed." Replaced "8" with "10A" Replaced "5,244,900" with "6,200,000" Replaced "148,500" with "175,564" Deleted "CH" Deleted "CH" Added "or emplaced in holes in the walls of the panels in up to 730 boreholes per panel, subject to the limitations in Permit Part 4, Section 4.1.1.2.ii. These boreholes shall be drilled on nominal eight-foot centers, horizontally, about mid-height in the ribs of a disposal room. The thermal loading from RH TRU mixed waste shall not exceed 10 kilowatts per acre when averaged over the area of a panel, as shown in Permit Attachment A3, plus 100 feet of each of a Panel's adjoining barrier pillars." Deleted "Panels 4 through 8 provide room for up to 93,050 ft^3 (2,635 m^3) of RH TRU mixed waste. RH TRU mixed waste may be disposed of in up to 730 boreholes per panel, subject to the limitations in Permit Part 4, Section 4.1.1.2.ii. These boreholes shall be drilled on nominal eight-foot centers, horizontally, about mid-height in the ribs of a disposal room. The thermal loading from RH TRU mixed waste shall not exceed 10 kilowatts per acre when averaged over the area of a panel, as shown in Permit Attachment A3, plus 100 feet of each of a Panel's adjoining barrier pillars."
Attachment A2, Section A2-2a(3) Subsurface Structures	Deleted "During the terms of this and the preceding Permit, " Replaced "t" with uppercase "T" in "the" Deleted "CH" Replaced "5,244,900" with "6,200,000" Replaced "148,500" with "175,564" Replaced "93,050" with "250,000" Replaced "2,635" with "7,079" Replaced "8" with "10A" Replaced "8" with "10A" Replaced "8" with "10A" Deleted "As currently planned, future Permits may allow disposal of TRU mixed waste containers in two additional panels, identified as Panels 9 and 10. Disposal of TRU mixed waste in Panels 9 and 10 is prohibited under this Permit. If waste volumes disposed of in the eight panels fail to reach the stated design capacity, the Permittees may request a Permit to allow disposal of TRU mixed waste in the four main entries and crosscuts adjacent to the waste panels (referred to as the disposal area access drifts). These areas are labeled Panels 9 and 10 in Figure A2-1. A permit modification or future permit would be submitted describing the condition of those drifts and the controls exercised for personnel safety and environmental protection while disposing of waste in these areas. These areas have the following nominal dimensions: The E-140 waste transport route south of the Waste Shaft Station is mined to be 25 ft wide nominally and its height ranges from about 14 ft to 20 ft. The W-30 waste transport route south of S-700 is mined to be 20 ft wide nominally and its height will be mined to at least 14 ft. All other drifts that are part of the waste transport route will be at least 20 ft wide and 14 ft high to accommodate waste transport equipment. Other drifts (i.e. mains and cross-cuts) vary in width and height according to their function typically ranging from 14 ft to 20 ft wide and 12 ft to 20 ft

Affected Permit Section	Explanation of Change
	high. The layout of these excavations is shown on Figure A2-1." Replaced "path for the" with "flow is split prior to passing S-1600 so that the flow that passes through the" Replaced "side" with "areas" Added "ventilation flow that passes through the" Added ". This separation is established" Added "These flows are combined prior to exhausting the air from the underground. Under normal operations" Changed "A" to a lowercase "a" Deleted "between the mining side and the waste disposal side" Added "between these flow paths"
Attachment A2, Section A2-5b(2)(a) Description of the Geomechanical Monitoring System	Replaced "eight" with "10"
Attachment A4, Section A4-4 Underground Traffic	Added "The primary waste transportation pathway is E-140. The alternate waste transportation pathway is W-30. Construction equipment traffic is restricted and administratively separated from waste handling equipment traffic by WIPP SOPs while waste is being transported in either the primary or alternate waste transportation path. In general," Changed "T" to lowercase "t" in "The" Added "." after the word "equipment" Deleted ", except that" Added "However, there are two exceptions as follows. First," Added "Second, where construction and waste transport routes cross at ventilation overcasts, traffic may temporarily enter into a different ventilation circuit." Deleted "to maximize isolation of this activity from personnel" Added "waste disposal" Added "s" to "drift" Deleted "in the waste disposal area" Deleted "." after the word "access" Added "except, when necessary to conduct activities (e.g., geotechnical monitoring, ground control, ventilation adjustment, and calibration of continuous air monitoring equipment)."
Attachment B, 8. PROCESS – CODES AND DESIGN CAPACITIES (continued)	Replaced "175,600" with "175,564" Replaced "175,600" with "175,564" Replaced "7,080" with "7,079" Deleted "During the ten year period of the permit, " Replaced "u" with uppercase "U" in "up" Replaced "148,500" with "175,564" Deleted "CH" Replaced "8" with "10A" Replaced "2,635" with "7,079" Replaced "8" with "10A" Deleted "Panels 9 and 10 will be constructed under the initial term of this permit. These latter areas will not receive waste for disposal under this permit."
Attachment G, Introduction	Replaced "8" with "10A"

Affected Permit Section	Explanation of Change
Attachment G, Section G-1, Closure Plan	Replaced “8” with “10A” Deleted “also” Deleted “future” Deleted “including Panels 9 and 10”
Attachment G, Section G-1c Maximum Waste Inventory	Replaced “8” with “10A” Deleted “Note that panels 9 and 10 are scheduled for excavation only under this permit.”
Attachment G, Section G-1d(1) Schedule for Panel Closure	Replaced “8” with “10A” Replaced “7” with “10A”
Attachment G, Table G-1 Anticipated Earliest Closure Dates for the Underground HWDUs	Replaced “6” with “5” in two instances Added “*” to Panel 5 Closure End Date Replaced “1/13” with “2/14” Replaced “2/13” with “3/14” Replaced “8/13” with “9/14 SEE NOTE 5” Replaced “1/13” with “8/13” Replaced “1/15” with “9/17” Replaced “2/15” with “10/17” Replaced “8/15” with “4/18” Replaced “1/15” with “1/17” Replaced “1/17” with “5/21” Replaced “2/17” with “6/21” Replaced “8/17” with “12/21” Added “A” to “9” Replaced “1/17” with “9/20” Replaced “1/28” with “1/25” Replaced “2/28” with “2/25” Replaced “SEE NOTE 4” with “8/25” Added “A” to “10” Replaced “1/28” with “5/24” Replaced “SEE NOTE 4” with “4/31” Replaced “Only Panels 1 to 4 will be closed under the initial term of this permit. Closure schedules for Panels 5 through 10 are projected assuming new permits will be issued in 2009 and 2019.” with “Reserved” in NOTE 1 Replaced “60 days following notification to the NMED of closure” with “the date when ventilation to the panel is blocked per Permit Attachment A2” in NOTE 2 Replaced “The time to close these areas may be extended depending on the nature and extent of the disturbed rock zone. The excavations that constitute these panels will have been opened for as many as 40 years so that the preparation for closure may take longer than the time allotted in Figure G-2. If this extension is needed, it will be requested as an amendment to the Closure Plan.” with “Reserved” in NOTE 4 Deleted “Installation of the 12 foot isolation wall for Panels 1, 2, and 5 must be completed by the closure end date.” in NOTE 5 Replaced “, 2, and 5” with “through 6” in NOTE 5 Deleted NOTE 6
Attachment H1, Introduction	Replaced “eight” with “10” Replaced “8” with “10A” Deleted “Ground control maintenance and evaluation with appropriate corrective

Affected Permit Section	Explanation of Change
	action will be required to ensure that Panels 9 and 10 (ventilation and access drifts in the repository) remain stable." Replaced "access entries (Panels 9 and/or 10)." with "last open panel."
Attachment H1, Section H1.1.1 Repository Footprint Fencing	Replaced "2,780" with "2,870" Replaced "2,360" with "2,610" Replaced "720" with "796"
Attachment N, Table of Contents	Added "Sampling Locations for" Deleted "in Panels 3 through 8"
Attachment N, Section N-1a Background	Replaced "8" with "10A"
Attachment N, Section N-3a(1) Sampling Locations for Repository VOC Monitoring	Replaced "8" with "10A"
Attachment N, Section N-3a(3) Ongoing Disposal Room VOC Monitoring in Panels 3 through 8	Added "Sampling Locations for" Deleted "in Panels 3 through 8" Changed "Panels 3 through 8 after completion of waste emplacement" to "a filled panel"
Attachment N1, Title	Changed "VOLATILE ORGANIC COMPOUND" to "HYDROGEN AND METHANE"
Attachment N1, Section N1-1 Introduction	Replaced "8" with "10A" Replaced "8" with "10A" Replaced "8" with "10A"
Attachment N1, Section N1-2 Parameters to be Analyzed and Monitoring Design	Replaced "8" with "10A"
Attachment A2, Figure A2-1	Deleted Panels 9 and 10 Added Panels 9A and 10A
Attachment A2, Figure A2-2	Deleted Panel Closure Areas for Panels 9 and 10 Added Panels 9A and 10A
Attachment B3, Figure B3-1	Deleted Panel Closure Areas for Panels 9 and 10 Added Panels 9A and 10A
Attachment B3, Figure B3-2	Deleted Panels 9 and 10 Added Panels 9A and 10A
Attachment D, Figure D-2	Deleted Panel Closure Areas for Panels 9 and 10 Added Panels 9A and 10A
Attachment D, Figure D-3	Deleted Panels 9 and 10 Added Panels 9A and 10A
Attachment D, Figure D-5	Deleted Panels 9 and 10 Added Panels 9A and 10A
Attachment D, Figure D-9	Deleted Panels 9 and 10 Added Panels 9A and 10A
Attachment G, Figure G-1	Deleted Panels 9 and 10 Added Panels 9A and 10A

Affected Permit Section	Explanation of Change
Attachment G, Figure G-6	Deleted Panels 9 and 10 Added Panels 9A and 10A
Attachment G2, Figure G2-1	Removed dimensions for Panels 1 through 8 Added Panels 9A and 10A
Attachment H1, Figure H1-1	Deleted Panel Closure Areas for Panels 9 and 10 Added Panels 9A and 10A
Attachment H1, Figure H1-4	Added Panels 9A and 10A
Attachment N, Figure N-1	Removed Panels 9 and 10 Added Panels 9A and 10A

Appendix B
Proposed Revised Permit Text

Proposed Revised Permit Text:

PART 4 - GEOLOGIC REPOSITORY DISPOSAL

Table 4.1.1 - Underground HWDUs				
Description[1]	**Waste Type**	**Maximum Capacity**[2]	**Delete Column**	**Final Waste Volume**[3]
Panel 1	CH TRU	636,000 ft^3 (18,000 m^3)	Delete Column	370,800 ft^3 (10,500 m^3)
Panel 2	CH TRU	636,000 ft^3 (18,000 m^3)	Delete Column	635,600 ft^3 (17,998 m^3)
Panel 3	CH TRU	662,150 ft^3 (18,750 m^3)	Delete Column	603,600 ft^3 (17,092 m^3)
Panel 4	CH TRU	662,150 ft^3 (18,750 m^3)	Delete Column	503,500 ft^3 (14,258 m^3)
	RH TRU	12,570 ft^3 (356 m^3)	Delete Column	6,200 ft^3 (176 m^3)
Panel 5	CH TRU	662,150 ft^3 (18,750 m^3)	Delete Column	562,500 ft^3 (15,927 m^3)
	RH TRU	15,720 ft^3 (445 m^3)	Delete Column	8,300 ft^3 (235 m^3)
Panel 6	CH TRU	662,150 ft^3 (18,750 m^3)	Delete Column	
	RH TRU	18,860 ft^3 (534 m^3)	Delete Column	
Panel 7	CH TRU	662,150 ft^3 (18,750 m^3)	Delete Column	
	RH TRU	22,950 ft^3 (650 m^3)	Delete Column	
Panel 8	CH TRU	662,150 ft^3 (18,750 m^3)	Delete Column	
	RH TRU	22,950 ft^3 (650 m^3)	Delete Column	
Panel 9A	CH TRU	662,150 ft^3 (18,750 m^3)	Delete Column	
	RH TRU	22,950 ft^3 (650 m^3)	Delete Column	

Panel 10A	CH TRU	662,150 ft³ (18,750 m³)	Delete Column	
	RH TRU	22,950 ft³ (650 m³)	Delete Column	
Total Disposed in Filled Panels	**CH TRU**	**~~5,244,900 ft³ (148,500 m³)~~***	Delete Column	**2,676,000 ft³ (75,775 m³)**
	RH TRU	**~~93,050 ft³ (2,635 m³)~~***	Delete Column	**14,500 ft³ (411 m³)**

[1] The area of each panel is approximately 124,150 ft2 (11,533 m2).

[2] "Maximum Capacity" is the maximum volume of TRU mixed waste that may be emplaced in each panel. ~~The maximum repository capacity of "6.2 million cubic feet of transuranic waste" is specified in the WIPP Land Withdrawal Act (Pub. L. 102-579, as amended)~~

[3] The total final waste volume cannot exceed the maximum repository capacity (final waste volume) of "6.2 million cubic feet of transuranic waste" is specified in the WIPP Land Withdrawal Act (Pub. L. 102-579, as amended)

*Total only applies to the Final Waste Volume column.

4.4.3 Ongoing Disposal Room VOC Monitoring ~~in Panels 3 Through 8~~

The Permittees shall continue disposal room VOC monitoring in Room 1 of a filled panel~~Panels 3 through 8 after completion of waste emplacement~~ until final panel closure unless ~~the~~an explosion-isolation wall ~~specified in Permit Attachment G1 (Detailed Design Report for an Operation Phase Panel Closure System)~~ is installed in the panel.

4.5.2.1 Construction Requirements

Subject to Permit Section 4.5.1, the Permittees may excavate the following Underground HWDUs, as depicted in Permit Attachment A2, Figure A2-1, "Repository Horizon", and specified in Section A2-2a(3), "Subsurface Structures (Underground Hazardous Waste Disposal Units (HWDUs))":

- ~~Panel 10 (Disposal area access drift)~~
- Panel 2
- ~~Panel 9 (Disposal area access drift)~~
- Panel 3
- Panel 4
- Panel 5
- Panel 6
- Panel 7
- Panel 8
- Panel 9A
- Panel 10A

Prior to disposal of TRU mixed waste in a newly constructed Underground HWDU, the Permittees shall comply with the certification requirements specified in Permit Section 1.7.11.2.

4.5.3.1 Underground Traffic Flow

The Permittees will manage underground traffic in accordance with Permit Attachment A4, "Traffic Patterns," Section A4-4, "Underground Traffic," in order to provide adequate separation of traffic and ventilation air when waste is being transported in the underground. ~~The Permittees shall restrict and separate the ventilation and traffic flow areas in the underground TRU mixed waste handling and disposal areas from the ventilation and traffic flow areas for mining and construction equipment, except that during waste transport in W-30, ventilation need not be separated north of S-1600.~~

PART 7 - POST-CLOSURE CARE PLAN

7.2 UNIT IDENTIFICATION

The Permittees shall provide post-closure care for the closed Underground HWDUs (~~eight~~10 panels~~ and two access drifts~~), and for the facility after final closure, as specified in Permit Attachment H (Post-Closure Plan) and as required by 20.4.1.500 NMAC (incorporating 40 CFR §264.110(b)).

ATTACHMENT A

GENERAL FACILITY DESCRIPTION AND PROCESS INFORMATION

A-4 Facility Type

The underground structures include the underground Hazardous Waste Disposal Units (**HWDUs**), an area for future underground HWDUs, the shaft pillar area, interconnecting drifts and other areas unrelated to the Hazardous Waste Facility Permit. The underground HWDUs are defined as waste panels, each consisting of seven rooms and two access drifts. The WIPP underground area is designated as Panels 1 through 8, 9A, and 10A~~10, although only Panels 1 through 8 will be used under the terms of this permit~~. Each of the seven rooms is approximately 300 feet long, 33 feet wide and 13 feet high. Part 4 of the permit authorizes the management and disposal of CH and RH TRU mixed waste containers in underground HWDUs. The Disposal Phase consists of receiving CH and RH TRU mixed waste shipping containers, unloading and transporting the waste containers to the underground HWDUs, emplacing the waste in the underground HWDUs, and subsequently achieving closure of the underground HWDUs in compliance with applicable State and Federal regulations. As required by 20.4.1.500 NMAC (incorporating 40 CFR §264.601), the Permittees shall ensure that the environmental performance standards for a miscellaneous unit, which are applied to the underground HWDUs in the geologic repository, will be met. Permit Attachment A2 describes the underground HWDUs, the TRU mixed waste management facilities and operations, and compliance with the technical requirements of 20.4.1.500 NMAC.

ATTACHMENT A2

GEOLOGIC REPOSITORY

A2-1 Description of the Geologic Repository

The WIPP geologic repository is mined within a 2,000-feet (ft) (610-meters (m))-thick bedded-salt formation called the Salado Formation. The Underground HWDUs (miscellaneous units) are located 2,150 ft (655 m) beneath the ground surface. TRU mixed waste management activities underground will be confined to the southern portion of the 120-acre (48.6 hectares) mined area during the Disposal Phase. ~~During the term of this Permit, d~~Disposal of TRU mixed waste will occur only in the HWDUs designated as Panels 1~~5~~ through 10A~~8 and in any currently active panel~~ (See Figure A2-1). RH TRU mixed waste disposal began in Panel 4. ~~The Permittees may also request in the future a Permit to allow disposal of containers of TRU mixed waste in the areas designated as Panels 9 and 10 in Figure A2-1.~~ This Permit ~~, during its 10-year term~~authorizes the excavation of and disposal of waste in Panels 6 through 10A ~~and the disposal of waste in Panels 1 through 8~~.

Panels 1 through 10A~~8~~ will consist of seven rooms and two access drifts each. ~~Panels 9 and 10 have yet to be designed.~~ Access drifts connect the rooms and have the same cross section (see Section A2-2a(3)). The closure system installed in each HWDU after it is filled will prevent anyone from entering the HWDU and will restrict ventilation airflow. The point of compliance for air emissions from the Underground is Sampling Station VOC-A, as defined in Permit Attachment N (Volatile Organic Compound Monitoring Plan). Sampling Station VOC-A is the location where the concentration of volatile organic compounds (VOCs) in the air emissions from the Underground HWDUs will be measured and then compared to the VOC concentration of concern as required by Permit Part 4.

The HWDUs identified as Panels 1 through ~~8~~10A (Figure A2-1) provide room for up to ~~5,244,900~~6,200,000 cubic feet (ft^3) (~~148,500~~175,564 cubic meters (m^3)) of ~~CH~~ TRU mixed waste. The ~~CH~~ TRU mixed waste containers may be stacked up to three high across the width of the room or emplaced in holes in the walls of the panels in up to 730 boreholes per panel, subject to the limitations in Permit Part 4, Section 4.1.1.2.ii. These boreholes shall be drilled on nominal eight-foot centers, horizontally, about mid-height in the ribs of a disposal room. The thermal loading from RH TRU mixed waste shall not exceed 10 kilowatts per acre when averaged over the area of a panel, as shown in Permit Attachment A3, plus 100 feet of each of a panel's adjoining barrier pillars.

~~Panels 4 through 8 provide room for up to 93,050 ft^3 (2,635 m^3) of RH TRU mixed waste. RH TRU mixed waste may be disposed of in up to 730 boreholes per panel, subject to the limitations in Permit Part 4, Section 4.1.1.2.ii. These boreholes shall be drilled on nominal eight-foot centers, horizontally, about mid-height in the ribs of a disposal room. The thermal loading from RH TRU mixed waste shall not exceed 10 kilowatts per acre when averaged over the area of a panel, as shown in Permit Attachment A3, plus 100 feet of each of a Panel's adjoining barrier pillars.~~

A2-2a(3) Subsurface Structures

Underground Hazardous Waste Disposal Units (HWDUs)

~~During the terms of this and the preceding Permit, t~~The volume of ~~CH~~ TRU mixed waste emplaced in the repository will not exceed ~~5,244,900~~6,200,000 ft^3 (~~148,500~~175,564 m^3) and the volume of RH TRU mixed waste shall not exceed ~~93,050~~250,000 ft^3 (~~2,635~~7,079 m^3). CH TRU mixed waste will be disposed of in Underground HWDUs identified as Panels 1 through 10A~~8~~. RH TRU mixed waste may be disposed of in Panels 4 through 10A~~8~~.

Main entries and cross cuts in the repository provide access and ventilation to the HWDUs. The main entries link the shaft pillar/service area with the TRU mixed waste management area and are separated by pillars. Each of the Underground HWDUs labeled Panels 1 through 10A~~8~~ will have seven rooms. The locations of these HWDUs are shown in Figure A2-1. The rooms will have nominal dimensions of 13 ft (4.0 m) high by 33 ft (10 m) wide by 300 ft (91 m) long and will be supported by 100 ft- (30 m-) wide pillars.

~~As currently planned, future Permits may allow disposal of TRU mixed waste containers in two additional panels, identified as Panels 9 and 10. Disposal of TRU mixed waste in Panels 9 and 10 is prohibited under this Permit. If waste volumes disposed of in the eight panels fail to reach the stated design capacity, the Permittees may request a Permit to allow disposal of TRU mixed waste in the four main entries and crosscuts adjacent to the waste panels (referred to as the disposal area access drifts). These areas are labeled Panels 9 and 10 in Figure A2-1. A permit modification or future permit would be submitted describing the condition of those drifts and the controls exercised for personnel safety and environmental protection while disposing of waste in these areas. These areas have the following nominal dimensions:~~

~~The E-140 waste transport route south of the Waste Shaft Station is mined to be 25 ft wide nominally and its height ranges from about 14 ft to 20 ft.~~

~~The W-30 waste transport route south of S-700 is mined to be 20 ft wide nominally and its height will be mined to at least 14 ft.~~

~~All other drifts that are part of the waste transport route will be at least 20 ft wide and 14 ft high to accommodate waste transport equipment.~~

~~Other drifts (i.e. mains and cross-cuts) vary in width and height according to their function typically ranging from 14 ft to 20 ft wide and 12 ft to 20 ft high.~~

~~The layout of these excavations is shown on Figure A2-1.~~

Underground Ventilation System Description

The ventilation ~~path for the~~flow is split prior to passing S-1600 so that the flow that passes through the waste disposal ~~side~~areas is separated from the ventilation flow that passes through the mining side. This separation is established by means of air locks, bulkheads, and salt pillars. These flows are combined prior to exhausting the air from the underground. Under normal operations ~~A~~a pressure differential is maintained ~~between the mining side and the waste disposal side~~ to ensure that any leakage between these flow paths is towards the disposal side. The pressure differential is produced by the surface fans in conjunction with the underground air regulators.

A2-5b(2)(a) Description of the Geomechanical Monitoring System

The minimum instrumentation for each of the ~~eight~~10 panels will be one borehole extensometer installed in the roof at the center of each disposal room. The roof extensometers will monitor the dilation of the immediate salt roof beam and possible bed separations along clay seams. Additional instrumentation will be installed as conditions warrant.

ATTACHMENT A4

TRAFFIC PATTERNS

A4-4 Underground Traffic

The Permittees shall designate the traffic routes of TRU mixed waste handling equipment and construction equipment and record this designation on a map that is posted in a location where it can be examined by personnel entering the underground. The map will be updated whenever the routes are changed. Maps will be available in facility files until facility closure. The primary waste transportation pathway is E-140. The alternate waste transportation pathway is W-30. Construction equipment traffic is restricted and administratively separated from waste handling equipment traffic by WIPP SOPs while waste is being transported in either the primary or alternate waste transportation path. In general, ~~T~~the ventilation and traffic flow path in the TRU mixed waste handling areas underground are restricted and separate from those used for mining and haulage (construction) equipment.~~, except that~~ However, there are two exceptions as follows. First, during waste transport in W-30, ventilation need not be separated north of S-1600 (Figures A4-4 and A4-4a). Second, where construction and waste transport routes cross at ventilation overcasts, traffic may temporarily enter into a different ventilation circuit. In general, the Permittees restrict waste traffic to the intake ventilation drift~~ to maximize isolation of this activity from personnel~~. The waste disposal exhaust drifts ~~in the waste disposal area~~ will normally not be used for personnel access except, when necessary to conduct activities (e.g., geotechnical monitoring, ground control, ventilation adjustment, and calibration of continuous air monitoring equipment). Non-waste and non-construction traffic is generally comprised of escorted visitors only and is minimized during each of the respective operations.

ATTACHMENT B

HAZARDOUS WASTE PERMIT APPLICATION PART A

NM4890139088

8. PROCESS—CODES AND DESIGN CAPACITIES (continued)

The Waste Isolation Pilot Plant (WIPP) geologic repository is defined as a “miscellaneous unit” under 40 CFR §260.10. “Miscellaneous unit” means a hazardous waste management unit where hazardous waste is treated, stored, or disposed of and that is not a container, tank, surface impoundment, waste pile, land treatment unit, landfill, incinerator, containment building, boiler, industrial furnace, or underground injection well with appropriate technical standards under 40 CFR Part 146, corrective action management unit, or unit eligible for research, development, and demonstration permit under 40 CFR §270.65. The WIPP is a geologic repository designed for the disposal of defense-generated transuranic (TRU) waste. Some of the TRU wastes disposed of at the WIPP contain hazardous wastes as co-contaminants. More than half the waste to be disposed of at the WIPP also meets the definition of debris waste. The debris categories include manufactured goods, biological materials, and naturally occurring geological materials. Approximately 120,000 cubic meters (m^3) of the ~~175,600~~175,564 m^3 of WIPP wastes is categorized as debris waste. The geologic repository has been divided into ten discrete hazardous waste management units (HWMU) which are being permitted under 40 CFR Part 264, Subpart X.

During the Disposal Phase of the facility, which is expected to last 25 years, the total amount of waste received from off-site generators and any derived waste will be limited to ~~175,600~~175,564 m^3 of TRU waste of which up to ~~7,080~~7,079 m^3 may be remote-handled (RH) TRU mixed waste. For purposes of this application, all TRU waste is managed as though it were mixed.

The process design capacity for the miscellaneous unit (composed of ten underground HWMUs in the geologic repository) shown in Section 8 B, is for the maximum amount of waste that may be received from off-site generators plus the maximum expected amount of derived wastes that may be generated at the WIPP facility. In addition, two HWMUs have been designated as container storage units (S01) in Section 8 B. One is inside the Waste Handling Building (WHB) and consists of the contact-handled (CH) bay, waste shaft conveyance loading room, waste shaft conveyance entry room, RH bay, cask unloading room, hot cell, transfer cell, and facility cask loading room. This HWMU will be used for waste receipt, handling, and storage (including storage of derived waste) prior to emplacement in the underground geologic repository. No treatment or disposal will occur in this S01 HWMU. The capacity of this S01 unit for storage is 194.1 m^3, based on 36 ten-drum overpacks on 18 facility pallets, four CH Packages at the TRUDOCKs, one standard waste box of derived waste, two loaded casks and one 55-gallon drum of derived waste in the RH Bay, one loaded cask in the Cask Unloading Room, 13 55-gallon drums in the Hot Cell, one canister in the Transfer Cell and one canister in the Facility Cask Unloading Room. The second S01 HWMU is the parking area outside the WHB where the Contact- and Remote-Handled Package trailers and the road cask trailers will be parked awaiting waste handling operations. The capacity of this unit is 50 Contact-Handled Packages and twelve Remote-Handled Packages with a combined volume of 242 m^3. The HWMUs are shown in Figures B3-2, B3-3, and B3-4.

~~During the ten year period of the permit, u~~Up to ~~148,500~~175,564 m^3 of ~~CH~~ TRU mixed waste could be emplaced in Panels 1 to 10A~~8~~ and up to ~~2,635~~7,079 m^3 of RH TRU mixed waste could be emplaced in Panels 4 to 10A8. Panels 9 and 10 will be constructed under the initial term of this permit. These latter areas will not receive waste for disposal under this permit.

ATTACHMENT G

CLOSURE PLAN

Introduction

The hazardous waste management units (**HWMUs**) addressed in this Closure Plan include the aboveground HWMU in the WHB, the parking area HWMU, and Panels 1 through 10A~~8~~, each consisting of seven rooms.

G-1 Closure Plan

This Closure Plan is prepared in accordance with the requirements of 20.4.1.500 NMAC (incorporating 40 CFR §264 Subparts G, I, and X), Closure and Post-Closure, Use and Management of Containers, and Miscellaneous Units. The WIPP underground HWDUs, including Panels 1 through ~~8~~10A on Figure G-1, will be closed under this permit to meet the performance standards in 20.4.1.500 NMAC (incorporating 40 CFR §264.601). The WIPP surface facilities, including Waste Handling Building Container Storage Unit and the Parking Area Container Storage Unit, will be closed in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.178). The Permittees may perform partial closure of the WHB and PAU HWMUs prior to final facility closure and certification. For final facility closure, this plan ~~also~~ includes closure of ~~future~~ waste disposal areas ~~including Panels 9 and 10~~ and closure and sealing of the facility shafts in accordance with 20.4.1.500 NMAC (incorporating 40 CFR §264.601).

G-1c Maximum Waste Inventory

The maximum extent of operations during the term of this permit is expected to be Panels 1 through 10A~~8~~ as shown on Figure G-1, the WHB Container Storage Unit, and the Parking Area Container Storage Unit. ~~Note that panels 9 and 10 are scheduled for excavation only under this permit.~~ If other waste management units are permitted during the Disposal Phase, this Closure Plan will be revised to include the additional waste management units. At any given time during disposal operations, it is possible that multiple rooms may be receiving TRU mixed waste for disposal at the same time. Underground HWDUs in which disposal has been completed (i.e., in which CH and RH TRU mixed waste emplacement activities have ceased) will undergo panel closure.

G-1d(1) Schedule for Panel Closure

The anticipated schedule for the closure of the underground HWDUs known as Panels 3 through 10A~~8~~ is shown in Figure G-2. This schedule assumes there will be little contamination within the exhaust drift of the panel. Underground HWDUs should be ready for closure according to the schedule in Table G-1. These dates are estimates for planning and permitting purposes. Actual dates may vary depending on the availability of waste from the generator sites.

To ensure continued protection of human health and the environment, the Permittees will initially block ventilation through Panels 3 through 10A~~7~~ as described in Permit Attachment A2, Section A2-2a(3), after waste disposal in each panel has been completed. The Permittees shall continue VOC monitoring in such panels until final panel closure. If the measured concentration, as confirmed by a second sample, of any VOC in a panel exceeds the "95% Action Level" in Permit Part 4, Table 4.6.3.2, the Permittees will initiate closure of that panel by installing the 12-foot explosion-isolation wall as described in Section G-1e(1) and submit a Class 1* permit modification request to extend closure of that panel, if necessary. Regardless of the outcome of disposal room VOC monitoring, final closure of Panels 3 through 7 will be completed as specified in this Permit no later than January 31, 2016.

Table G-1
Anticipated Earliest Closure Dates for the Underground HWDUs

HWDU	OPERATIONS START	OPERATIONS END	CLOSURE START	CLOSURE END
PANEL 1	3/99*	3/03*	3/03*	7/03* SEE NOTE 5
PANEL 2	3/03*	10/05*	10/05*	3/06* SEE NOTE 5
PANEL 3	4/05*	2/07*	2/07*	2/07* SEE NOTE 5~~6~~
PANEL 4	1/07*	5/09*	5/09*	8/09* SEE NOTE 5~~6~~
PANEL 5	3/09*	7/11*	7/11*	1/12* SEE NOTE 5
PANEL 6	3/11*	~~1/13~~2/14	~~2/13~~3/14	~~8/13~~9/14 SEE NOTE 5
PANEL 7	~~1/13~~8/13	~~1/15~~9/17	~~2/15~~10/17	~~8/15~~4/18
PANEL 8	~~1/15~~1/17	~~1/17~~5/21	~~2/17~~6/21	~~8/17~~12/21
PANEL 9A	~~1/17~~9/20	~~1/28~~1/25	~~2/28~~2/25	~~SEE NOTE 4~~8/25
PANEL 10A	~~1/28~~5/24	9/30	10/30	~~SEE NOTE 4~~4/31

* Actual date

NOTE 1: ~~Only Panels 1 to 4 will be closed under the initial term of this permit. Closure schedules for Panels 5 through 10 are projected assuming new permits will be issued in 2009 and 2019~~Reserved.

NOTE 2: The point of closure start is defined as the date when ventilation to the panel is blocked per Permit Attachment A2~~60 days following notification to the NMED of closure~~.

NOTE 3: The point of closure end is defined as 180 days following placement of final waste in the panel.

NOTE 4: ~~The time to close these areas may be extended depending on the nature and extent of the disturbed rock zone. The excavations that constitute these panels will have been opened for as many as 40 years so that the preparation for closure may take longer than the time allotted in Figure G-2. If this extension is needed, it will be requested as an amendment to the Closure Plan~~Reserved.

NOTE 5: ~~Installation of the 12-foot explosion-isolation wall for Panels 1, 2, and 5 must be completed by the closure end date.~~ Final closure of Panels 1 through 6~~, 2, and 5~~ will be completed as specified in this Permit no later than January 31, 2016.

~~NOTE 6: Final closure of Panels 3 and 4 will be completed as specified in this Permit no later than January 31, 2016.~~

ATTACHMENT H1

ACTIVE INSTITUTIONAL CONTROLS DURING POST-CLOSURE

Introduction

Background: The WIPP was sited and designed as a research and development facility to demonstrate the safe disposal of radioactive wastes. The wastes are derived from DOE defense-related activities. Specifically, the mission of the WIPP project is to conduct research, demonstration, and siting studies relevant to the permanent disposal of TRU wastes. Most of these wastes will be contaminated with hazardous constituents, making them mixed wastes.

Upon receipt and inspection of the waste containers in the waste handling building, the containers will be moved into the repository 2,150 feet (655 meters) below the surface. The containers will then be transported to a disposal room. (See Figure H1-1 for room and panel arrangement.) The initial seven disposal rooms are in Panel 1. Panel 1 is the first of ~~eight~~10 panels planned to be excavated. Special supports and ground control corrective actions have been implemented in Panel 1 to ensure its stability. Upon filling an entire panel, that panel will be closed to isolate it from the rest of the repository and the ventilation system. During the period of time it takes to fill a given panel, an additional panel will be excavated. Sequential excavation of Panels 2 through 10A~~8~~ will ensure that these individual panels remain stable during the entire time a panel is being filled with waste. ~~Ground control maintenance and evaluation with appropriate corrective action will be required to ensure that Panels 9 and 10 (ventilation and access drifts in the repository) remain stable.~~

Decontamination of the WIPP facility will commence with a detailed radiation survey of the entire site. Contaminated areas and equipment will be evaluated and decontaminated in accordance with applicable requirements. Where decontamination efforts identify areas that meet clean closure standards for permitted container storage units and are below radiological release criteria, routine dismantling and salvaging practices will determine the disposition of the material or equipment involved. Material and equipment that do not meet these standards and criteria will be emplaced in the ~~access entries (Panels 9 and/or 10)~~last open panel. Upon completion of emplacement of the contaminated facility material, the entries will be closed and the repository shafts will be sealed. Final repository closure includes sealing the shafts leading to the repository. Figure H1-3 illustrates the shaft sealing arrangement. Certification of closure will end disposal operations and initiate the post-closure care period for implementation of active institutional controls.

H1.1.1 Repository Footprint Fencing

Access to an area approximately ~~2,780~~2,870 feet by ~~2,360~~2,610 feet (875 meters by ~~720~~796 meters) will be controlled by a four-strand barbed wire fence. A single gate will be included along each side of the fence for access. These gates will remain locked with access controlled by the Permittees. Around the perimeter of the fence, an unpaved roadway 16 feet (4.9 meters) wide will be cut to allow for patrolling of the perimeter. Figure H1-4 is an illustration of the fence line in relation to the repository footprint. Patrolling of the perimeter is based upon the need to ensure that no mining or well drilling activity is initiated that could threaten the integrity of the repository.

ATTACHMENT N

VOLATILE ORGANIC COMPOUND MONITORING PLAN

TABLE OF CONTENTS

N-1a Background

The Underground HWDUs are located 2,150 feet (ft) (655 meters [m]) below ground surface, in the WIPP underground. As defined for this Permit, an Underground HWDU is a single excavated panel consisting of seven rooms and two access drifts designated for disposal of contact-handled (**CH**) and remote-handled (**RH**) transuranic (**TRU**) mixed waste. Each room is approximately 300 ft (91 m) long, 33 ft (10 m) wide, and 13 ft (4 m) high. Access drifts connect the rooms and have the same cross section. The Permittees shall dispose of TRU mixed waste in Underground HWDUs designated as Panels 1 through 10A~~8~~.

N-3a(1) Sampling Locations for Repository VOC Monitoring

The initial configuration for the repository VOC monitoring stations is shown in Figure N-1. All mine ventilation air which could potentially be impacted by VOC emissions from the Underground HWDUs identified as Panels 1 through 10A~~8~~ will pass monitoring Station VOC-A, located in the E-300 drift as it flows to the exhaust shaft. Air samples will be collected at two locations in the facility to quantify airborne VOC concentrations. VOC concentrations attributable to VOC emissions from open and closed panels containing TRU mixed waste will be measured by placing one VOC monitoring station just downstream from Panel 1 at VOC-A. The location of Station VOC-A will remain the same throughout the term of this Permit. The second station (Station VOC-B) will always be located upstream from the open panel being filled with waste (starting with Panel 1 at monitoring Station VOC-B (Figure N-1). In this configuration, Station VOC-B will measure VOC concentrations attributable to releases from the upstream sources and other background sources of VOCs, but not releases attributable to open or closed panels. The location of Station VOC-B will change when disposal activities begin in the next panel. Station VOC-B will be relocated to ensure that it is always upstream of the open panel that is receiving TRU mixed waste. Station VOC-A will also measure upstream VOC concentrations measured at Station VOC-B, plus any additional VOC concentrations resulting from releases from the closed and open panels. A sample will be collected from each monitoring station on designated sample days. For each quantified target VOC, the concentration measured at Station VOC-B will be subtracted from the concentration measured at Station VOC-A to assess the magnitude of VOC releases from closed and open panels.

N-3a(3) Sampling Locations for Ongoing Disposal Room VOC Monitoring in Panels 3 through 8

The Permittees shall continue VOC monitoring in Room 1 of a filled panelPanels 3 through 8 after completion of waste emplacement until final panel closure unless an explosion-isolation wall is installed in the panel.

ATTACHMENT N1

~~VOLATILE ORGANIC COMPOUND~~HYDROGEN AND METHANE MONITORING PLAN

N1-1 Introduction

This Permit Attachment describes the monitoring plan for hydrogen and methane generated in Underground Hazardous Waste Disposal Units (**HWDUs**) 3 through 10A~~8~~, also referred to as Panels 3 through 10A~~8~~.

Monitoring for hydrogen and methane in Panels 3 through 10A~~8~~ until final panel closure, unless an explosion-isolation wall is installed, may be an effective way to gather data to establish realistic gas generation rates. This plan includes the monitoring design, a description of sampling and analysis procedures, quality assurance (**QA**) objectives, and reporting activities.

N1-2 Parameters to be Analyzed and Monitoring Design

The Permittees will monitor for hydrogen and methane in filled Panels 3 through 10A~~8~~ until final panel closure, unless an explosion-isolation wall is installed. A “filled panel” is an Underground HWDU that will no longer receive waste for emplacement.

Appendix C
Proposed Revised Permit Figures

Figures with Revisions Showing the Changes in “Clouds"

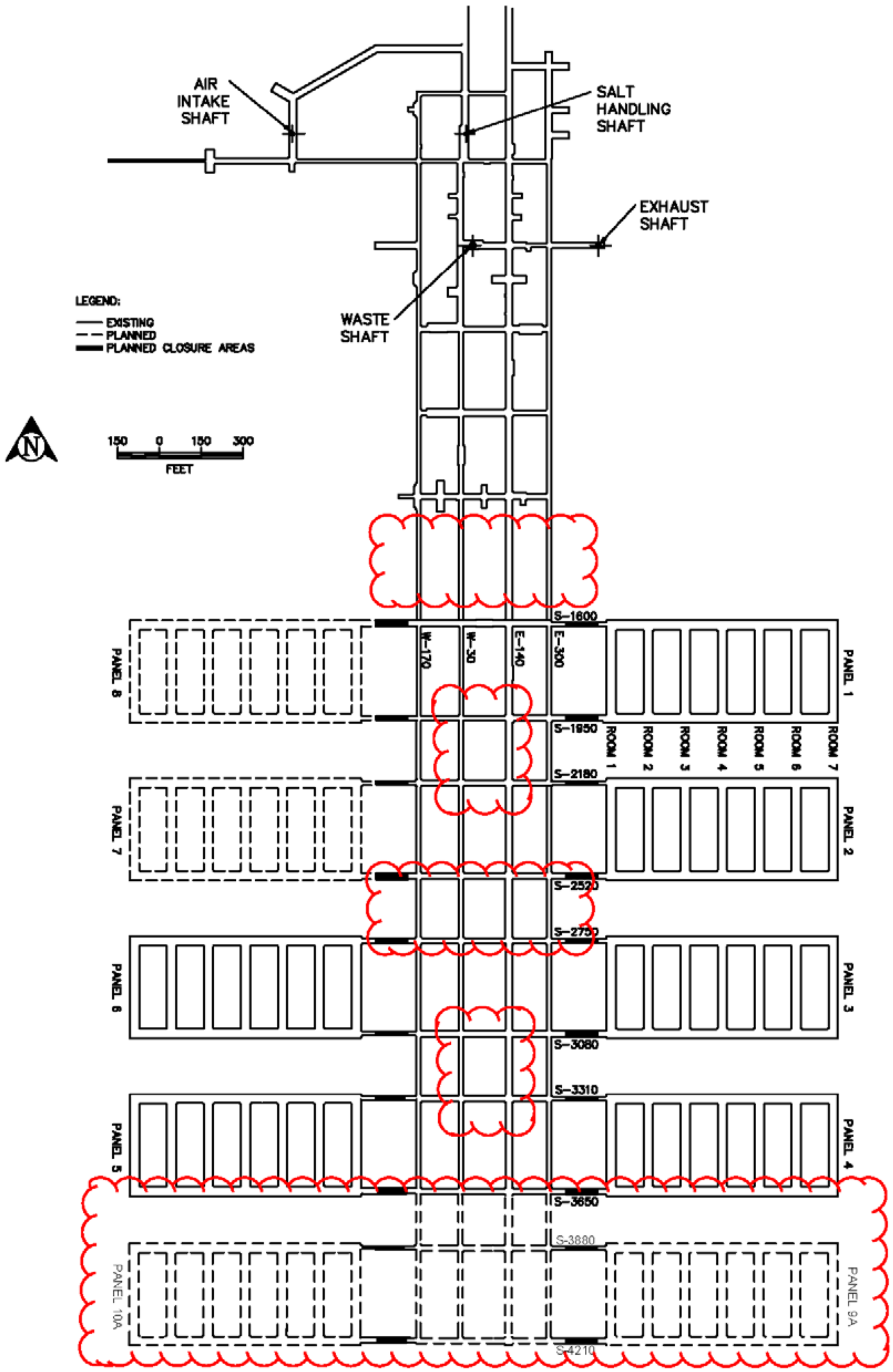


Figure A2-1
Repository Horizon

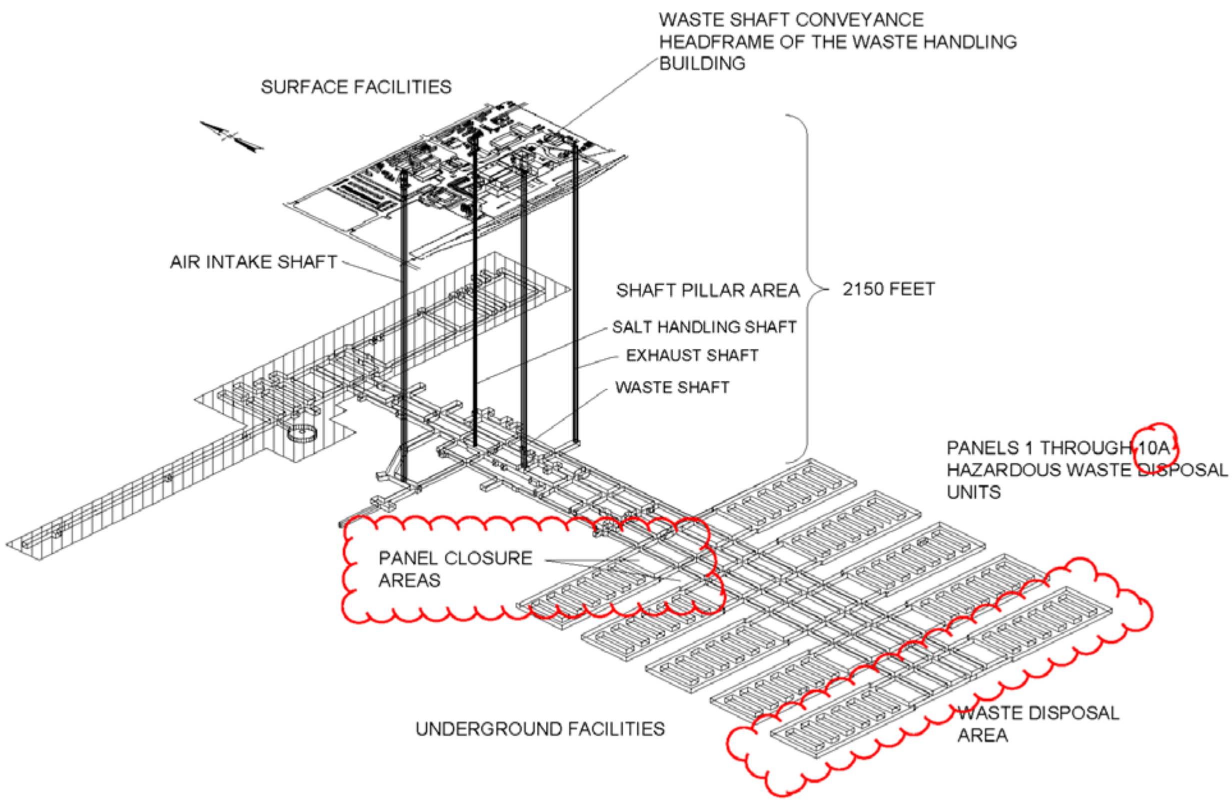


Figure A2-2
Spatial View of the Miscellaneous Unit and Waste Handling Facility

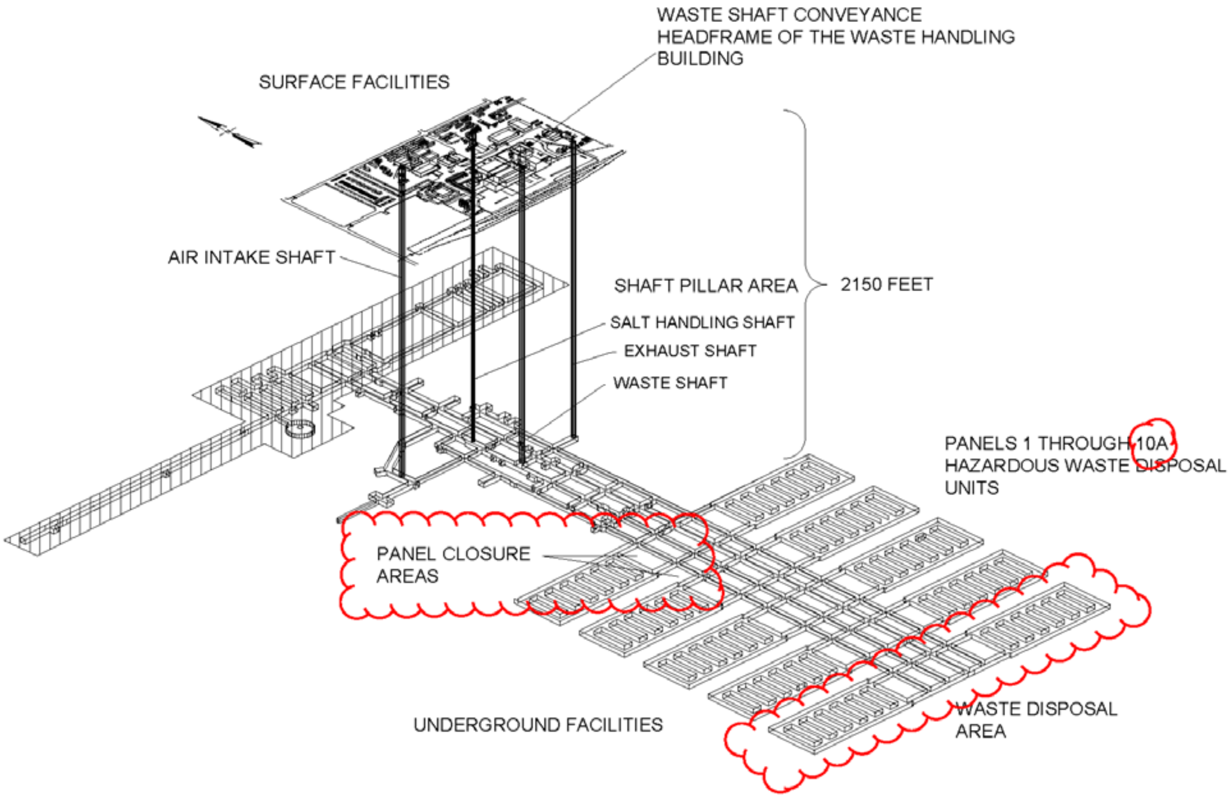


Figure B3-1
Spatial View of the WIPP Facility

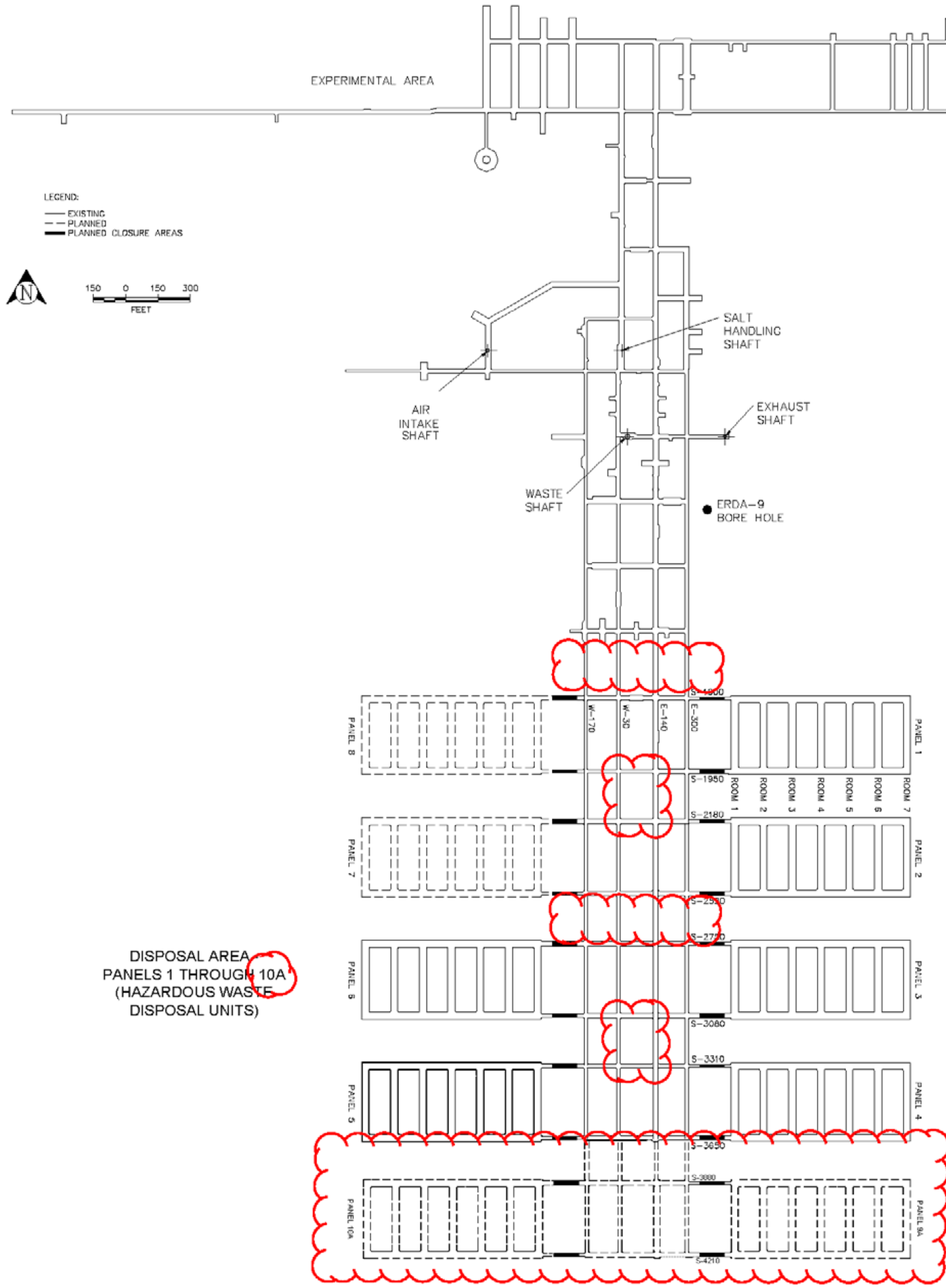


Figure B3-2
Repository Horizon

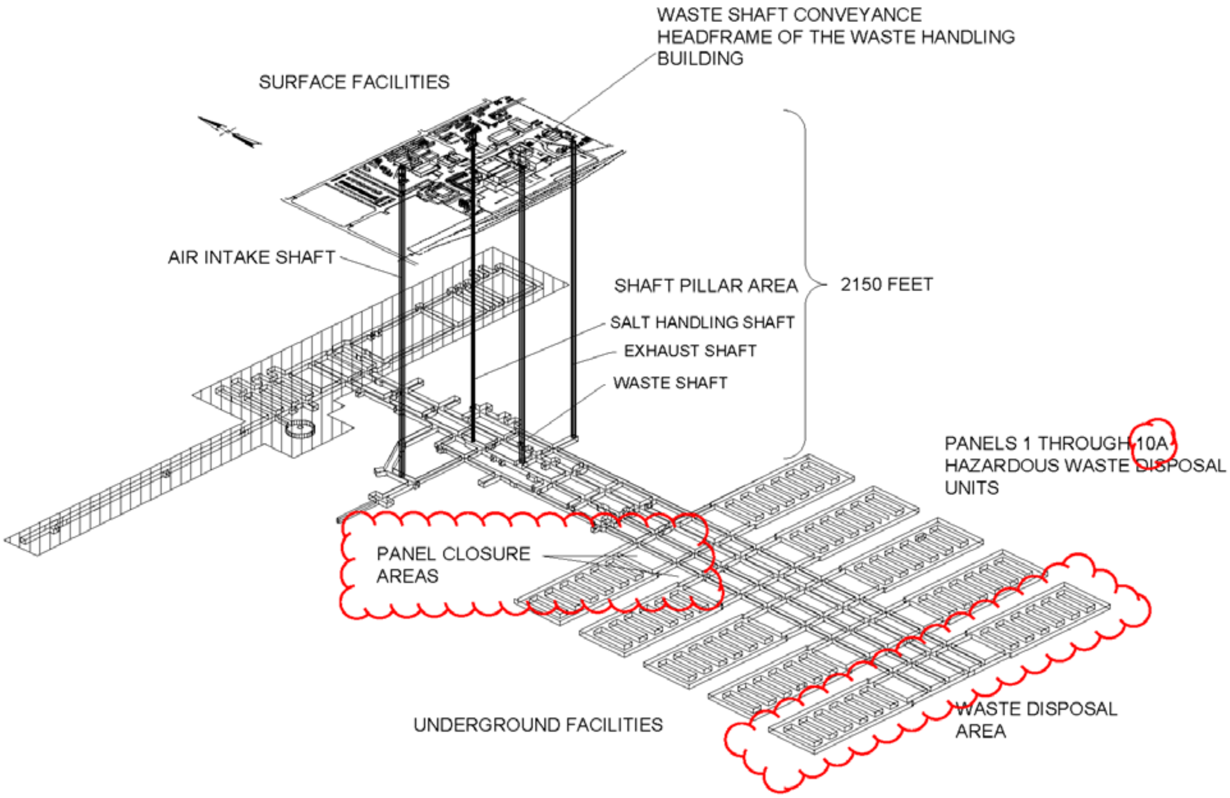


Figure D-2
Spatial View of the WIPP Facility

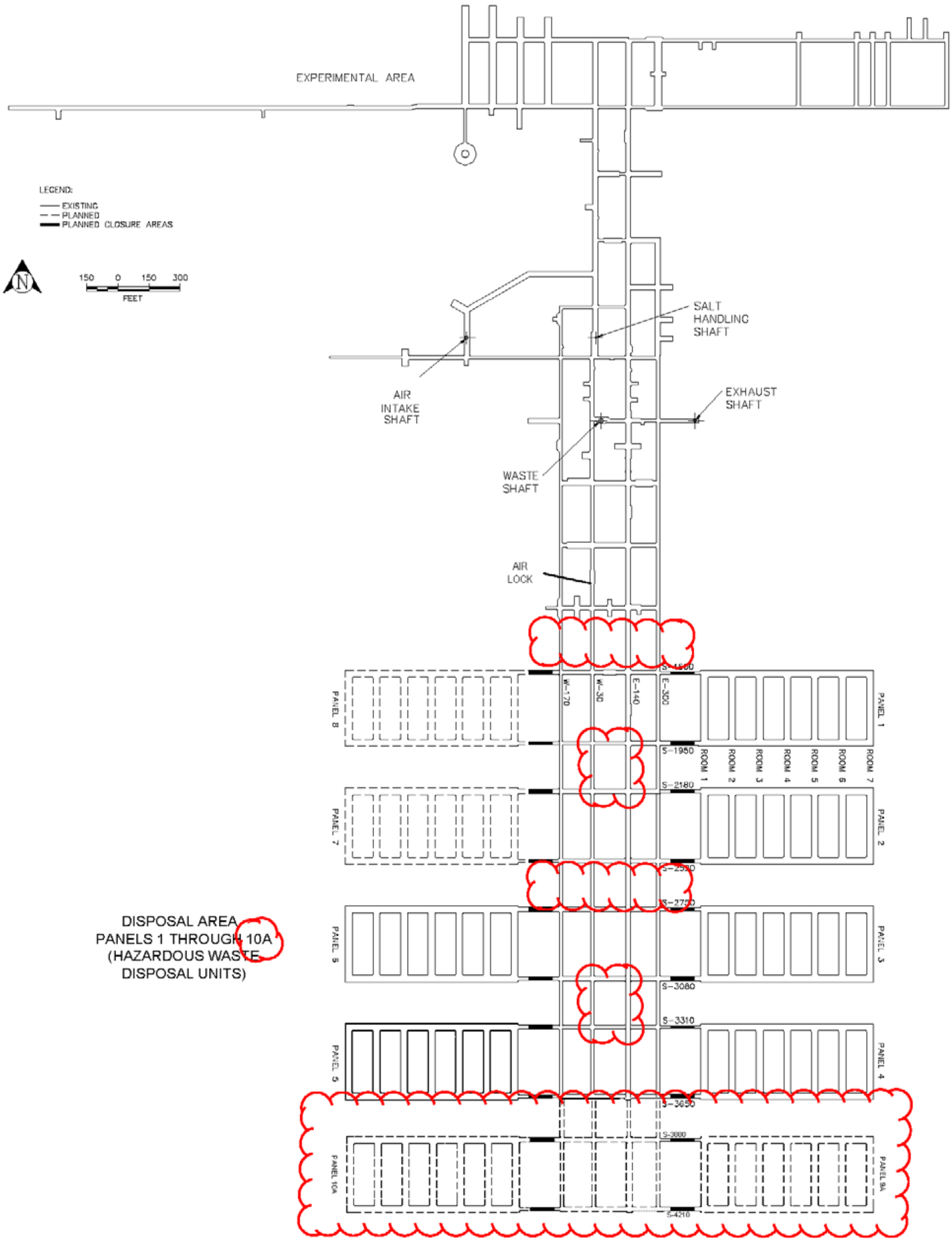


Figure D-3
WIPP Underground Facilities

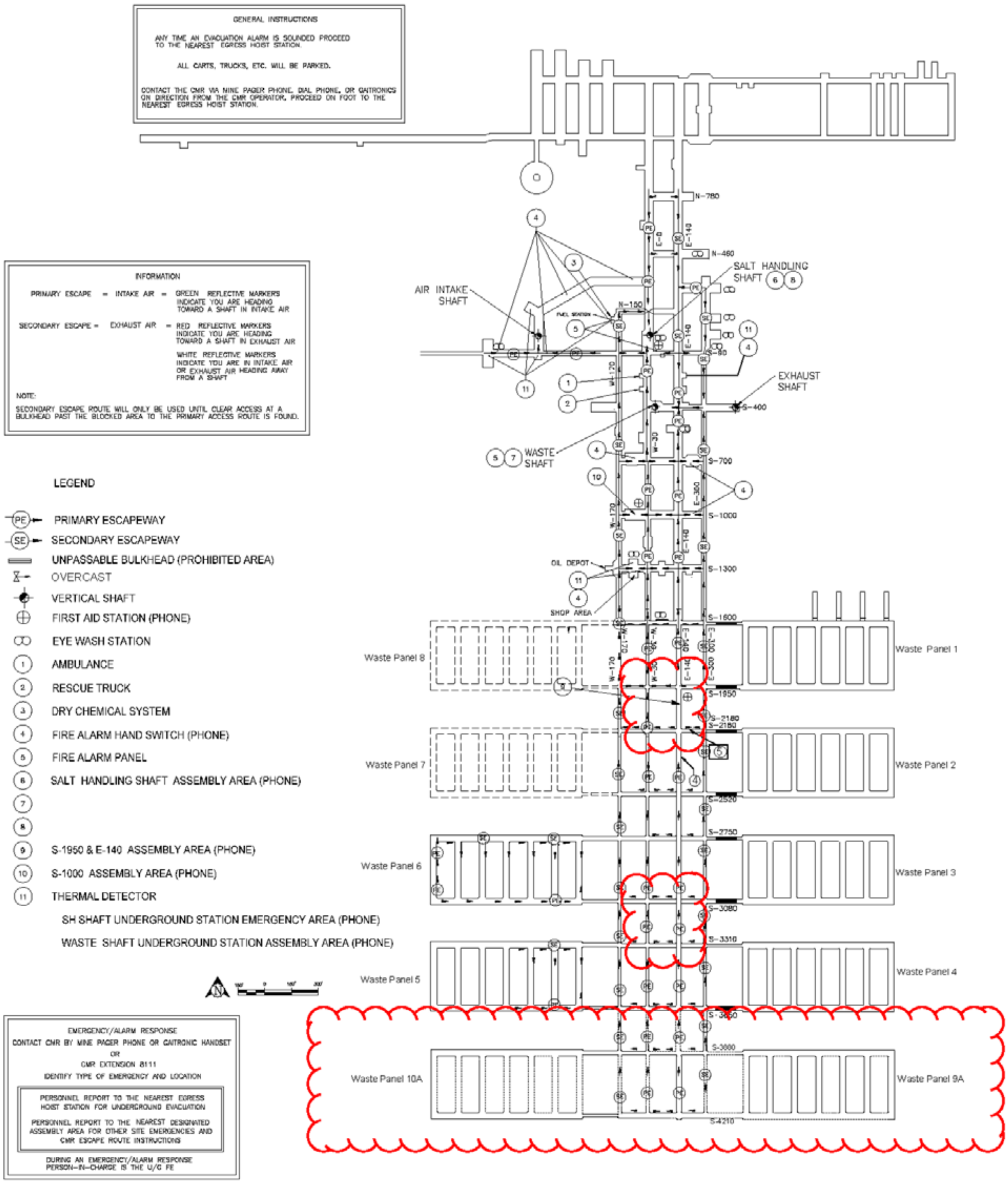


Figure D-5
Underground Emergency Equipment Locations and Underground Evacuation Routes

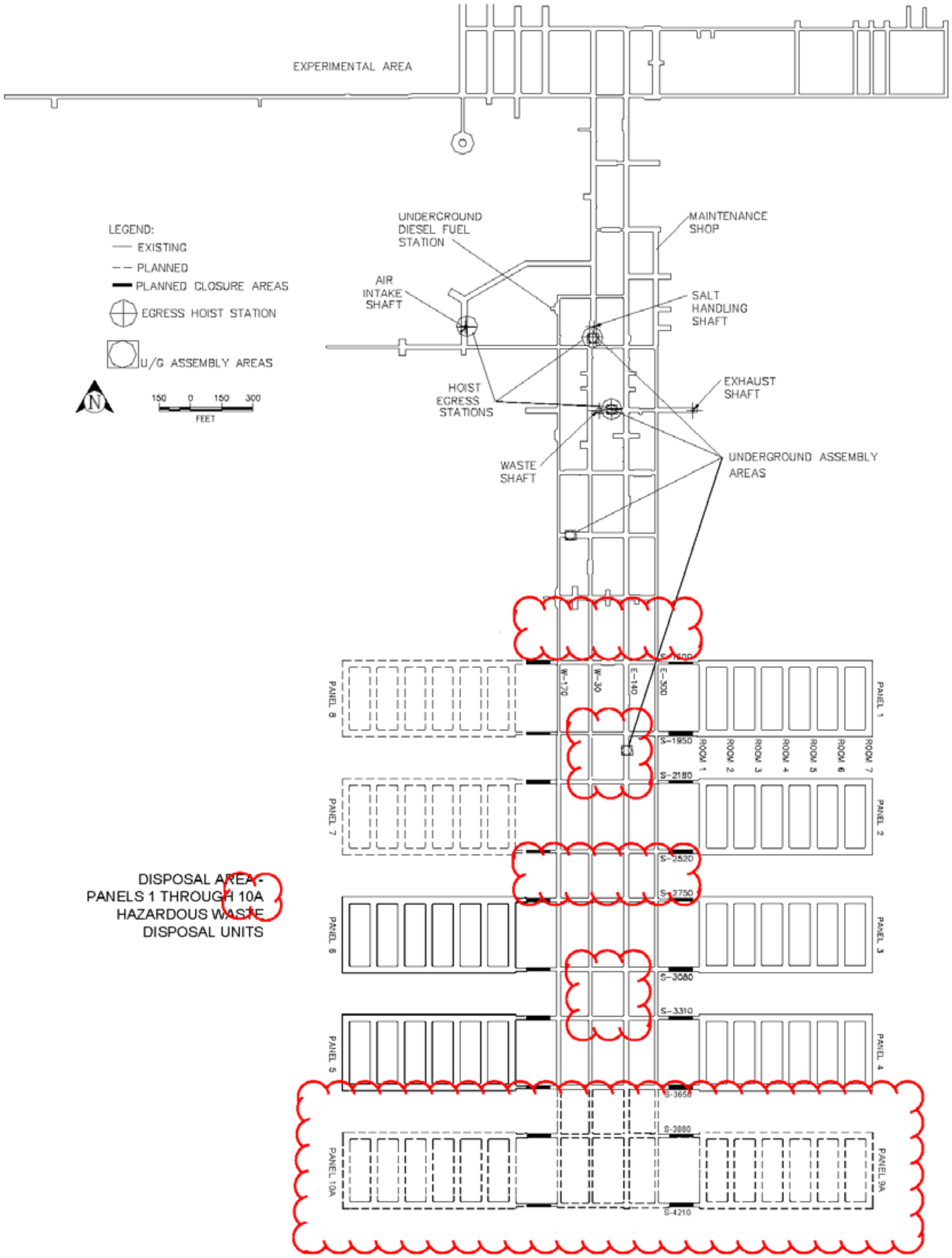


Figure D-9
Designated Underground Assembly Areas

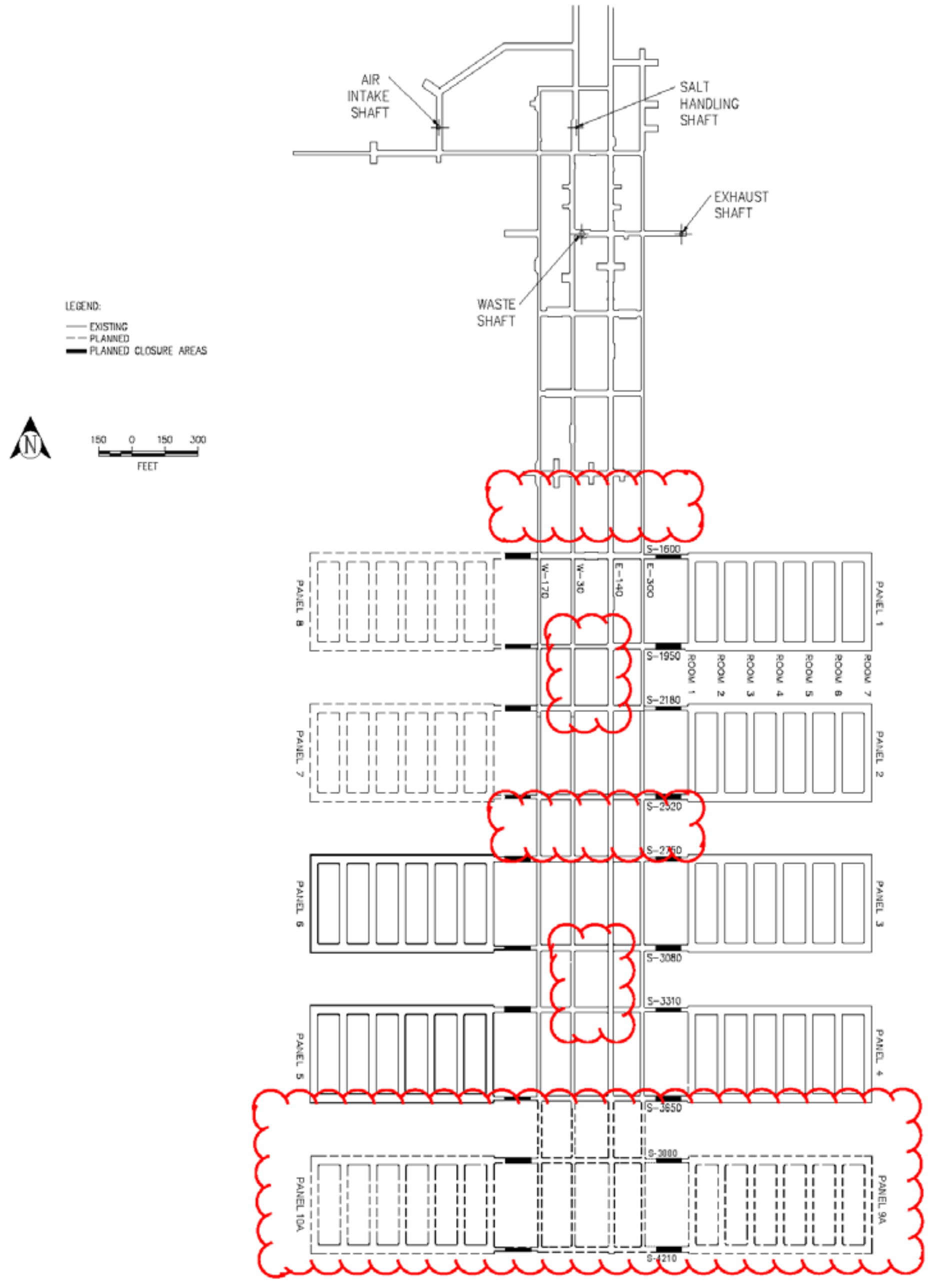


Figure G-1
Location of Underground HWDUs and Anticipated Closure Locations

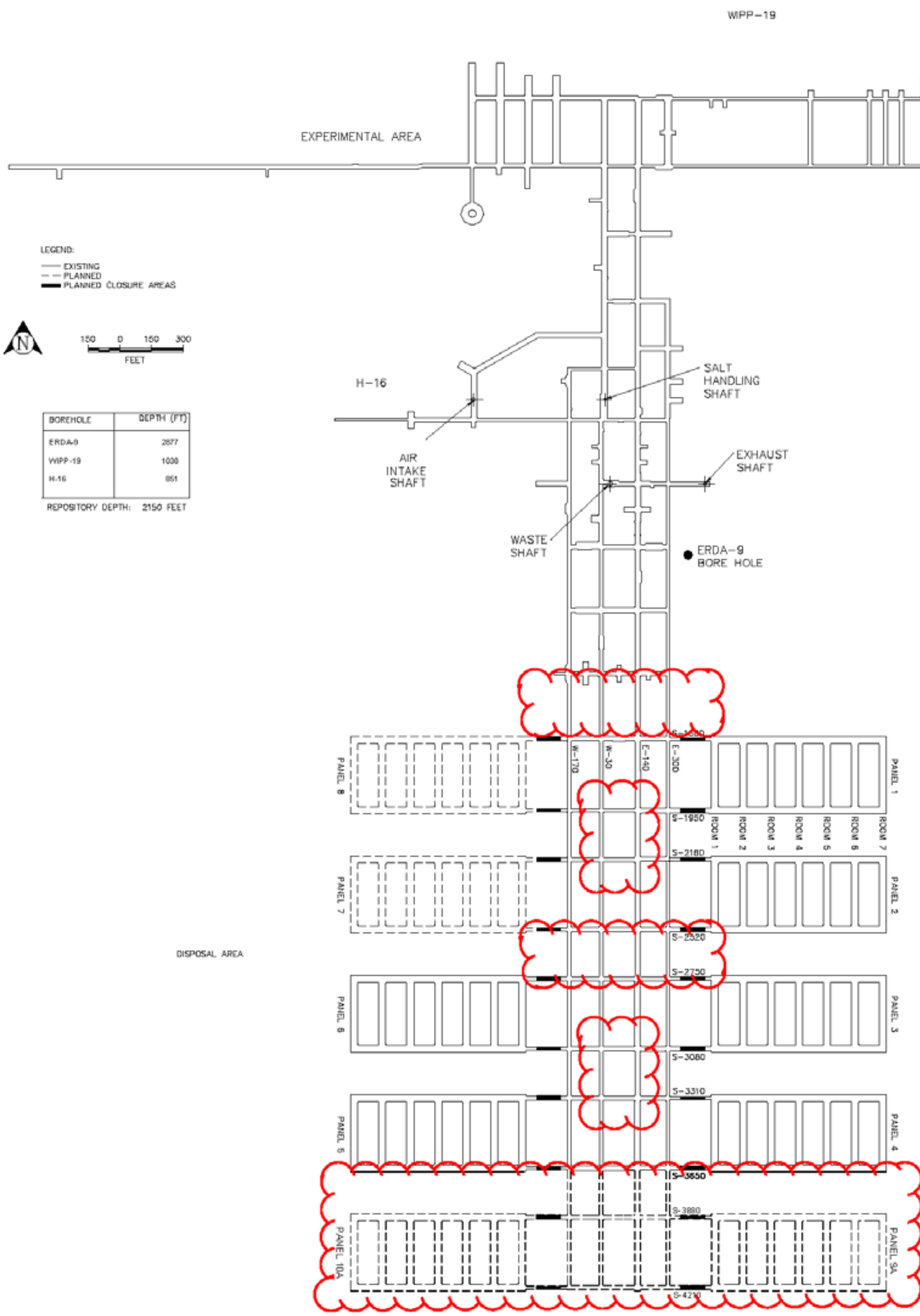


Figure G-6
Approximate Location of Boreholes in Relation to the WIPP Underground

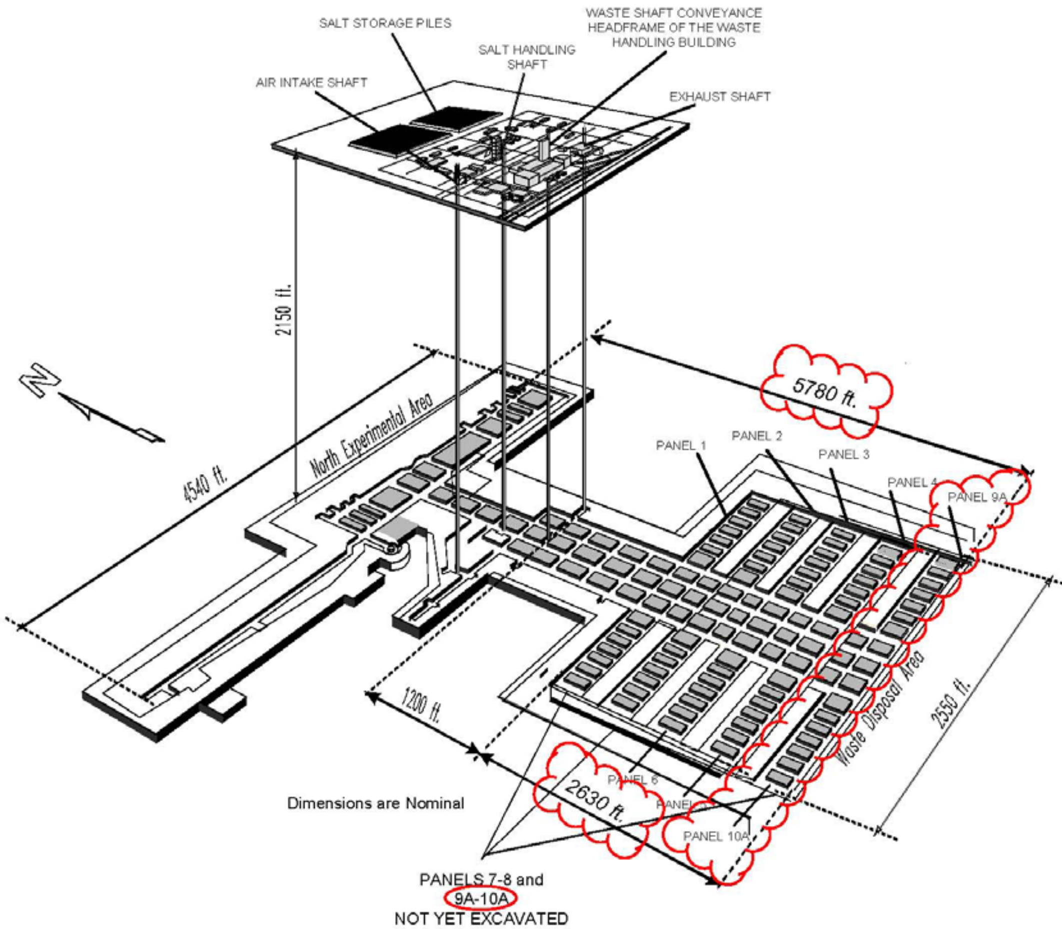


Figure G2-1
View of the WIPP Underground Facility

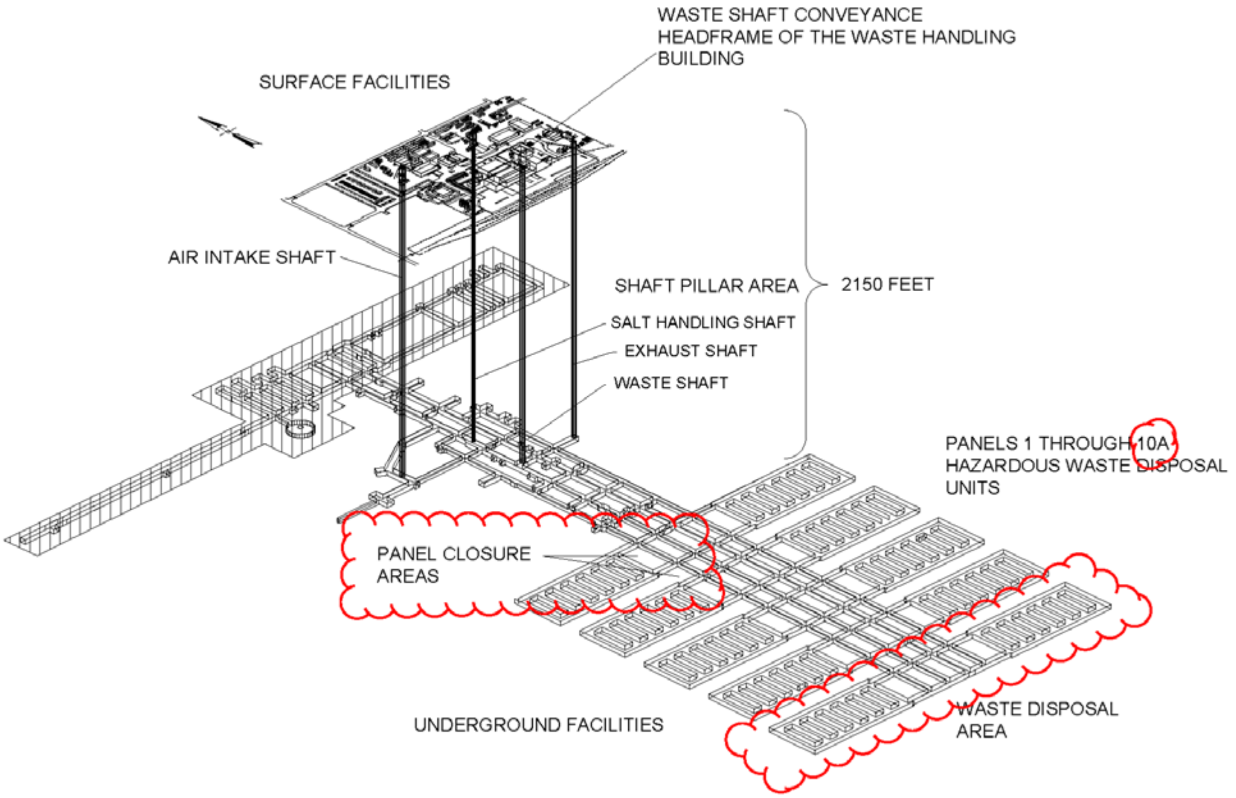


Figure H1-1
Spatial View of WIPP Surface and Underground Facilities

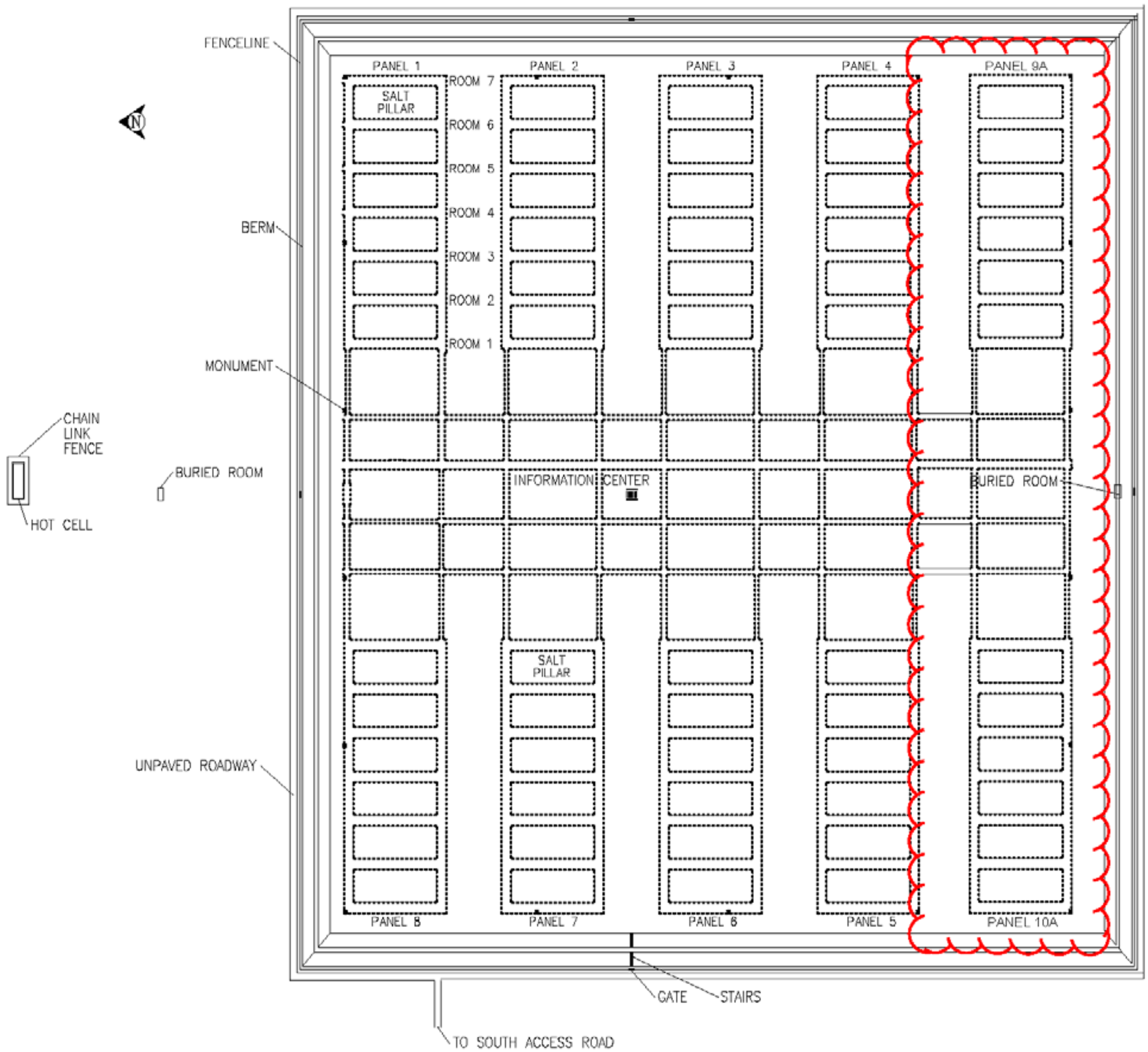


Figure H1-4
Perimeter Fenceline and Roadway

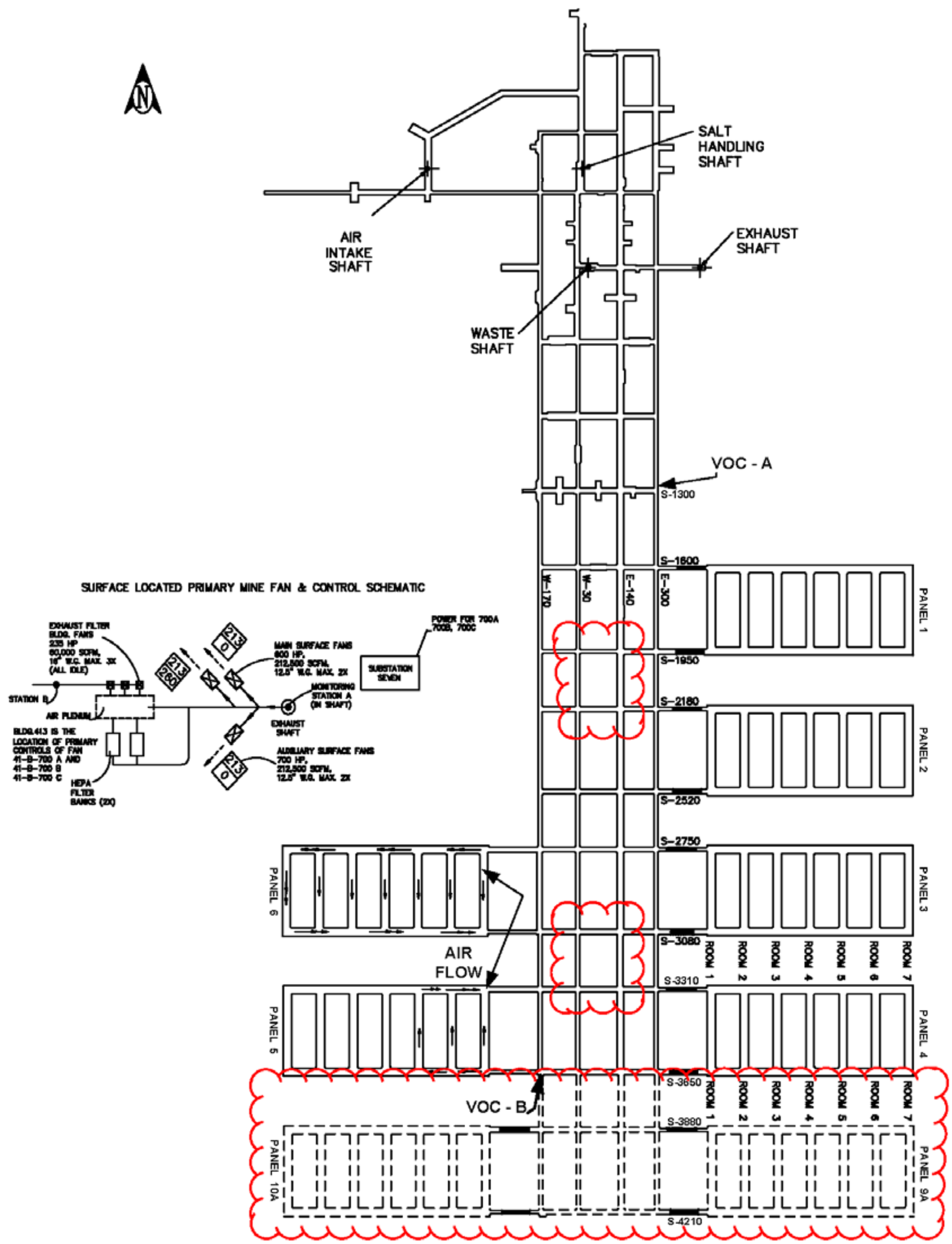
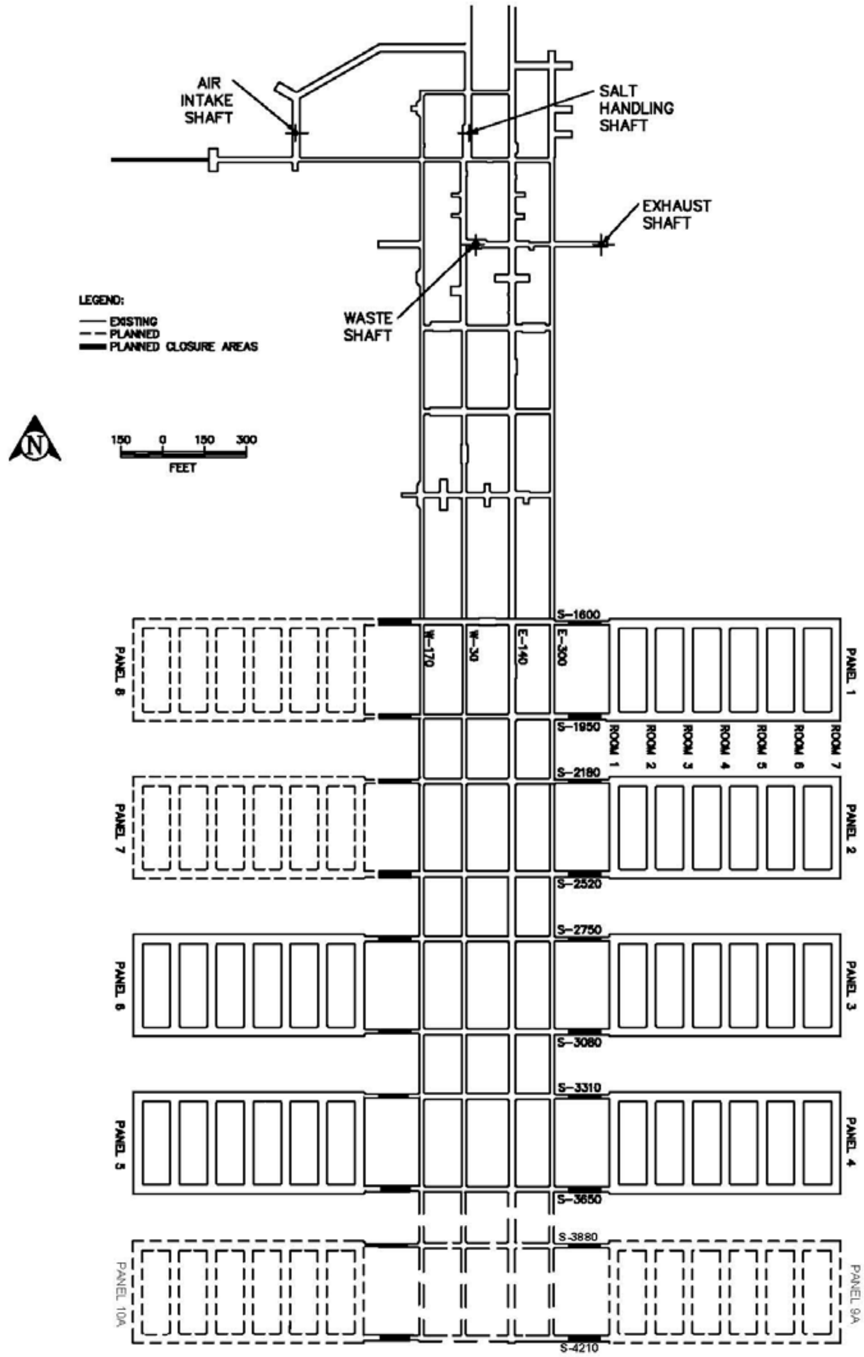


Figure N-1
Panel Flow Area

“Clean Figures” which are ones without the “clouds”



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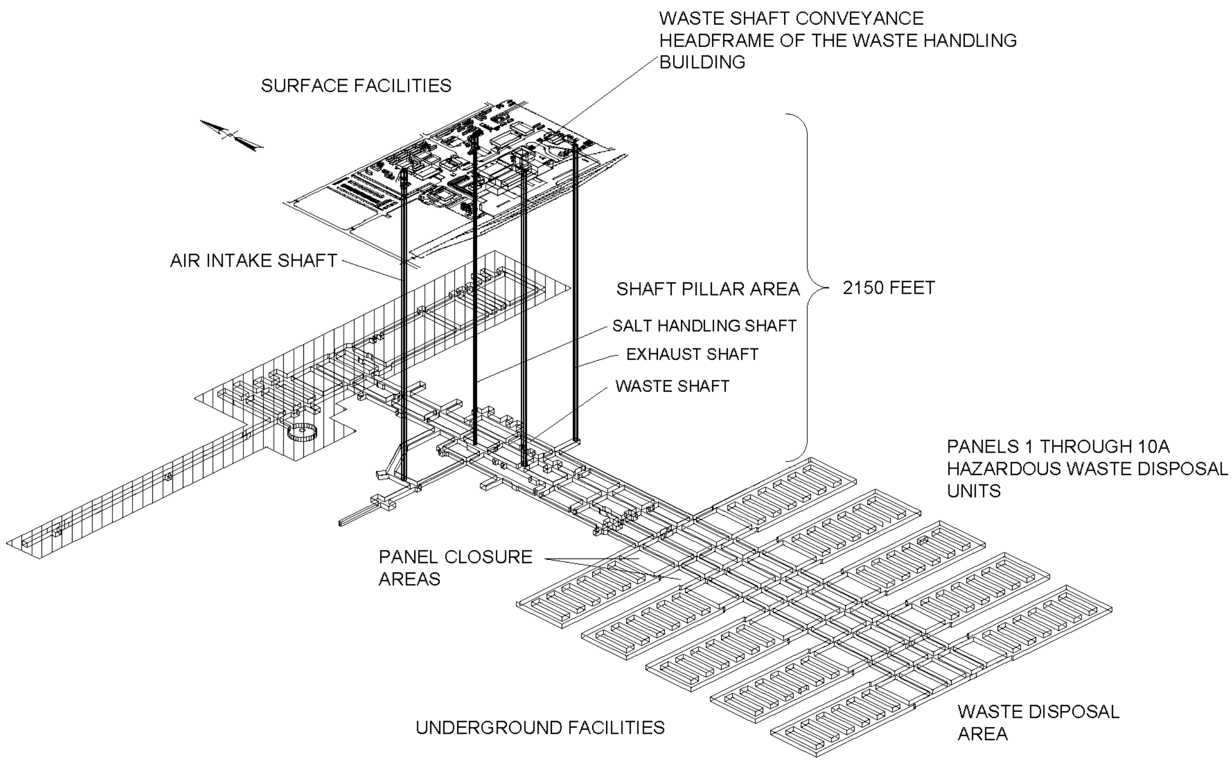

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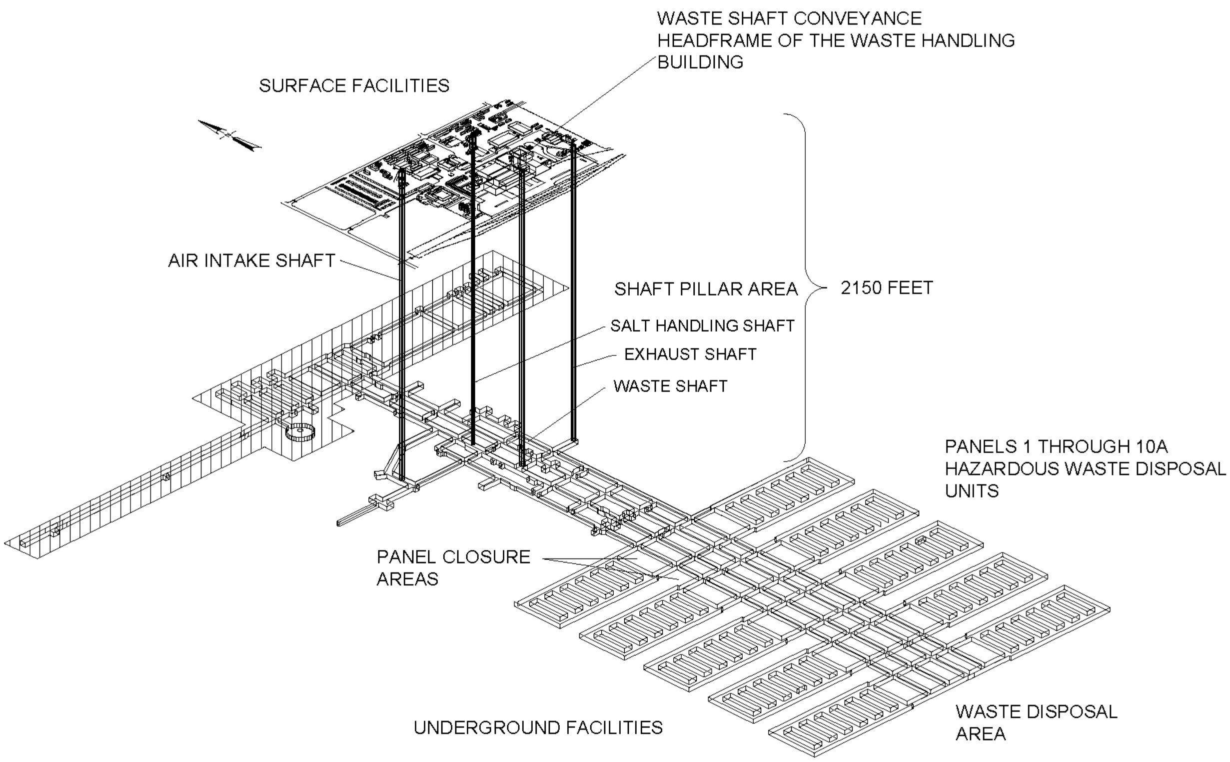

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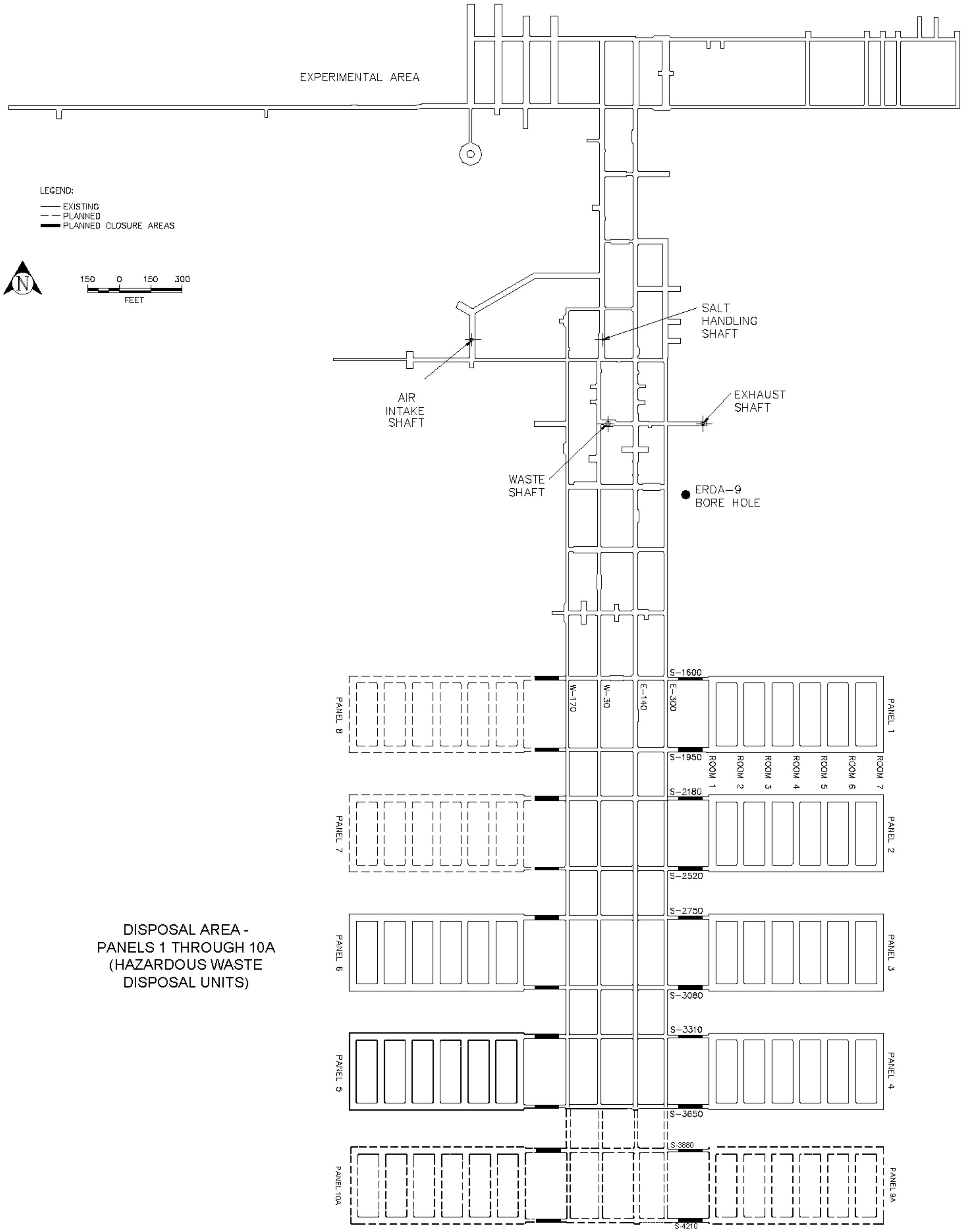
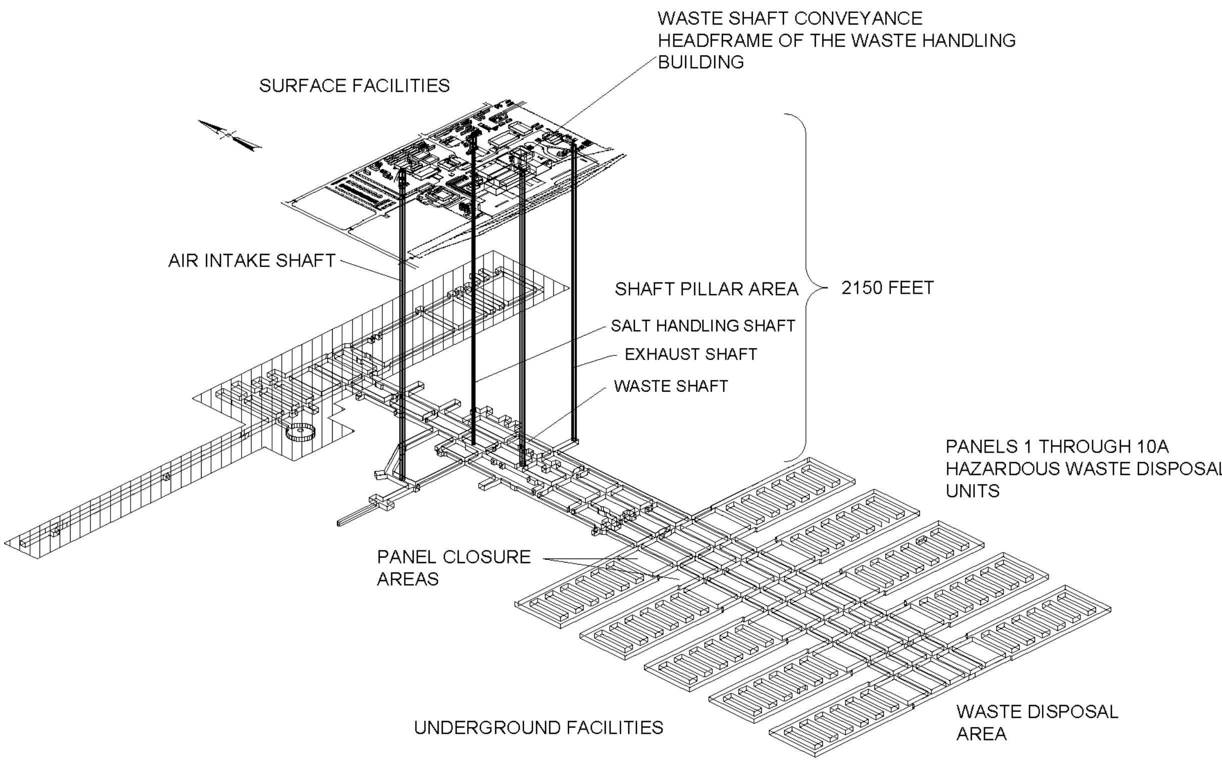


Figure B3-2
Repository Horizon



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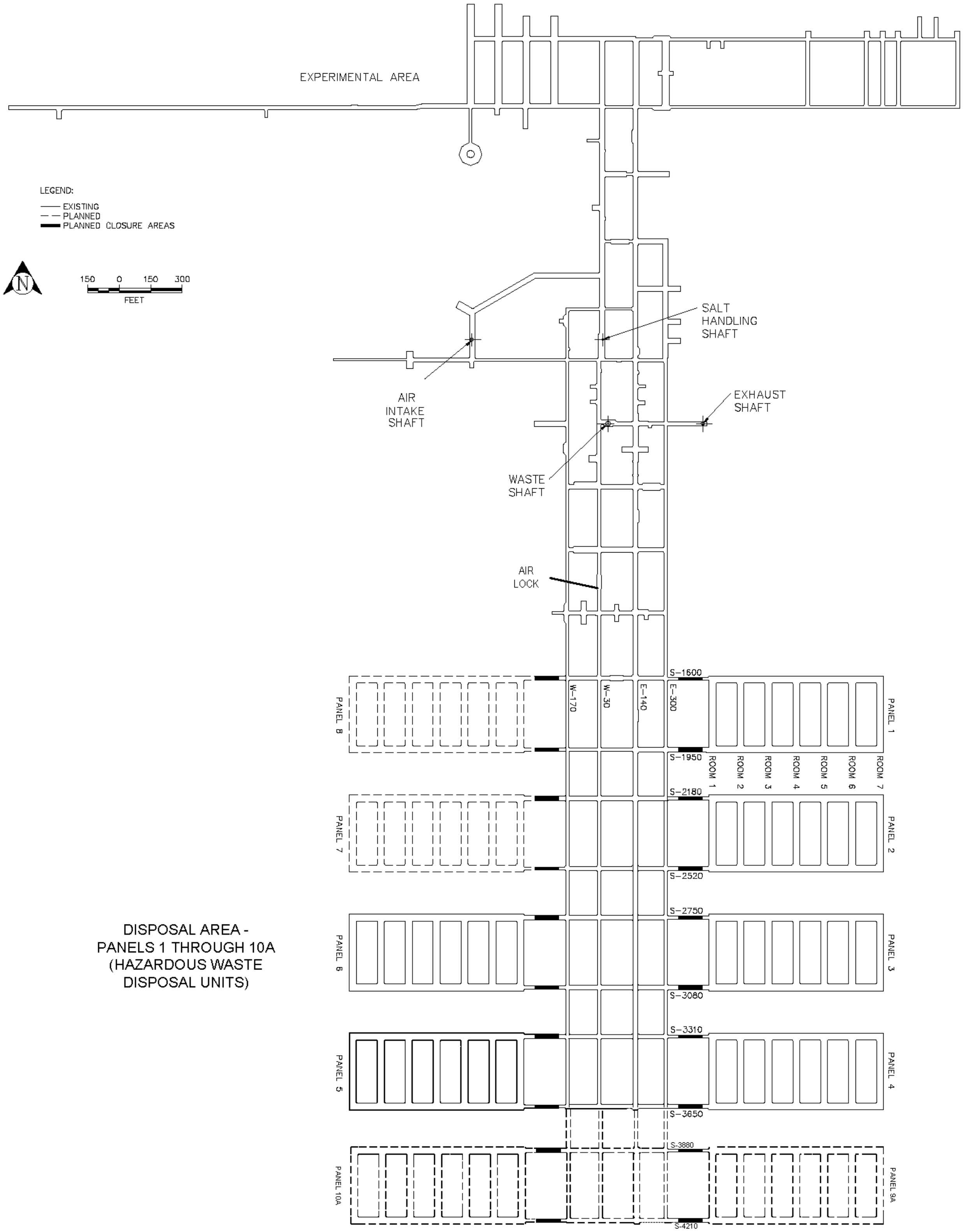
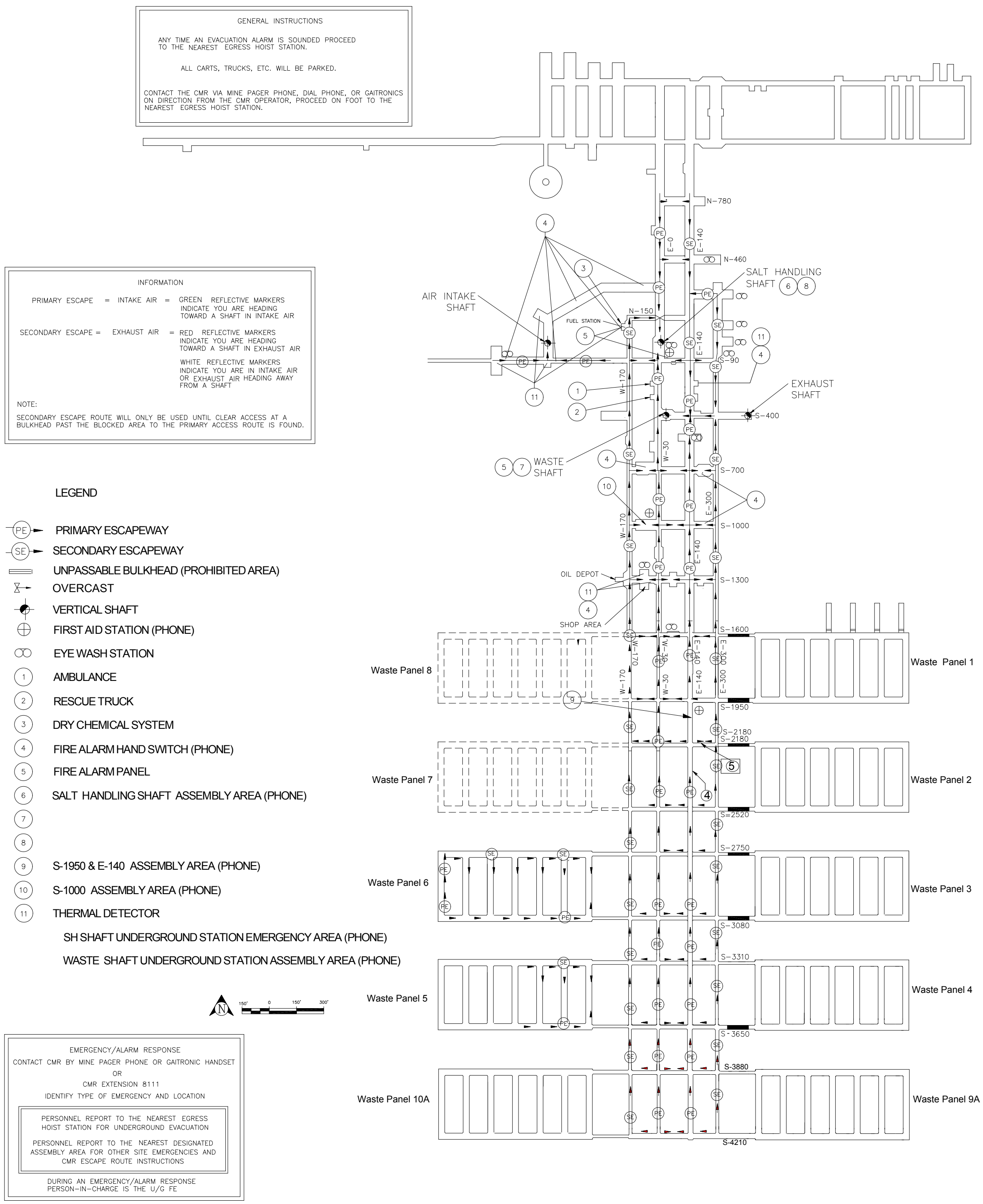


Figure D-3
WIPP Underground Facilities



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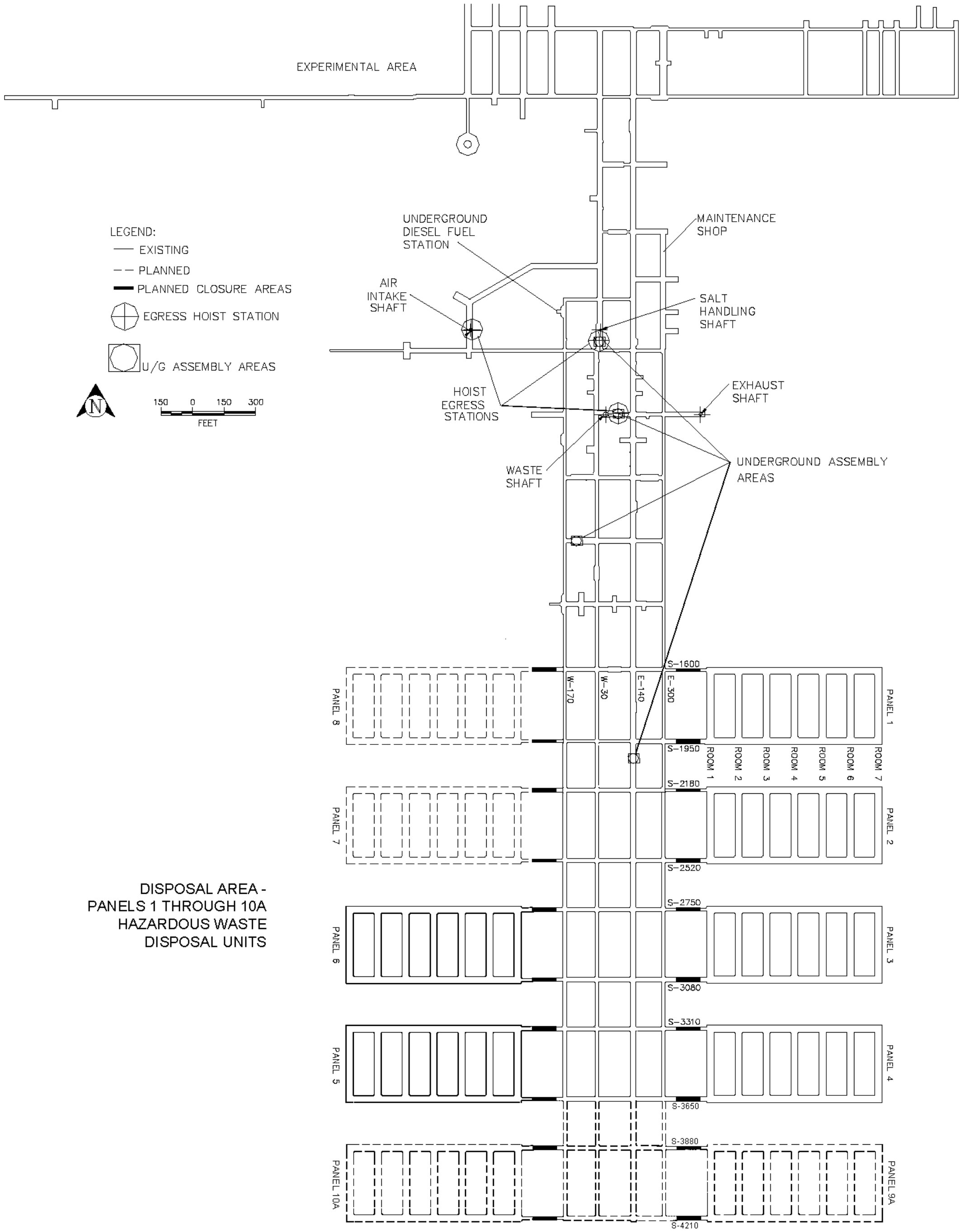

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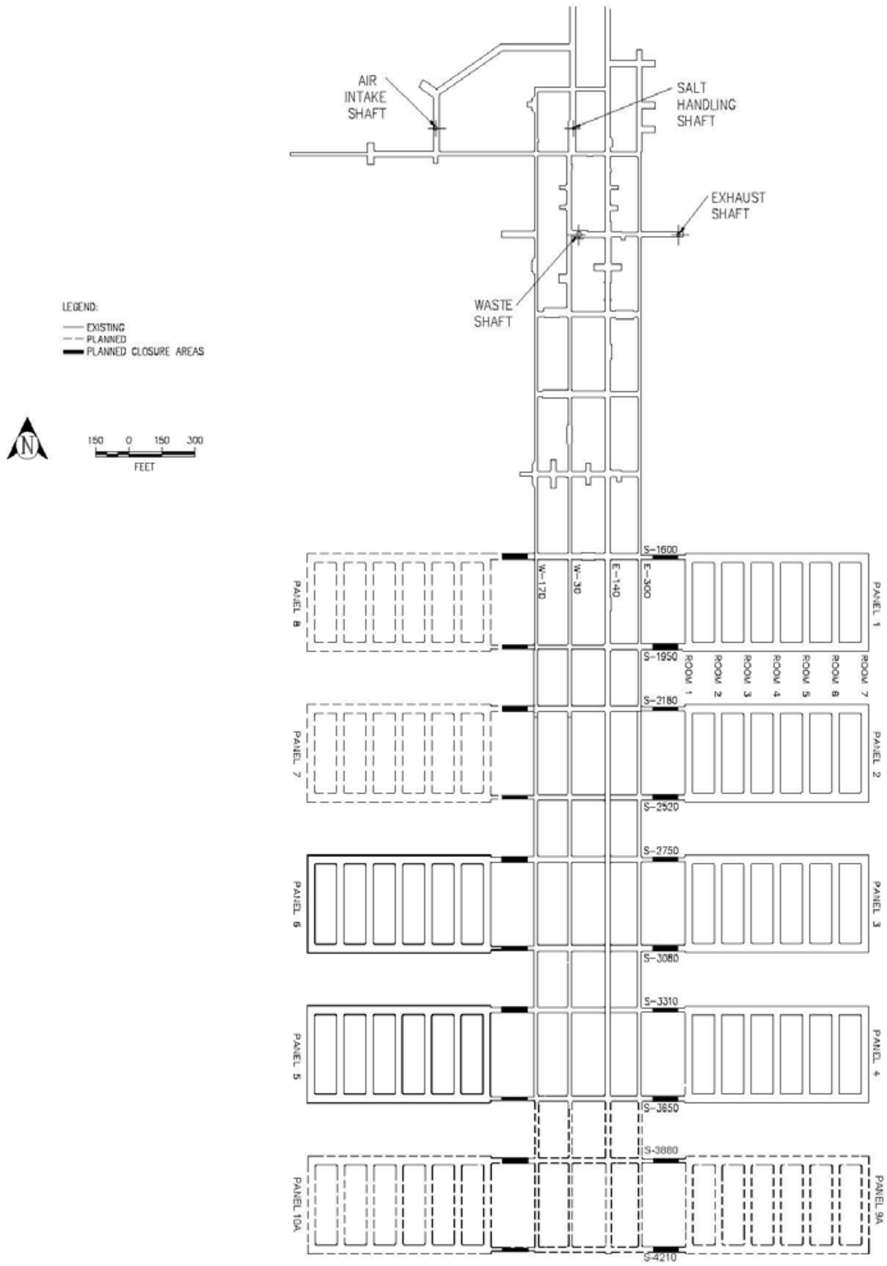

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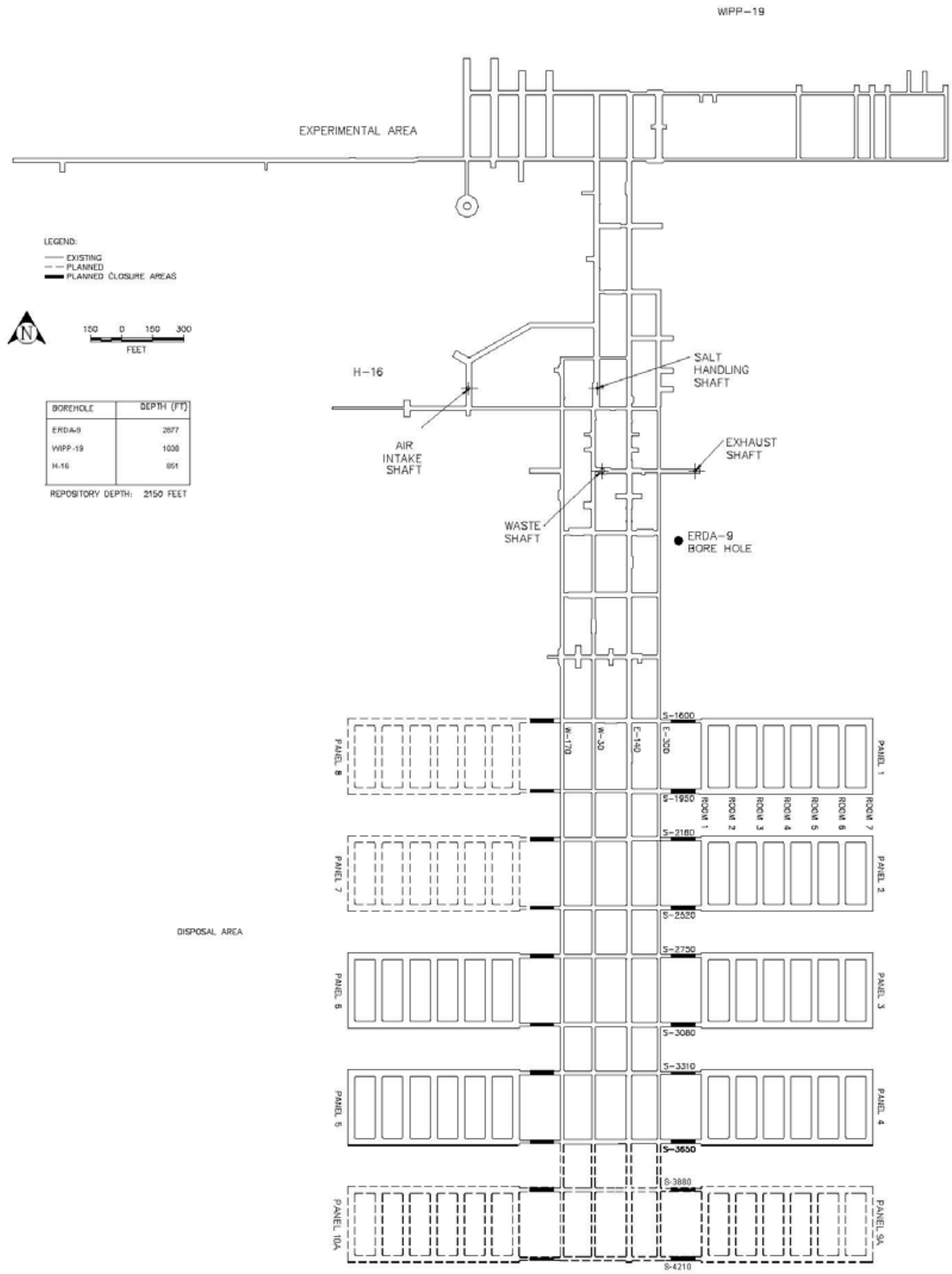

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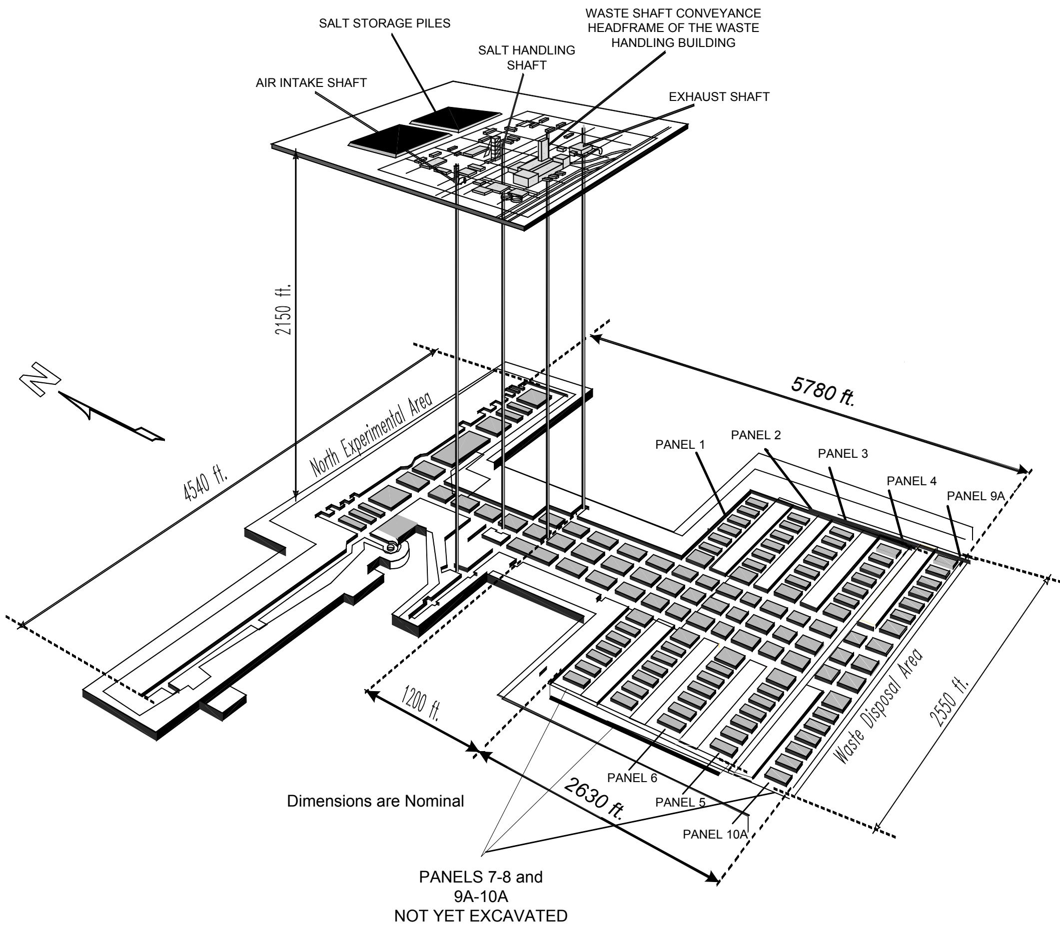

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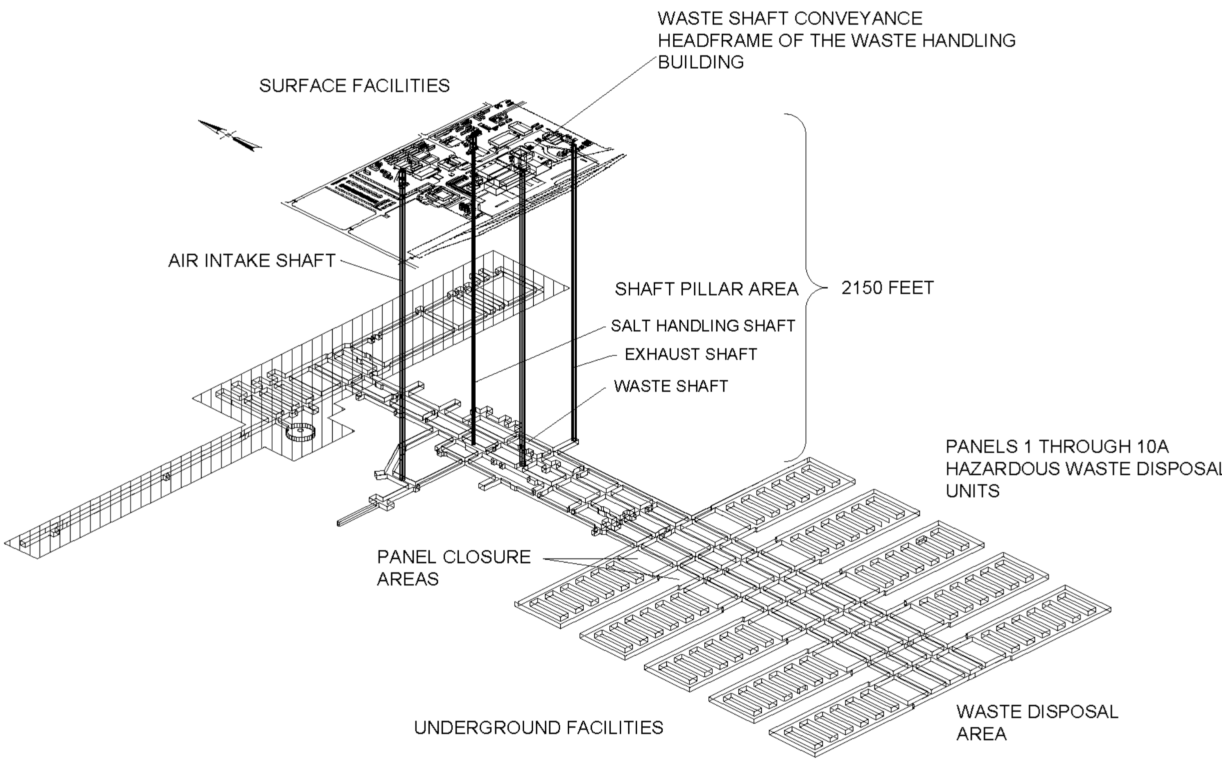

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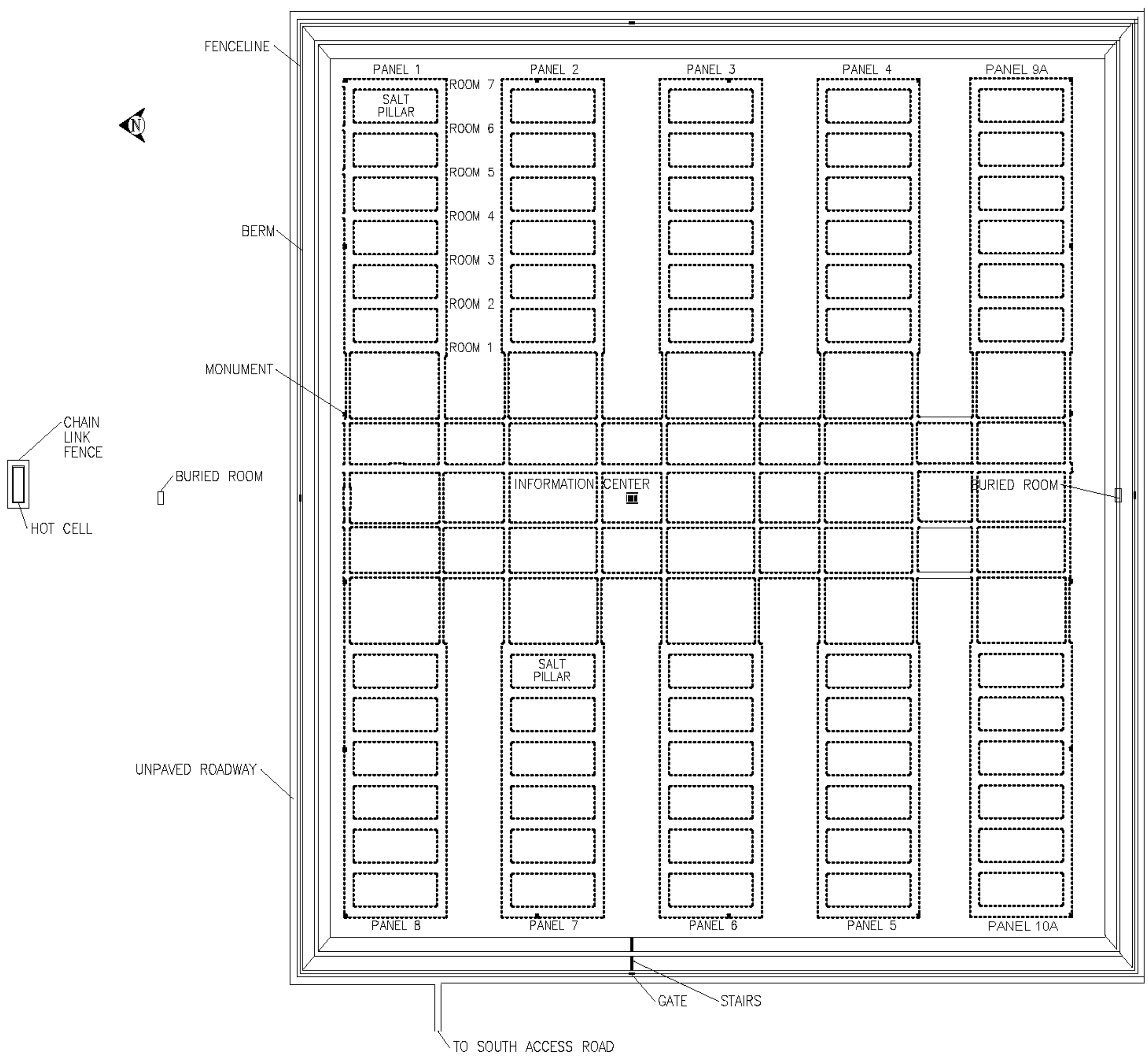

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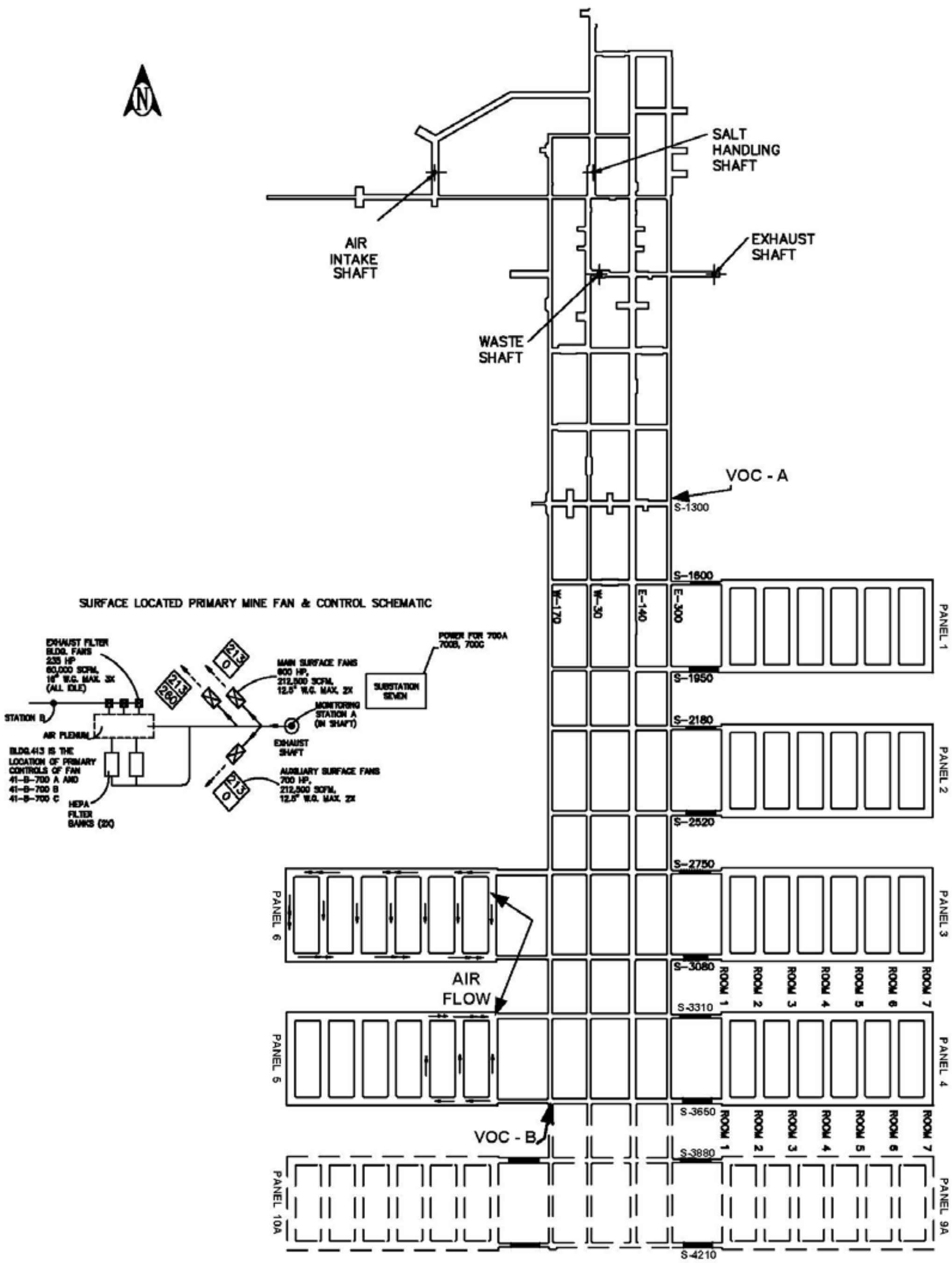

Figure N-1
Panel Flow Area

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Item 3

Class 3 Permit Modification Request

Revise Volatile Organic Compound (VOC) Target Analyte List
Other changes to VOC Monitoring Program

Waste Isolation Pilot Plant
Carlsbad, New Mexico

WIPP Permit Number - NM4890139088-TSDF

March 2013

Table of Contents

Acronyms and Abbreviations

ADF	air dispersion factor
ARA	additional requested analyte
CFR	Code of Federal Regulations
CH	contact-handled
COC	concentration of concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
HI	hazard index
HWDU	hazardous waste disposal unit
IDLH	immediately dangerous to life and health
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
LEL	lower explosive limit
MDL	method detection limit
MRL	method reporting limit
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
OSHA	Occupational Safety and Health Administration
PASK	passive air sampling kit
Permit	Hazardous Waste Facility Permit
PMR	Permit Modification Request
ppbv	parts per billion by volume
ppmv	parts per million by volume
RAA	running annual average
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RH	remote-handled
RVMP	Repository VOC Monitoring Program
SOP	standard operating procedure
TIC	tentatively identified compound
TRU	transuranic
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant
WMCG	Waste Matrix Code Group

Overview of the Permit Modification Request

This document contains one Class 3 Permit Modification Request (**PMR**) for the Waste Isolation Pilot Plant (**WIPP**) Hazardous Waste Facility Permit (**Permit**) Number NM4890139088-TSDF.

This PMR is being submitted by the U.S. Department of Energy (**DOE**) Carlsbad Field Office and Nuclear Waste Partnership LLC, collectively referred to as the Permittees, in accordance with the WIPP Permit, Condition 1.3.1 (20.4.1.900 New Mexico Administrative Code (**NMAC**) incorporating Title 40 Code of Federal Regulations (**CFR**) 270.42(d)). These changes do not reduce the ability of the Permittees to provide continued protection to human health and the environment. The modification provides for the following changes:

- Update the volatile organic compound (**VOC**) target analyte list for the WIPP facility VOC monitoring programs
- Revise the method of determining compliance with the environmental performance standard and establish alternative remedial actions should risk action levels be reached
- Establish new room-based action levels (concentration of concern [**COC**]) for the revised target analyte list
- Eliminate the requirement to sample and report threshold exceedances for VOCs in closed disposal rooms that are not immediately adjacent to an active transuranic (**TRU**) waste disposal room and remove closed room monitoring for non-adjacent rooms
- VOC Monitoring Program clarifications and updates

The requested modification to the WIPP Permit and related supporting documents are provided in this PMR. The proposed modification to the text of the WIPP Permit has been identified using red text and a double underline and a ~~strikeout~~ font for deleted information. All direct quotations are indicated by italicized text. The following information specifically addresses how compliance has been achieved with the WIPP Permit requirement, Permit Condition 1.3.1 for submission of this Class 3 PMR.

1. 20.4.1.900 NMAC (incorporating 40 CFR 270.42(c)(1)(i)) requires the applicant to describe the exact change to be made to the permit conditions and supporting documents referenced by the Permit.

Permit Attachment N, Section N-2, states that the target analytes in the Permit for VOC monitoring were established by selecting the VOCs that constituted approximately 99 percent of the risk associated with VOC emissions from the repository. Selection of these targets is documented in the Part B Permit Application (DOE, 1996), Appendix D13 “VOC Screening Methodology.” The methodology calculated the risk factor for each VOC to determine those most likely to contribute to a total risk factor using publically available risk information. The percentage contribution of each risk factor from each VOC was determined and those VOCs contributing to 99 percent of the total risk factor were selected as targets. Two parameters used in this screening that have changed since the original calculations are the average concentration of VOCs in the waste and the recommended U.S. Environmental Protection

Agency (**EPA**) risk factors used to determine the risk associated with exposure to the VOCs. The changes have been such that the current VOC Monitoring Program target analyte list represents about 96 percent of the total carcinogenic risk and about 30 percent of the non-carcinogenic hazard based on current information. Therefore, the Permittees are proposing to update the list of target compounds. The proposed target list consists of the following six compounds:

Carbon Tetrachloride	Chloroform	Trichloroethylene
1,1,2,2-Tetrachloroethane	1,2-Dichloroethane	1,1,1-Trichloroethane

The Permittees are also proposing a revised methodology for demonstrating compliance with the surface worker environmental performance standards and to establish associated action levels for the repository. This revised methodology relies on the calculation of the actual risk to the receptor as opposed to a concentration of concern in the underground repository. Reporting will be based on the allowable total risk to the worker on the surface. This risk has been established by the New Mexico Environment Department (**NMED**) as one excess cancer death in 100,000 (i.e., 10^{-5}) for exposure to carcinogens and a hazard index (**HI**) of 1.0 (i.e., HI=1.0) for exposure to non-carcinogens.[1] This revised methodology affects the Repository VOC Monitoring Program (**RVMP**) only. The Permittees are also proposing to add an alternative remedial action should the risk action levels be reached. The methodology for determining compliance with the environmental performance standards for underground workers as measured by the Room-Based VOC Monitoring Program remains the same because these exposures are based on acute exposure limits determined by the Occupational Safety and Health Administration (**OSHA**) and they have not changed. The Permittees are also proposing to eliminate the requirement to monitor and report threshold exceedances for VOCs in closed disposal rooms that are not immediately adjacent to an active TRU waste disposal room. Other than increasing the sampling frequency, there is no action required associated with these exceedances and therefore the Permittees do not believe that monitoring in these areas and reporting the results are needed.

In addition to the changes mentioned above, the Permittees have identified several VOC monitoring program enhancements that are also proposed in this PMR. These changes are based on 13 years of operating experience and are expected to make the program more efficient, improve the reliability of the data, and provide flexibility to make non-administrative changes to the program when needed without having to submit a permit modification notification or request.

The Permittees are proposing the following changes in this PMR:

1. Update the VOC target analyte list for the WIPP facility VOC monitoring programs. This impacts tables in Permit Part 4.4 and 4.6 and Attachment N. The following is the proposed VOC target analyte list; carbon tetrachloride, chloroform, trichloroethylene, 1,1,2,2-tetrachloroethane, 1,2-dichloroethane, 1,1,1-trichloroethane.

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[1] The NMED rationale for establishing the environmental performance standards is provided in the NMED Direct Testimony Regarding Regulatory Process and Imposed Conditions, submitted for the record in the 1999 WIPP Permit Hearing, Section “VOC Concentrations,” page 10 of 15. This modification does not propose to change these standards.

2. Revise the method of determining compliance with the environmental performance standard and establish alternative remedial actions should risk action levels be reached.

3. Establish new room-based action levels (COC) and update Permit Part 4, Table 4.4.1 to correspond with the revised target analyte list.

4. Eliminate the requirement to sample and report threshold exceedances for VOCs in closed disposal rooms that are not immediately adjacent to an active TRU waste disposal room and remove closed room monitoring for these non-adjacent rooms. This requires a text revision in Permit Part 4.6.

5. Provide clarifications for the VOC Monitoring Program as well as updates and editorial changes. This impacts numerous places in Attachment N. The primary changes being proposed are:

   - Using sub-atmospheric sampling techniques for repository monitoring

   - Changing the repository monitoring sample to a 24-hour sample instead of the current six-hour sample

   - Reducing the sampling frequency from twice per week to once per week

   - Eliminating Station VOC-B

   - Reporting VOC results annually instead of semi-annually.

The reason why these changes are needed is discussed below.

This item (item 1 of the Overview) and item 3 of the Overview, the Table of Changes in Appendix A of this PMR and the redline strike out in Appendix B of this PMR describe the exact changes to be made to the Permit Conditions and Permit Attachments. Proposed text changes are included in Appendices A and B of this PMR. Appendix A provides a detailed list of changes by Permit section.

2. 20.4.1.900 NMAC (incorporating 40 CFR 270.42(c)(1)(ii)), requires the applicant to identify that the modification is a Class 3.

This PMR is classified as a Class 3 modification in accordance with 20.4.1.900 NMAC (incorporating 40 CFR 270.42(d)(1)) which states:

> (d) Other modifications. (1) *In the case of modifications not explicitly listed in appendix I of this section, the Permittee may submit a Class 3 modification request to the Agency…*

The Permittees are requesting that this modification be managed under the Class 3 process since the Permittees were unable to identify a similar item justifying a different classification for some of the changes. The Permittees are updating information relative to VOCs provided in the original Permit Application to satisfy the requirements of 20.4.1.900 NMAC (incorporating 40 CFR 270.23 (c) and (e)). This information is being updated based on waste characterization measurements and on changes to human risk factors recommended by the EPA. Other changes proposed in this modification can be classified as “other changes in the frequency of or procedures for monitoring, reporting, sampling, or maintenance activities by the permittee" and therefore could be classified as Class 2 changes in accordance with 20.4.1.900 NMAC (incorporating 40 CFR 270.42 Appendix 1), item A4. This notwithstanding, the Permittees are submitting the entire package to be reviewed as a Class 3 modification.

3. 20.4.1.900 NMAC (incorporating 40 CFR 270.42(c)(1)(iii)), requires the applicant to explain why the modification is needed.

This modification is needed because changes in the requirements upon which the Permit is based with regard to VOC monitoring have changed, creating a cause for modification as defined by 20.4.1.900 NMAC (incorporating 40 CFR 270.41(a)(3)). This change is the result of the EPA evaluation of risk associated with the inhalation of VOCs and changes in the risk factors associated with these VOCs. Second, the Permittees have identified numerous improvements to the VOC monitoring program based on technological advances in VOC monitoring and experience with the program over the last 13 years of operation. The need for this modification is further explained in the following sections.

Topic 1: Update the VOC target analyte list for the WIPP facility VOC monitoring programs.

An updated concentration/toxicity screening was performed on VOC data from wastes currently disposed at the facility. The purpose of this screening was to update the list of chemicals contributing significantly to the total cancer risk and non-cancer hazard, using current waste inventory data and current EPA toxicity criteria. Changes in inventory and EPA toxicity criteria have been such that the current VOC Monitoring Program target analyte list represents only about 96 percent of the total carcinogenic risk and only about 30 percent of the non-carcinogenic hazard based on current information and not all significant contributors are included.

The original Resource Conservation and Recovery Act (**RCRA**) Part B Permit Application for WIPP specified emission limits and monitoring for the following nine VOCs:

Carbon Tetrachloride	Chlorobenzene	Chloroform
1,1-Dichloroethylene	1,2-Dichloroethane	Methylene Chloride
1,1,2,2-Tetrachloroethane	Toluene	1,1,1-Trichloroethane

The choice of these specific chemicals to be monitored was based on an initial screening of the concentrations and toxicities of VOCs present in the waste that was anticipated for disposal in the WIPP facility. A facility source term and emission rate for each VOC was modeled from measured concentrations in the waste, and the relative contribution of each VOC to overall risk was subsequently calculated from the source term and emission rate using the concentration/toxicity screening procedure outlined in EPA (1989). With regard to the use of this screening method, the EPA states, *This screening procedure could greatly reduce the number of chemicals carried through a risk assessment, because in many cases only a few chemicals contribute significantly to the total risk for a particular medium*. [2] The concentration/toxicity screening procedure indicated that these chemicals were expected to contribute 99 percent of

[2] U.S. Environmental Protection Agency. (1989). Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final. EPA/540/1-89/002. Washington, D.C.: U.S. Environmental Protection Agency, p. 5-24.

the potential cancer risk and non-cancer hazard. This screening was documented in Appendix D13 of the 1996 RCRA Part B Permit Application and was based on the toxicity information available at the time of the analysis.

In performing the screening, the medium of interest is the air in a disposal room. It was necessary, therefore, to develop a source term that represented the air in the disposal room after the room was filled with drums of TRU mixed waste. Since no single waste drum contains all of the compounds, and since the variability of VOC concentrations from drum to drum tends to be high, depending on contents, the source term was developed based on the contents of multiple drums sampled across the various final waste forms that were to be shipped to the WIPP facility for disposal. The method for doing this was to sample the drums, analyze the samples, and average the results. The average represented the expected concentration in the disposal room containing waste from all of the final waste forms sampled. This approach maximized the amount and variety of compounds in the screening while preserving the relative order of concentrations. The nine targets in the Permit were selected for monitoring based on a source term developed from a limited set of headspace gas samples taken prior to the start of waste disposal operations. Since the time of the initial evaluation, a substantially larger database of headspace gas samples, taken in conjunction with waste characterization activities for WIPP-bound waste, has been developed leading to a much more statistically relevant updated source term. In addition, the toxicity criteria used to evaluate several of these chemicals, as well as chemicals not on the original target analyte list, have been updated as the result of ongoing evaluations by the EPA. As such, this original list of VOCs does not reflect current conditions and requires an update.

Updated Source Term: The VOC source term that was used in the Part B Permit Application[3] was based on the headspace gas samples taken from 930 drums of waste stored at the Idaho National Laboratory and the Rocky Flats Plant. These containers represented the entire spectrum of TRU waste that was expected to be shipped to the WIPP facility with the exception of the soils waste form. The measured concentrations were accumulated by Waste Matrix Code Group (**WMCG**), which is nomenclature used to express the physical form of the waste. The following WMCGs were used:

Combustible Waste	Filter Waste	Graphite Waste
Heterogeneous Waste	Inorganic Non-Metal Waste	Lead/Cadmium Metal Waste
Salt Waste	Soils	Solidified Inorganic Waste
Solidified Organic Waste	Uncategorized Metal Waste	

In order to extend the data from the 930 containers to the entire inventory of WIPP-bound waste, a weighting scheme was developed. The TRU Waste Baseline Inventory Report was used to determine the then current and projected inventory of TRU waste in each of the WMCGs. This information was tabulated[4]. Since the total volume of stored and projected waste did not add up to the statutory waste limit for the WIPP facility, the quantities were scaled up accordingly. A weighting factor was then calculated, which represented the percentage of each of the WMCGs in the total (scaled inventory).

[3] DOE/CAO-96-2160 (Appendix WAP, Appendix VOC), DOE/WIPP 91-005, Rev. 6 (Appendix C2, Appendix D13)
[4] DOE/CAO-96-2160 (Appendix WAP)

This PMR proposes to change the source term by using the actual headspace gas sampling results from about 136,000 waste containers that have been sampled and analyzed under earlier Permit requirements. In order to calculate the source term, the average concentration of each VOC had to be weighted for each WMCG and then summed. A new weighting factor for each WMCG was determined using the scaled contact-handled (**CH**) TRU waste inventory used in the 2004 Compliance Recertification Application[5]. Updated weighting factors are shown in Table 1. These weighting factors are based on the revised source term information and were calculated by taking the ratio of the scaled volume for each WMCG to the total scaled volume (168,500 m^3) [6].

Table 1: Recalculated Waste Matrix Code Group Weighting Factors based on the 2004 Compliance Recertification CH TRU Waste Inventory (m^3)

Final Waste Forms	Stored Waste	Projected Waste	Emplaced Waste	Total Waste	Scaled	Weighting Factor
Combustible Material	4,300	1,900	610	6,810	8,136	0.05
Filter Material	990	590	340	1,920	2,294	0.01
Graphite	120	1	0	121.3	145	0.00
Heterogeneous Debris	49,000	9,700	570	59,270	70,812	0.42
Inorganic Non-Metal	11,000	68	970	12,038	14,382	0.09
Lead/Cadmium Metal	140	32	81	253	302	0.00
Salt	150	190	1,500	1,840	2,198	0.01
Soil	300	6,000	0	6,300	7,527	0.04
Solidified Inorganic Material	35,000	730	3,300	39,030	46,631	0.28
Solidified Organic Material	5,200	380	0	5,580	6,667	0.04
Uncategorized Metal	2,400	5,100	360	7,860	9,391	0.06

The weighted average concentration of each VOC is calculated by the following equation:

$$\overline{X} = \sum_{j=1}^{t} w_j * \overline{x}_j \quad (1)$$

where:

$\overline{X}$ = *weighted average concentration*

$\overline{x}_j$ = *average concentration for* $WMCG_j$

w_j = *weighting factor for* $WMCG_j$ (from Table 1)

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[5] DOE/WIPP 91-005, Rev. 6 (Appendix C2, Appendix D13).

[6] Remote-handled (**RH**) TRU waste is neglected because its contribution will be no more than four percent of the total waste volume and it is not expected to have a hazardous waste content that is different than CH TRU waste.

t = *number of* $WMCG_j$

$\bar{x}_j$ = *is calculated by:*

$$\bar{x}_j = \frac{1}{n_j} * \sum_{j=1}^{n_j} x_{jk} \qquad (2)$$

where:

n_j = *number of sample in* $WMCG_j$

x_{jk} = *concentration k for* $WMCG_j$

The updated source term uses over 136,000 sample results collected from TRU waste prior to shipment to the WIPP facility. These analyses were conducted in accordance with the WIPP Permit. Prior to October 2006, analyses were required on nearly 100 percent of the containers. After this time, only representative sampling was required resulting in fewer samples per waste stream.

The process for developing the new source term is as follows:

Step 1—data resulting from headspace gas measurements were obtained from the WIPP Waste Information System beginning with the first shipment in 1999 through October 6, 2010. The data were provided as concentrations in parts per million by volume (ppmv) for each VOC for each container.

Step 2—measurements that were shown with a "U" flag were below method detection limits. The values shown represent the method detection limit (MDL). These values were divided by two prior to including them in the total[7].

Step 3—each container was assigned to a WMCG.

Step 4—the data were sorted by WMCG.

Step 5—the concentrations were averaged for each VOC for each WMCG.

Step 6—the average concentrations for each compound and each WMCG was multiplied by the weighting factor to estimate the average concentration for each VOC in a full repository. This is shown in Table 2.

[7] The practice of using one-half the detection limit in averaging gas measurements that are below method detection limits is a well established analytical practice and is required by the Permit for waste characterization (Permit Attachment C4, Section C4-3e)

Table 2: Updated Volatile Organic Compound Weighted Average Source Term

Volatile Organic Compound	Molecular Weight (g/Mole)	Weighted Average Concentration	
		(ppmv)	mg/m^3
Acetone	58.1	53.1	126.1
Benzene	78.1	4.3	13.7
Bromoform	252.8	1.8	18.6
Butanol	74.1	13.8	41.8
Carbon Disulfide	76.1	10.5	32.7
Carbon Tetrachloride	153.8	921.5	5,798.2
Chlorobenzene	112.6	2.7	12.3
Chloroform	119.4	16.1	78.7
Cyclohexane	84.2	10.8	37.2
1,1-Dichloroethane	99.0	9.9	40.1
1,2-Dichloroethane	99.0	3.8	15.3
1,1-Dichloroethylene	97.0	12.9	51.2
cis-1,2-Dichloroethylene	97.0	3.9	15.5
trans-1,2-Dichloroethylene	97.0	4.1	16.3
Ethyl Benzene	106.2	3.6	15.6
Ethyl Ether	74.1	4.8	14.6
Methanol	32.1	71.3	93.4
Methyl Chloride	50.5	15.6	32.2
Methylene Chloride	84.9	36.0	125.1
Methyl Ethyl Ketone	72.1	13.8	40.7
Methyl isobutyl Ketone	100.2	12.4	50.8
Tetrachloroethylene	165.9	5.1	34.6
1,1,2,2-Tetrachloroethane	167.9	2.8	18.9
Toluene	92.1	12.2	46.1
1,1,1-Trichloroethane	133.4	739.8	4,037.1
Trichloroethylene	131.4	51.2	275.1
1,1,2-Trichloro-1,2,2-Trifluoroethane	187.4	208.9	2,159.3
1,2,4-Trimethylbenzene	120.2	2.6	12.8
1,3,5-Trimethylbenzene	120.2	3.2	15.7
m,p-Xylene	106.2	6.5	28.2
o-Xylene	106.2	3.8	16.5

Revised Risk Screening: An updated concentration/toxicity evaluation was performed on the updated source term values. The results of this screening were employed to identify those chemicals expected to contribute significantly to the potential cancer risk and non-cancer hazard. As described in EPA (1989), a concentration/toxicity screen is conducted in a two-step process:

Step 1—the individual chemical scores are calculated for each chemical based on the chemical concentration (source term) and the chemical-specific toxicity values. The toxicity value used to evaluate non-cancer effects is termed the reference concentration (**RfC**), and the toxicity value used to evaluate cancer effects is termed the inhalation unit risk (**IUR**). Toxicity values used in this evaluation were obtained from the EPA. In cases where toxicity values were not available from the EPA, toxicity values were obtained from secondary sources following EPA recommended hierarchy of sources of toxicity values (EPA, 2003)[8]. The toxicity values used in this evaluation are those recommended by the EPA and are listed in Table 3.

Table 3: Recommended EPA Risk Factor for Volatile Organic Compounds (as of 8/9/2012)

Volatile Organic Compound	Non-Carcinogen Reference Concentration (RfC) mg/m^3	Carcinogen Inhalation Unit Risk (IUR) $(ug/m^3)^{-1}$
Acetone	3.1×10^{1}	---
Benzene	3.0×10^{-2}	7.8×10^{-6}
Bromoform	---	1.1×10^{-6}
Butanol	---	---
Carbon Disulfide	7.0×10^{-1}	---
Carbon Tetrachloride	1.0×10^{-1}	6.0×10^{-6}
Chlorobenzene	5.0×10^{-2}	---
Chloroform	9.8×10^{-2}	2.3×10^{-5}
Cyclohexane	6.0	---
1,1-Dichloroethane	---	1.6×10^{-6}
1,2-Dichloroethane	7.0×10^{-3}	2.6×10^{-5}
1,1-Dichloroethylene	2.0×10^{-1}	---
cis-1,2-Dichloroethylene	---	---
trans-1,2-Dichloroethylene	6.0×10^{-2}	---
Ethyl Benzene	1.0	2.5×10^{-6}
Ethyl Ether	---	---
Methanol	4.0	---
Methyl Chloride	9.0×10^{-2}	---
Methyl Ethyl Ketone	5.0	---
Methyl Isobutyl Ketone	3.0	---
Methylene Chloride	6.0×10^{-1}	1.0×10^{-8}
1,1,2,2-Tetrachloroethane	---	5.8×10^{-5}

[8] EPA, 2003, Human Health Toxicity Values in Superfund Risk Assessments, OSWER Directive 9285.7-53.

Volatile Organic Compound	Non-Carcinogen Reference Concentration (RfC) mg/m^3	Carcinogen Inhalation Unit Risk (IUR) (ug/m^3)$^{-1}$
Tetrachloroethylene	4.0×10^{-2}	2.6×10^{-7}
Toluene	5.0	---
1,1,1-Trichloroethane	5.0	---
Trichloroethylene	2.0×10^{-3}	4.1×10^{-6}
1,1,2-Trichloro-1,2,2-Trifluoroethane	3.0×10^{1}	---
1,2,4-Trimethylbenzene	7.0×10^{-3}	---
1,3,5-Trimethylbenzene	---	---
m,p-Xylene	1.0×10^{-1}	---
o-Xylene	1.0×10^{-1}	---

--- No data/not classifiable/inadequate data

The equations used to calculate the individual chemical scores are shown below:

$$CS(nc)_{VOC_j} = \overline{X}_{VOC_J} / RfC \quad (3)$$

where:

$CS(nc)_{VOC_j}$ = *chemical score for non-carcinogenic* VOC_j

$\overline{X}_{VOC_J}$ = *weighted average concentration for non-carcinogenic* VOC_j *[mg/m^3]*

RfC = *reference concentration for non-carcinogenic* VOC_j *[mg/m^3]*

$$CS(c)_{VOC_j} = \overline{X}_{VOC_J} \times IUR \quad (4)$$

where:

$CS(c)_{VOC_j}$ = *chemical score for carcinogenic* VOC_j

$\overline{X}_{VOC_J}$ = *weighted average concentration for carcinogenic VOCj [ug/m^3]*

IUR = *inhalation unit risk for carcinogenic* VOC_j *[ug/m^3]*

The calculated chemical scores, based on the updated source term, are presented in Table 4.

Table 4: Chemical Scores Based on Updated Source Term and Risk Factors

Chemical	Non-Cancer Hazard Chemical Score	Cancer Risk Chemical Score
Acetone	4.07	0
Benzene	460.48	1.08E-04
Bromoform	0	2.09E-05

Chemical	Non-Cancer Hazard Chemical Score	Cancer Risk Chemical Score
Butanol	0	0
Carbon Disulfide	46.65	0
Carbon Tetrachloride	57,974.79	3.48E-02
Chlorobenzene	245.63	0
Chloroform	802.92	1.81E-03
Cyclohexane	6.17	0
1,1-Dichloroethane	0	6.40E-05
1,2-Dichloroethane	2,180.68	3.97E-04
1,1-Dichloroethylene	255.87	0
cis-1,2-Dichloroethylene	0	0
trans-1,2-Dichloroethylene	268.76	0
Ethyl Ether	0	0
Ethyl Benzene	15.49	3.87E-05
Methanol	23.35	0
Methyl Chloride	357.43	0
Methyl Ethyl Ketone	8.13	0
Methyl Isobutyl Ketone	16.92	0
Methylene Chloride	208.48	1.25E-06
1,1,2,2-Tetrachloroethane	0	1.09E-03
Tetrachloroethylene	860.49	8.95E-06
Toluene	9.22	0
1,1,1-Trichloroethane	807.35	0
Trichloroethylene	137,526.94	1.13E-03
1,1,2-Trichloro-1,2,2-Trifluoroethane	53.37	0
1,2,4-Trimethylbenzene	1,534.40	0
1,3,5-Trimethylbenzene	0	0
m,p-Xylene	280.55	0
o-Xylene	165.03	0
Total Chemical Score	204,113.2	0.039469

Step 2—the percent contribution of each individual chemical to the overall non-cancer hazard or cancer risk is calculated using the following equation:

$$C_{VOC_j} = \left(CS_{VOC_j} / \sum_{i=1}^{m} CS_{VOC_i} \right) \times 100 \quad (5)$$

where:

C_{VOC_j} = *percent contribution for* VOC_j

CS_{VOC_j} = *chemical score for* VOC_j

CS_{VOC_i} = *chemical score for* VOC_i

m = number of VOCs in the analysis

The calculated percent contributions for each chemical are presented in Table 5.

Table 5: Percent Contribution to Overall Risk or Hazard Score Based on Updated Source Term and Risk Factors

Chemical	Non-Cancer Hazard Contribution	Cancer Risk Contribution
Acetone	0.00%	0.00%
Benzene	0.23%	0.27%
Bromoform	0.00%	0.05%
Butanol	0.00%	0.00%
Carbon Disulfide	0.02%	0.00%
Carbon Tetrachloride	28.40%	88.16%
Chlorobenzene	0.12%	0.00%
Chloroform	0.39%	4.59%
Cyclohexane	0.00%	0.00%
1,1-Dichloroethane	0.00%	0.16%
1,2-Dichloroethane	1.07%	1.01%
1,1-Dichloroethylene	0.13%	0.00%
cis-1,2-Dichloroethylene	0.00%	0.00%
trans-1,2-Dichloroethylene	0.13%	0.00%
Ethyl Ether	0.00%	0.00%
Ethyl Benzene	0.01%	0.10%
Methanol	0.01%	0.00%
Methyl Chloride	0.18%	0.00%
Methyl Ethyl Ketone	0.00%	0.00%
Methyl Isobutyl Ketone	0.01%	0.00%
Methylene Chloride	0.10%	0.003%
1,1,2,2-Tetrachloroethane	0.00%	2.77%
Tetrachloroethylene	0.42%	0.02%
Toluene	0.00%	0.00%
1,1,1-Trichloroethane	0.40%	0.00%
Trichloroethylene	67.38%	2.68%
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.03%	0.00%

Chemical	Non-Cancer Hazard Contribution	Cancer Risk Contribution
1,2,4-Trimethylbenzene	0.75%	0.00%
1,3,5-Trimethylbenzene	0.00%	0.00%
m,p-Xylene	0.14%	0.00%
o-Xylene	0.08%	0.00%
SUM	100%	100%

The list of chemicals was subsequently sorted to identify those chemicals contributing the greatest potential non-cancer hazard (Table 6) or cancer risk (Table 7). Carbon tetrachloride contributed the majority of the total cancer risk (88 percent). Trichloroethylene, a compound recommended for addition to the list of targets, contributed 67 percent of the non-cancer hazard. The list of chemicals contributing 99 percent of total risk and hazard is summarized below:

Carbon Tetrachloride	Chloroform	Trichloroethylene
1,1,2,2-Tetrachloroethane	1,2-Dichloroethane	Tetrachloroethylene
1,2,4-Trimethylbenzene	1,1,1-Trichloroethane	Benzene

Table 6: Identification of Chemicals Contributing 99 Percent of Non-Cancer Hazard

Sorted by Magnitude of Percent Contribution (Most to Least)

Chemical	Contribution	Cumulative Contribution
Trichloroethylene	67.38%	67.38%
Carbon tetrachloride	28.40%	95.78%
1,2-Dichloroethane	1.07%	96.85%
1,2,4-Trimethylbenzene[1]	0.75%	97.60%
Tetrachloroethylene	0.42%	98.02%
1,1,1-Trichloroethane	0.40%	98.42%
Chloroform	0.39%	98.81%
Benzene	0.23%	99.04%
Methyl Chloride	0.18%	99.21%
m,p-Xylene	0.14%	99.35%
trans-1,2-Dichloroethylene	0.13%	99.48%
1,1-Dichloroethylene	0.13%	99.61%
Chlorobenzene	0.12%	99.73%
Methylene Chloride	0.10%	99.83%
o-Xylene	0.08%	99.91%
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.03%	99.94%
Carbon Disulfide	0.02%	99.96%
Methanol[2]	0.01%	99.97%

Chemical	Contribution	Cumulative Contribution
Methyl Isobutyl Ketone	0.01%	99.98%
Ethyl Benzene	0.01%	99.99%
Toluene	0.005%	99.99%
Methyl Ethyl Ketone	0.004%	99.99%
Cyclohexane	0.003%	100.00%
Acetone	0.002%	100.00%
Bromoform	0.00%	100.00%
1,1-Dichloroethane	0.00%	100.00%
cis-1,2-Dichloroethylene	0.00%	100.00%
Ethyl Ether	0.00%	100.00%
1,1,2,2-Tetrachloroethane	0.00%	100.00%
1,3,5-Trimethylbenzene[3]	0.00%	100.00%
Butanol[4]	0.00%	100.00%

[1] 1,2,4-Trimethylbenzene contribution is based on current RfC. Using recently proposed RfC [2.0E-02 mg/m^3 (June 2012)], contribution decreases to 0.26%, but remains in top 99%.

[2] Methanol contribution is based on current RfC. Using proposed RfC (2.0E+00 mg/m^3), contribution increases to 0.02%, which does not impact results of screen for non-cancer hazard.

[3] 1,3,5-Trimethylbenzene currently has no RfC. Using recently proposed RfC [2.0E-02 mg/m^3 (June 2012)], contribution increases to 0.32%, adding it to top 99%.

[4] Butanol currently has no RfC. Using proposed RfC (6.0E-02 mg/m^3), contribution increases to 0.34%, adding it to top 99%.

Table 7: Identification of Chemicals Contributing 99 Percent of Cancer Risk

Sorted by Magnitude of Percent Contribution (Most to Least)

Chemical	Contribution	Cumulative Contribution
Carbon Tetrachloride	88.16%	88.16%
Chloroform	4.59%	92.75%
Trichloroethylene	2.86%	95.61%
1,1,2,2-Tetrachloroethane	2.77%	98.38%
1,2-Dichloroethane	1.01%	99.39%
Benzene	0.27%	99.66%
1,1-Dichloroethane	0.16%	99.82%
Ethyl Benzene	0.10%	99.92%
Bromoform	0.05%	99.98%
Tetrachloroethylene	0.02%	100.00%
Methylene Chloride	0.003%	100.00%
1,2,4-Trimethylbenzene	0.00%	100.00%
1,1,1-Trichloroethane	0.00%	100.00%

Chemical	Contribution	Cumulative Contribution
Butanol	0.00%	100.00%
Methyl Chloride	0.00%	100.00%
m,p-Xylene	0.00%	100.00%
trans-1,2-Dichloroethylene	0.00%	100.00%
1,1-Dichloroethylene	0.00%	100.00%
Chlorobenzene	0.00%	100.00%
o-Xylene	0.00%	100.00%
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.00%	100.00%
Carbon Disulfide	0.00%	100.00%
Methanol[1]	0.00%	100.00%
Methyl Isobutyl Ketone	0.00%	100.00%
Toluene	0.00%	100.00%
Methyl Ethyl Ketone	0.00%	100.00%
Cyclohexane	0.00%	100.00%
Acetone	0.00%	100.00%
cis-1,2-Dichloroethylene	0.00%	100.00%
Ethyl ether	0.00%	100.00%
1,3,5-Trimethylbenzene	0.00%	100.00%

[1]Methanol contribution is based on current IUR (currently not evaluated as an inhalation carcinogen). Using proposed IUR (1E-06 per µg/m^3), contribution increases to 0.24%, which does not impact results of screen for cancer risk.

Of the nine VOCs identified for monitoring in the original Permit, four are no longer contributing to 99 percent of the updated risk or HI (chlorobenzene, methylene chloride, toluene, 1,1-dichloroethylene). Four VOCs that were not originally identified are now contributing to 99 percent of the updated risk or HI (benzene, tetrachloroethylene, trichloroethylene, 1,2,4-trimethylbenzene).

Previously, the screening criterion was that the list of target analytes represents at least 99 percent of the risk. In addition, each of the compounds contributed to more than one percent of the risk. The EPA screening methodology also suggests that it is appropriate to specify a lower limit, such as one percent, below which compounds are eliminated. This was the case of the original screening and can be applied in this case as well. Several of the VOCs in Tables 6 and 7 contribute less than one percent of the risk. The Permittees further propose to limit the targets to those that contribute, or have the potential to contribute, one percent or more to the risk. It is clear from Table 7 that most of the compounds evaluated represent zero percent of the risk and therefore should not be included in the list of targets. Those that are less than one percent are inconsequential and are not included, due to their low overall risk and low concentrations. The following VOCs individually contribute one percent or more to the total risk:

Carbon Tetrachloride
Chloroform
Trichloroethylene
1,1,2,2-Tetrachloroethane
1,2-Dichloroethane

The following provides a discussion justifying the removal or retention of the targets that contribute to less than one percent of the risk. Discussions of RMVP results are based on samples collected through the end of June 2012.

Tetrachloroethylene: Tetrachloroethylene routinely appeared as a tentatively identified compound (**TIC**) in the RVMP since December 2008 and was added as an additional requested analyte (**ARA**) on January 25, 2011. Concentrations since 2011 have ranged from below method detection limit to nearly 15 parts per billion by volume (**ppbv**). The weighted average concentration for this compound, based on over 136,000 samples, is 5.1 ppmv. It is principally associated with organic sludges. Under the current screening, it contributes 0.02 percent of the carcinogenic risk and 0.42 percent of the non-carcinogenic hazard. The Permittees propose to delete this from the list of potential target analytes due to its low concentration and low contribution to risk.

1,2,4-Trimethylbenzene: 1,2,4-Trimethylbenzene was evaluated as a target analyte on May 3, 2011, based on screening results available at the time. It has been detected in RVMP Station VOC-A samples only at levels below the method reporting limits. It has a weighted average concentration of 2.6 ppmv, based on over 102,500 headspace gas samples. It currently contributes 0.75 percent of the non-carcinogenic hazard and none of the carcinogenic risk. The Permittees propose to delete this from the list of potential target analytes due to its low contribution to the total hazard and the fact that it has only been detected at levels below the method reporting limits.

1,1,1-Trichloroethane: 1,1,1-Trichloroethane is identified on the target analyte list in the Permit. At the time the Permittees performed the analysis, it was included in the risk assessment as a carcinogen. When the NMED prepared the 1998 draft permit, 1,1,1-Trichloroethane had been classified as a non-carcinogen by the EPA. This compound was first detected in the RVMP above method detection limits in March 2005. The toxicity of 1,1,1-Trichloroethane is relatively low, leading to the low ranking in the risk evaluation, however, because of its prevalence and relatively high measured concentrations the Permittees propose to retain this compound.

Benzene: Benzene was first detected in the RVMP above the method detection limit in isolated samples beginning in 2004. Beginning on January 25, 2011, Benzene was added as an ARA. Since that time, the RVMP has only recorded one measurable concentration of Benzene. The concentration in this RVMP sample was 4.27 ppbv. The weighted average concentration, based on over 136,000 headspace gas samples, is 4.3 ppmv. It currently contributes 0.23 percent of the non-carcinogenic hazard and 0.27 percent of the carcinogenic risk. The Permittees propose to delete this from the list of potential target analytes due to its low contribution to the total hazard and the fact that it has been detected at a measurable concentration only once since being added as an ARA.

Therefore, the Permittees are proposing the following six compounds as VOC monitoring system targets:

Carbon Tetrachloride	Chloroform	Trichloroethylene
1,1,2,2-Tetrachloroethane	1,2-Dichloroethane	1,1,1-Trichloroethane

Collectively, these compounds represent 99.4 percent of the carcinogenic risk and 97.6 percent of the non-carcinogenic hazard.

The Permittees propose that this list of analytes is sufficient for several reasons:

- The excluded compounds are expected to occur in low concentrations and measurements have confirmed this expectation.

- The excluded compounds are not major contributors to the overall risk.

- Should the concentrations increase in the samples taken by the VOC Monitoring Program, the TIC process in the Permit will force the Permittees to evaluate their significance and, if significant, language proposed in this PMR will require an update to the risk assessment process to include the compounds.

Topic 2: Revise the method of determining compliance with the environmental performance standard and establish alternative remedial actions should risk action levels be reached.

The Permit establishes environmental performance standards with regard to the VOC emissions from containers of TRU mixed waste for workers on the surface and for waste workers in the underground. According to the NMED, *the overriding criterion for specifying VOC limits is that for a maximally exposed person, the total risk from VOCs in the WIPP exhaust air (assuming a minimum overall mine ventilation rate of 260,000 scfm) will not exceed acceptable risk levels*. [9] The NMED established three risk levels:

- For a resident living at the WIPP site boundary, the total individual excess cancer risk from exposure to carcinogens and potential carcinogens shall be one in one million (10^{-6});

- For a WIPP non-waste surface worker, the total individual excess cancer risk from exposure to carcinogens and potential carcinogens shall be one in one hundred thousand (10^{-5}); and

- For the persons listed above, the acceptable risk level for exposure to non-carcinogens shall be a HI of less than 1.0.

The NMED justified the higher risk level for workers because the Permittees could exert control over the occupational exposures of workers at the WIPP site. As “employees” these workers are covered by the OSHA occupational exposure standards and health and safety regulations of the Mine Safety and Health Administration. The NMED also identified the surface non-waste worker as the receptor that could receive the greatest chronic dose from emissions in the underground. Therefore, this receptor (assumed to be a worker in the WIPP facility Training Building) was chosen as the receptor for compliance with the environmental performance standards for VOC emissions from the underground.[10]

The environmental performance standards for waste workers in the underground are established to prevent an acute exposure to VOCs. These are measured either as the lower explosive limit (**LEL**), or the concentration that would result in a fatal dose. Topic 2 addresses

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[9] NMED Direct Testimony Regarding Regulatory Process and Imposed Conditions, submitted for the record in the 1999 WIPP Permit Hearing, Section “VOC Concentrations,” page 9 of 15.
[10] NMED Direct Testimony Regarding Regulatory Process and Imposed Conditions, submitted for the record in the 1999 WIPP Permit Hearing, Section “VOC Concentrations,” page 10 of 15.

the surface worker environmental performance standard and Topic 3 addresses the underground waste worker environmental performance standard.

Environmental performance standards have been established for the emission of VOCs from the underground repository, a miscellaneous unit pursuant to 40 CFR Part 264, Subpart X. These standards are represented by a specific list of nine target VOCs and associated COCs for each. The COCs ensure protection of human health and the environment by requiring specific actions by the Permittees should the COCs be exceeded. The VOCs and their associated RVMP COCs are shown in Permit Part 4, Table 4.6.2.3.

In 2010[11], the Permittees re-evaluated the air dispersion modeling performed for the original Part B Permit Application. The goal of this re-evaluation was to determine potential human health risks associated with VOC emissions from the WIPP facility to above-ground receptors, based on information that updated the original air dispersion modeling. Changes to a number of site conditions and regulatory changes have occurred since the original RCRA Part B Permit Application was submitted in 1996[12]. Re-evaluation of the risk assessment to determine the significance of the changes was warranted to ensure that environmental performance standards established in the Permit were still being monitored effectively to ensure protection of the public and surface workers.

As part of this re-evaluation, the following technical components of the original air emission modeling approach were addressed:

- Chemical toxicity. As part of standard EPA protocol, EPA regularly reviews the current scientific toxicology literature of chemicals it regulates. As a result of these reviews, EPA has subsequently revised the toxicity values for several of the VOCs.

- Chemical releases from the repository. The original exhaust shaft air emission limits were developed to address cancer risks and non-cancer hazards associated with VOCs that were found in waste containers. Knowledge of the concentrations and relative proportions of VOC releases from the mine has been updated.

- Air modeling. Air modeling was performed to predict air concentrations at various on-site and off-site receptor points, based on dispersion of air releases from the exhaust shaft. The EPA air models have been updated.

- Receptor locations. The air dispersion factors (**ADFs**) derived during the original air modeling was based on the locations of maximum impact, regardless of whether receptor populations were present at those locations. The revised air modeling updated the original ADFs and added several new locations such as off-site residences.

- Regulatory requirements for derivation of risk-based values. NMED established the Permit limits using a risk-based approach. NMED guidance was reviewed to determine if the target allowable risk values used in their risk-based approach (10^{-5} for workers,

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[11] U.S. Department of Energy, (2010), Resource Conservation and Recovery Act Part B Permit Renewal Application. Carlsbad, NM.
[12] U.S. Department of Energy, (1996a), Resource Conservation and Recovery Act Part B Permit Application. Carlsbad, NM.

10^{-6} for residents) were still the recommended values. These risk values did not need to be updated.

Based on the re-evaluation, emissions from the facility and risks to surface receptors were re-calculated. An ADF of 0.0114 was derived from the revised modeling. The modeling and risk assessment report is attached to this PMR as Appendix C.

When Permit Part 4, Table 4.6.2.3 was issued in the Permit in November 2010 available risk was apportioned by the NMED to the various compounds in order to establish individual COCs at Station VOC-A in the underground. The changes proposed in this modification require further risk apportionment in order to accommodate the introduction of new compounds and the deletion of those that do not contribute significantly to the overall risk.

In evaluating COCs for the proposed list of analytes, several factors were considered:

- What percentage of the risk should be assigned to the compound based on the risk screening? This is found in Tables 6 and 7.

- What are the MRLs for the compound based on the sampling and analysis methods specified in the Permit? These are specified in Permit Attachment N, Table N-2. Concentrations of concern below or near the method reporting limit (**MRL**) are not recommended. Those below the MRL cannot be reliably detected, and those near the MRL may result in frequent exceedance of action levels for very low concentrations and negligible risk.

- What are the historical concentrations detected for the compound and the running annual average (**RAA**)? In some instances, a compound may appear infrequently at a relatively high level, yet have a low RAA. In this case, action levels may be exceeded numerous times although the risk posed by the compound is negligible.

- What is the relative percentage of non-carcinogenic hazard for carcinogenic compounds? In the Permit, VOCs are designated as either carcinogenic or non-carcinogenic, but not both. In the updated risk assessment in this PMR, some compounds contribute to both the carcinogenic risk and the non-carcinogenic hazard. However, the percent contributions to the total risk and the HI for these compounds are different, making the assignment of a COC difficult.

Applying these considerations to the determination of new COCs is problematic. In particular, avoiding the establishment of small concentrations for compounds that contribute little risk requires apportioning risk from those compounds that contribute a higher risk percentage and are present in higher concentrations. This process artificially lowers the COCs for those compounds for which high COCs are needed.

In order to overcome this, the Permittees are proposing replacing COCs for the repository monitoring program with actual risk calculations based on the concentrations measured with the RVMP. This calculation is straightforward and can be made using a spreadsheet. The process is as follows:

- Determine the concentration in mg/m^3 of proposed target VOCs being emitted from the repository based on measurements at Station VOC-A.

- Calculate the concentration at the top of the Exhaust Shaft based on the ratio of flow rate at Station VOC-A, and the total exhaust flow rate.

- Apply the ADF (0.0114) to determine the concentration at the receptor.

- Calculate the risk for each carcinogenic and non-carcinogenic proposed target VOC using the method and equations proposed in this PMR.

- Calculate a RAA of the resulting total carcinogenic and non-carcinogenic risks.

- Compare the RAA-based risk to 10^{-5} for carcinogens and the RAA for HI to 1.0 for non-carcinogens.

This methodology for calculating risk is documented in Appendix D9 of the 1996 RCRA Part B Permit Application. The following quote from that document captures the rationale for the modeling parameters:

> *Two additional exposure scenarios that hypothetically occur within the WIPP site boundary are also evaluated in this appendix. One additional scenario is that of a worker who works on site 1,920 hours/year (EF = 1,920 hours/year), for 10 years (ED = 10 years, AT = 613,200 hours) on the surface near the exhaust shaft. The 1920 hours are the hours for an employee after removing vacations and holidays. This is conservative since workers spend approximately ten percent of their time off site at training, travel, and meetings. The ten year exposure duration represents normal turnover in employees. Turnover, in this case includes new employment, new positions and new locations at the facility. The exposure location chosen corresponds to the maximum VOC exposure at the surface within the site boundary and is located in the property protection area. The scenario is referred to in following sections as* ***Surface Worker****. (Appendix D9, Section D9-3.5 1996 Part B Permit Application)*

For carcinogenic risk:

$$R_{VOC_j} = \frac{Conc_{VOC_j} \times EF * ED * IUR_{VOC_j} \times 1000}{AT} \tag{6}$$

Where:

R_{VOC_j} *= Risk due to exposure to* VOC_j

$Conc_{VOC_j}$ *= Concentration* VOC_j *at the receptor* mg/m^3

EF *= Exposure frequency (hours/year), = 1,920 hours/year*

ED *= Exposure duration, years, = 10 years*

IUR_{VOCj} *= Inhalation risk factor from EPA Integrated Risk Information System (IRIS) database* $(ug/m^3)^{-1}$

1000 = ug/mg

AT *= Averaging time for carcinogens (hours based on 70 years), = 613,200 hours*

The total risk is then the sum of the risk due to each carcinogenic VOC.

$$\text{Total Risk} = \sum_{j=1}^{m} R_{VOC_j} \tag{7}$$

Where:

Total Risk must be less than 10^{-5}
m = the number of carcinogenic VOCs

The formula for non-carcinogenic hazard is similar:

$$HI_{VOC_j} = \frac{Conc_{VOC_j} \times EF * ED}{AT * RfC_{VOC_j}} \tag{8}$$

Where:

HI_{VOC_j} = Hazard Index for exposure to VOC_j

$Conc_{VOC_j}$ = Concentration VOC_j at the receptor $\left(mg/m^3\right)$

EF = Exposure frequency (hours/year), = 1,920 hours/year

ED = Exposure duration, years, = 10 years

RfC_{VOC_j} = Reference concentration from EPA IRIS database $\left(mg/m^3\right)$

AT = Averaging time for non-carcinogens (hours, based on exposure duration), = 87,600 hours

The total hazard is then the sum of the HI due to each non-carcinogenic VOC.

$$\text{Total Hazard Index} = \sum_{j=1}^{m} HI_{VOC_j} \tag{9}$$

Where:

Hazard Index must be less than 1.0
m = the number of non-carcinogenic VOCs

As an example of this approach, the validated VOC data from June 27, 2012, are presented in Tables 8 (carcinogenic VOCs) and 9 (non-carcinogenic VOCs) for both the new list of target analytes proposed in this PMR and the target analytes specified in the Permit. Two data sets are shown for each table; one is the concentration at Station VOC-A based on a sample taken on June 27, 2012, and the other is the RAA for that date. The concentration at the receptor is derived by considering the dilution of the normalized concentration at Station VOC-A with the additional ventilation air that is exhausted from the WIPP underground facility (a factor of 0.305 based on the ratio of flow rates in Permit Attachment N, Section N-3e(1)) and accounting for dispersion (a factor of 0.0114).

Table 8 Calculation of Carcinogenic Risk for Repository Samples taken 6/27/12

VOC	6/27/12 Concentration, Station VOC-A (ppbv)	Non-waste Surface Worker (Training Building)		6/27/12 Running Annual Average, Station VOC-A (ppbv)	Non-waste Surface Worker (Training Building)	
		Conc. ug/m^3	Risk		Conc. ug/m^3	Risk
Carcinogenic Compounds (Proposed List)						
Carbon Tetrachloride	103.86	2.29	4.30E-07	185.88	4.07	7.64E-07
Chloroform	7.39	0.13	9.04E-08	15.55	0.26	1.90E-07
1,2-Dichloroethane	0	0	0	0	0	0
1,1,2,2-Tetrachloroethane	0	0	0	0	0	0
Tetrachloroethylene	0	0	0	0	0	0
Trichloroethylene	33.74	0.63	8.10E-08	60.04	1.122	1.44E-07
Total Risk			6.02E-07			1.10E-06
Carcinogenic Compounds (Permit List)						
Carbon Tetrachloride	103.86	2.29	4.30E-07	185.88	4.07	7.64E-07
Chloroform	7.39	0.13	9.04E-08	15.55	0.26	1.90E-07
Methylene Chloride	3	0.03	4.89E-10	3.01	0.04	5.35E-10
1,2-Dichloroethane	0	0	0	0	0	0
1,1,2,2-Tetrachloroethane	0	0	0	0	0	0
Total Risk			5.21E-07			9.55E-07

Table 9 Calculation of Non-Carcinogenic Hazard Index for Repository Samples taken 6/27/12

VOC	6/27/12 Concentration, Station VOC-A (ppbv)	Non-waste Surface Worker (Training Building)		6/27/12 Running Annual Average, Station VOC-A (ppbv)	Non-waste Surface Worker (Training Building)	
		Conc. ug/m^3	Hazard Index		Conc. ug/m^3	Hazard Index
Non-Carcinogenic Compounds (Proposed List)						
Carbon Tetrachloride	103.86	2.29	5.02E-03	185.88	4.07	8.92E-03
Chloroform	7.39	0.13	2.81E-04	15.55	0.26	5.91E-04
1,2-Dichloroethane	0	0	0	0	0	0
1,1,1-Trichloroethane	19.58	0.37	1.63E-05	30.43	0.58	2.53E-05
Tetrachloroethylene	0	0	0	0	0	0
Trichloroethylene	33.74	0.631	6.91E-02	60.04	1.12	1.23E-01
Total Hazard Index			7.44E-02			1.33E-01

VOC	6/27/12 Concentration, Station VOC-A (ppbv)	Non-waste Surface Worker (Training Building)		6/27/12 Running Annual Average, Station VOC-A (ppbv)	Non-waste Surface Worker (Training Building)	
		Conc. ug/m^3	Hazard Index		Conc. ug/m^3	Hazard Index
Non-Carcinogenic Compounds (Permit List)						
1,1,1-Trichloroethane	19.58	0.37	1.63E-05	30.43	0.58	2.53E-05
Toluene	0	0	0	0	0	0
Chlorobenzene	0	0	0	0	0	0
1,1, -Dichloroethylene	0	0	0	0	0	0
Carbon Tetrachloride	103.86	2.29	5.02E-03	185.88	4.07	8.92E-03
Chloroform	7.39	0.13	2.81E-04	15.55	0.26	5.91E-04
1,2-Dichloroethane	0	0	0	0	0	0
Methylene Chloride	2.75	0.03	1.21E-05	3.01	0.04	1.33E-05
Total Hazard Index			5.33E-03			9.55E-03

Note that 1,1,2,2-Tetrachloroethane does not have a published RfC

This approach offers tremendous advantages over the existing approach that uses COCs for repository monitoring. First, because the EPA is continually evaluating the health effects of organic compounds, future changes that the EPA makes to the risk factors can be handled using a Class 1 permit modification notification in accordance with proposed language in this PMR. Adjustments to COCs will not be necessary. Second, if new target compounds are identified as the result of the TIC requirements of the Permit, they can be added to the risk calculation without having to adjust COCs. Additions of new targets would also be via a Class 1 permit modification notification. Third, reporting will be greatly diminished since a single exceedance of a COC by any particular compound will no longer have to be reported unless it is high enough to cause the overall risk or HI to exceed the action levels. Fourth, the methodology provides a more comprehensive assessment of health impacts since it considers both the carcinogenic and non-carcinogenic effects of compounds.

The Permittees are proposing to revise Table 4.6.2.3 to update the list of target analytes consistent with the proposed changes in Topic 1 and to include the current recommended EPA risk factors. The formula for calculating risk are proposed to be added to Permit Attachment N. Action levels are the same as in the Permit; however, instead of being VOC-specific, they are established relative to the 10^{-5} risk level for carcinogens and the HI of 1.0 for non-carcinogens. Specifically, as currently required for individual VOCs, the Permittees will have to report to the NMED any instance that the risk based on the validated results from the monitoring system or the RAA-based risk indicates that the risk level of 10^{-5} or HI of 1.0 is exceeded. If the RAA-based risk exceeds the risk limit or the hazard limit, the Permittees will have the option of either closing the active CH TRU waste room and putting ventilation barriers in place or proposing an alternative remedial action to the Secretary for approval. If the RAA-based risk exceedance continues for six consecutive months, the affected underground hazardous waste disposal unit (**HWDU**) will either be closed or an alternative remedial action will be proposed to the Secretary for approval.

The Permittees' proposal for alternative actions to mitigate reaching action levels is based on several factors. First, as indicated above, the NMED anticipated that the Permittees could exert control over employees to ensure they do not receive chronic exposures to VOCs. This means that instead of closing portions of the repository, it may be more appropriate to move the affected employees so that continued exposure does not occur. Second, the Permittees may be able to remediate the emissions by managing waste emplacement activities. This could include embargoing high VOC waste until a room or panel is filled, or overpacking waste into larger containers with fewer filters left open. Both of these methods have been used successfully in the past to manage high VOC concentrations. The Permit text changes provide for the submittal, NMED approval, and implementation of the alternative remedial actions.

Section 4.6.2.3 Notification Requirements and Section 4.6.2.4 Remedial Actions: Changes to these sections are necessary to implement the Permittees' proposed change to base repository VOC action levels on total risk to the surface worker and not on VOC-specific COCs as discussed above and to allow the proposal of alternative action to remediate exceeding action levels.

N-3b Analytes to Be Monitored: The Permittees are proposing changes to clarify the list of targets and the method for adding compounds to the list, should they appear in the analysis. Non-target compounds (i.e., compounds not listed in Table 4.6.2.3) may appear in the VOC analytical results as TICs, which means the measured concentrations are approximate since they are not targets in the analysis. Requirements in the Permit indicate when TICs must be added to the analytical suite so that their concentrations are more accurately determined. Some non-targets may be included on the laboratory's target analyte list as ARAs at the Permittees' request to gain a better understanding of potential concentrations and associated risk. The Permittees will report ARAs in the annual report. When new analytes are added as targets they will also be evaluated to determine if they have an impact on the risk calculation. If the ARA contributes to more than one percent of the risk, requirements are proposed to add these compounds to Table 4.6.2.3 during the annual update and to include their respective risk factors. These analytes are also added to the risk calculations. Recordkeeping and reporting for these compounds remains the same.

N-3e(1) Data Evaluation and Reporting for Repository VOC Monitoring: This section is rewritten to incorporate the calculation of risk instead of using COCs as discussed earlier.

<u>Topic 3: Establish new room-based action level COCs and update Permit Part 4, Table 4.4.1 to correspond with the revised target analyte list.</u>

The use of COCs for room-based monitoring is currently used to impose the environmental performance standards for underground waste workers. The Permittees are not proposing an alternate method to impose the environmental performance standards for underground waste workers. In this case, the exposure is an acute exposure as the result of a roof fall in an adjacent closed room. The COCs in the Permit were established based on either a LEL for the compound or a concentration that prevents an exposure that is immediately dangerous to life and health (**IDLH**). The rationale for each value is found in the NMED written testimony from the 1999 Permit Hearing. Trichloroethylene is not flammable and has an IDLH value. This change is required to update Table 4.4.1 to make it consistent with the revised target analyte list. Table 4.4.1 is revised by adding a new COC for trichloroethylene of 48,000 ppmv and deleting the COCs for the following compounds; chlorobenzene, 1,1, dichloroethene, methylene chloride, toluene. The following describes the rational for determining the COC for trichloroethylene.

The rationale for calculating the disposal room concentration that will limit the exposure to no more than the IDLH value is based on the assumption in the original Permit Application that a roof fall occurs in a closed room adjacent to an active CH TRU waste room. The roof fall displaces 10 percent of the void volume in the closed room. The amount of void space in a closed room is calculated using the dimensions 300 feet long, 33 feet wide, and 1.5 feet open space above the waste (14,850 cubic feet). One half of this displaced volume (742.5 cubic feet) is expelled from each end of the room with a limiting concentration of the compound of interest (referred to as a puff). A waste worker who is in the active room is exposed to this puff and the associated concentration of VOC from the closed room ($Conc_{voc}$). The ventilation rate in the active room is a minimum of 35,000 cubic feet per minute. So the puff is added to this air and is transported to the receptor. The dose is calculated as a one minute exposure. The concentration of the VOC that the receptor is exposed to ($Dose_{voc}$) can be determined multiplying the concentration and multiplying it by the ratio of the puff volume to the sum of the puff volume and the 35,000 cubic feet that is moved each minute. This can be written as follows:

$$Dose_{voc} = Conc_{voc} \times \frac{742.5}{(35{,}000 + 742.5)} \qquad (10)$$

Where:

$Dose_{voc}$ = Concentration at the receptor in ppmv for a one minute exposure

$Conc_{voc}$ = Concentration in adjacent closed room in ppmv

If $Dose_{voc}$ is set to the $IDLH$, the limiting concentration can be determined as follows:

$Conc_{voc} = IDLH \times 48.0$

Trichloroethylene has an IDLH of 1,000 ppmv[13] giving a COC for room-based monitoring of 48,000 ppmv. This value has been added to Permit Part 4, Table 4.4.1 and the associated action levels to Table 4.6.3.2.

The PMR also deletes chlorobenzene, 1,1-dichloroethylene, methylene chloride, and toluene from Table 4.4.1. A separate evaluation of these compounds is warranted because their health effects are not based on the EPA risk values. Instead, their COCs are based on OSHA health-based values or the LEL. Results of the Room-Based VOC Monitoring program are reported semi-annually to the NMED. These data can be used to determine if deleting these compounds from Table 4.4.1 poses a risk to underground workers. Four data sets are provided in Table 10 to support the conclusion that removing these compounds from Table 4.4.1 does not pose a risk to underground workers. The first dataset is from Panel 5 which contains the greatest amount of high VOC concentration waste. The second data set is the most recent reported results for Panel 6, the current panel that is being filled. The third and fourth data sets are the most recent reported results for ongoing room-based monitoring for Panels 3 and 4.

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[13] http://www.epa.gov/ttn/atw/hlthef/tri-ethy.html

Table 10 Summary of Disposal Room VOC Monitoring Results[14,15]

Target Compound	Panel 5 for the Period July 1, 2011 through December 31, 2011 Maximum Detected Value (ppmv)	Panel 6 for the Period January 1, 2012 through June 30, 2012 Maximum Detected Value (ppmv)	Panel 3 for the Period January 1, 2012 through June 30, 2012 Maximum Detected Value (ppmv)	Panel 4 for the Period January 1, 2012 through June 30, 2012 Maximum Detected Value (ppmv)
Carbon Tetrachloride	6,119	535	4.9	887
Chlorobenzene	<MDL	<MDL	<MDL	<MDL
Chloroform	753.5	29	0.15	67
1,1-Dichloroethylene	<MRL	<MDL	0.05 J	<MDL
1,2-Dichloroethane	<MDL	<MDL	0.01 J	<MDL
Methylene Chloride	76.8	3.1 J	1.3	31
1,1,2,2-Tetrachloroethane	<MDL	<MDL	<MDL	<MDL
Toluene	<MRL	0.05 J	0.09	1.4 J
1,1,1-Trichloroethane	232.7	79	4.5	160

ppmv = parts per million by volume

MDL = method detection level

MRL = method reporting limit (contract-specified limit of 0.5 ppmv)

J = Estimated value, below the method reporting limit (MRL), but above the method detection limit (MDL)

Two of the compounds, chlorobenzene and toluene, have COCs set at their LELs (13,000 ppmv and 11,000 ppmv respectively). Both compounds are consistently not detected in the analysis above their method detection limit or method reporting limit, indicating they have concentrations that are less than 0.5 ppmv or are reported with very low values. Therefore dropping these two compounds from the Room-Based VOC Monitoring program does not pose a risk to underground workers. The remaining two compounds (1,1-dichloroethylene and methylene chloride) have limits that are based on either the IDLH (5,490 ppmv for 1,1-dichloroethylene) or a concentration below the IDLH (100,000 ppmv for methylene chloride). An evaluation of Room-Based VOC Monitoring program data from Panel 5 which contains the greatest amount of waste with VOCs indicate that the highest concentration of methylene chloride observed is 76.8 ppmv, well below its limit and 1,1-dichloroethylene is consistently not detected in the analysis above its method detection limit or method reporting limit. Therefore dropping these two compounds from the Room-Based VOC Monitoring program does not pose a risk to underground workers.

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[14] United States Department of Energy, DOE/WIPP-11-3443-2, Semi-Annual VOC, Hydrogen, and Methane Data Summary Report for Reporting Period July 1, 2011 through December 31, 2011.

[15] United States Department of Energy, DOE/WIPP-12-3492-1, Semi-Annual VOC, Hydrogen, and Methane Data Summary Report for Reporting Period January 1, 2012 through June 30, 2012.

Topic 4: Remove closed room monitoring for non-adjacent rooms.

Room-based action levels have been established to protect workers in the event of a roof fall in the adjacent closed CH TRU waste room. The action items are triggered by reaching the COCs in the adjacent room. To protect workers only the concentration of VOCs in the adjacent room is relevant. That is why the actions in the current Permit are for the adjacent room only. However, the Permit requires continued monitoring of non-adjacent rooms. The Permit currently requires that if the concentration in non-adjacent rooms reaches an action level in Table 4.6.3.2, reporting within seven days is necessary, even though reaching the higher action levels in non-adjacent rooms will not trigger the closure requirements. Therefore, the Permittees are proposing to revise the text to limit monitoring and reporting of results to the adjacent room only and removing the requirement to monitor non-adjacent rooms since monitoring results do not trigger closure. This change is required to make the monitoring consistent with the reporting and remedial action requirements and to eliminate unnecessary monitoring in non-adjacent rooms. Data from non-adjacent rooms is currently provided on a semi-annual basis in the VOC monitoring reports.

Section 4.6.3.2 Notification Requirements: Changes to this section are necessary to eliminate notifications for closed rooms that are not immediately adjacent to an active TRU waste disposal room. In addition, the Permittees are proposing the option to identify an alternate action(s) to mitigate the high VOC concentrations in an adjacent room and to propose this action(s) to the Secretary for approval in lieu of closing an active room. As with repository-based monitoring, alternatives to closing an unfilled room exist to mitigate high VOC levels in an adjacent room. For example, ventilation rates can be established above the minimum required to assure worker protection. The proposal accommodates this option.

N-3a(2) Sampling Locations for Disposal Room VOC Monitoring: The Permittees are clarifying the sequence for establishing monitoring points in active disposal rooms and in the closed room adjacent to the active TRU waste disposal room. In addition, the Permittees are proposing to terminate sampling in closed disposal rooms that are not adjacent to an active room. These samples are currently taken and analyzed; however, there are no actions other than increasing sampling frequency and reporting associated with these results. Only samples in closed rooms adjacent to active TRU waste disposal rooms can trigger actions related to mitigating VOC emissions in accordance with the requirements in Permit Part 4. Additional samples in rooms that are closed and non-adjacent may be useful to understanding VOC emissions; however, they need not be mandatory.

N-3e(2) Data Evaluation for Disposal Room VOC Monitoring: This section is rewritten to reduce the application of action levels in Table 4.6.3.2 to measurements in active rooms and closed rooms adjacent to an active room.

Topic 5: VOC Monitoring Program clarifications and updates. This impacts numerous places in Attachment N.

The Permittees are proposing to rewrite portions of the VOC Monitoring Program found in Attachment N. These principally fall into three categories: editorial changes to update program language, remove unnecessary detail, and make editorial corrections; technical changes to align the program with EPA methods for ambient air monitoring; and clarifications to make the requirements internally consistent. These changes are required to update the VOC monitoring program to be consistent with industry practices, to simplify implementation and make editorial corrections. These changes are in addition to the ones described in Topics 1 through 4.

Recently, the Permittees successfully revised the Groundwater Monitoring Program to accomplish many of the same purposes and the result of the groundwater program modification has been a clearer, easier to implement program document. The revisions proposed to Attachment N are intended to have the same effect.

The following is a section-by-section discussion of the proposed program changes.

Section 4.4.3 Ongoing Disposal Room VOC Monitoring in Panels 3 through 8: Changes proposed to this section are editorial.

Section 4.6.2.2 Reporting Requirements: The Permittees are proposing to reduce the reporting of the VOC results to annually. Currently, VOC results are being reported semi-annually. However, because these are data reports and because there are interim reporting requirements that go into effect should action levels be exceeded (as required by Permit Part 4, Sections 4.6.2.3 and 4.6.3.2), annual reports are sufficient. Reports would be due in October and would report results for the year ending the previous June 30th.

G-1d(1) Schedule for Panel Closure: The changes in this section are editorial in nature as a result of changes to Permit Part 4, Section 4.6.3.3.

N-1 Introduction: The changes in this section are editorial in nature, clarifying the remedial action if any VOC in a panel exceeds the "95% Action Level."

N-1a Background: The changes in this section are editorial in nature, clarifying the program content and the basis for room-based monitoring.

N-1b Objectives of the Volatile Organic Compound Monitoring Plan: In addition to editorial changes, the filled panel monitoring requirements are added to the list of objectives for clarity.

N-2 Target Volatile Organic Compounds: Changes proposed to this section are editorial.

N-3 Monitoring Design: The Permittees are proposing to change the monitoring design by changing from pressurized sampling to an industry standard subatmospheric sampling. Subatmospheric sampling techniques are currently used for ongoing disposal room VOC monitoring and hydrogen and methane monitoring. This section introduces this concept; however, the details are deferred to Section N-3c.

N-3a Sampling Locations: Changes proposed to this section are editorial.

N-3a(1) Sampling Locations for Repository VOC Monitoring: The major change proposed for this section is the elimination of Station VOC-B. This station was established and operated to determine the background concentrations of VOCs in the ventilation air. These background values are subtracted from the concentrations measured at Station VOC-A before calculating the emissions from the disposed waste. Station VOC-B is being eliminated because VOC concentrations are seldom detected at Station VOC-B indicating that the only source of the target VOCs is the waste. In addition, with the elimination of Station VOC-B, the underground map in Figure N-1 is no longer needed since the location of VOC-A does not change as more panels of waste are added to the underground operation. Removing the requirement for VOC-B will also eliminate the need to move VOC-B to be upstream of from the open panel being filled with waste as currently required by the Permit in Attachment N, Section N-3a(1) and eliminate the need to submit future Permit modifications to update the location of VOC-B in Figure N-1. References to Station VOC-B are edited out of this section.

N-3a(2) Sampling Locations for Disposal Room VOC Monitoring: Changes to this section are to clarify the sequence for installing sample heads. Sample head number, types, or locations are not being modified.

N-3a(3) Ongoing Disposal Room VOC Monitoring in Panels 3 through 8: Changes proposed to this section are editorial.

N-3c Sampling and Analysis Methods:

The Permittees are proposing two major changes to this section. First, the Permittees are proposing to use the passive air sampling kit (PASK) for repository VOC monitoring (i.e., Station VOC-A) which is a subatmospheric sampling technique not requiring power. This has reliably been used to collect VOC samples in the underground that are used by the Permittees for assessment purposes unrelated to the Permit. This experience with subatmospheric samplers at the WIPP facility has been excellent and the sampling devices are inherently simpler without the use of pumps and pump controllers and the need for an independent power supply. In addition, subatmospheric samplers are less likely to develop leaks that allow ambient air to dilute the sample due to the fact that there are fewer fittings and connections involved with subatmospheric sampling. Finally, the subatmospheric sampling approach, which is the preferred and ubiquitous sampling method used by many monitoring programs, has advantages because it requires less maintenance and provides more flexibility since a pump requiring electrical power is not required.

Second, the repository sample is being changed from two 6-hour integrated samples per week to a single 24 hour integrated sample at Station VOC-A along with short duration samples for room-based monitoring. Method TO-15 refers to integrated samples as having duration of 1 to 24 hours. Generally, samples that are aimed at identifying occupational exposures have duration on the order of a work shift, typically 6 to 8 hours. Samples for determining chronic effects to public receptors are longer in duration, typically 24-hours in duration, to average out the variability that may occur during the day. In this context, the Permit is modified to refer to 24-hour samples for the repository monitoring system because this system is established for monitoring chronic exposures and shorter-duration samples (as specified in sampling standard operating procedures (SOPs)) for room-based monitoring. Experience has shown that during a typical work day at the WIPP facility, the VOC concentrations at Station VOC-A will be affected by ventilation changes throughout the repository. These changes may be the result of moving bulkheads, realigning flow rates, power failures, or simply propping doors open to ventilate areas to allow work to proceed. Twenty-four hour samples at Station VOC-A are less likely to be affected by these changes than shorter-duration samples. Hence, the Permittees believe the 24-hour samples may remove some of the variability that is observed in the VOC results and result in more representative predictors of chronic exposure.

Figure 1 has been prepared in order to compare the effect on the RAA of VOC samples obtained using the PASK method (PASK samples) over a 24-hour period. In the figure, a 24-hour sample was substituted for the corresponding 6-hour sample and the adjacent day 6-hour sample was removed. The data show that the PASK samples are generally higher than VOC samples obtained using the pressurized method (pressurized samples) and will result in a slightly higher running annual average. This is likely due to the improvements in the sampling technology represented by the PASK method. For example, according to a recent comparison by David Shelow[16] of the EPA, the pressurized method has the disadvantages that the pump is a source of contamination, there are many connections involved and these represent potential sources of leaks, the pumps are subject to mechanical failure, and once contaminated, they are difficult to clean. Such leaks could allow fresh air from the underground to enter the sample path and thereby dilute the sample.

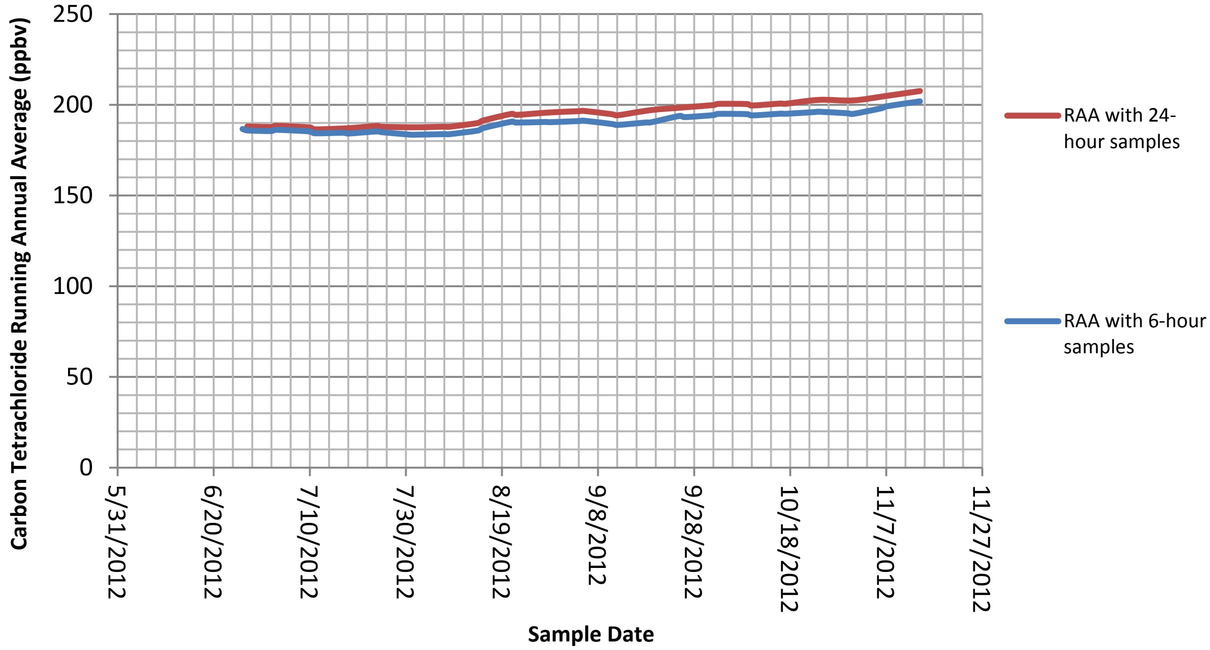

Figure 1 Comparison of the Running Annual Average for Carbon Tetrachloride based on 6-Hour Pressurized Samples versus 24-Hour PASK Samples

The Permittees are also proposing to gain the advantages of subatmospheric sampling over pressurized sampling in the Disposal Room VOC Monitoring Program. In this case the Permittees propose to use short-duration, time-integrated samples consistent with Method TO-15. These sample locations are not subject to the same degree of variability that is experienced at Station VOC-A, therefore, long-duration subatmospheric samples, such as those being proposed for Station VOC-A, are not necessary.

Editorial comments are being made to remove the trade name “Summa” from the text and replacing it with the generic term “passivated.”

N-3d Sampling Schedule: The introductory paragraphs are deleted since they were originally included to evaluate the monitoring system when the disposal operations were initiated in 1999. Sampling schedules are established by the Permit in the subsequent subsections.

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[16]David Shelow, VOC Sampling and Analysis, US EPA – OAR – OAQPS, Ambient Air Monitoring Group, National Air Monitoring Meeting, May 2012

N-3d(1) Sampling Schedule for Repository VOC Monitoring: Changes to this section remove obsolete text and revise sampling to a single 24-hour sample per week.

N-3d(2) Sampling Schedule for Disposal Room VOC Monitoring: Changes proposed to this section are editorial.

N-4a Sampling Equipment: Changes to this section remove the specification SUMMA®-type canisters and changes the requirement to passivated canisters. This change is required because SUMMA® is a trade name for one company's coating type (i.e., passivation process). What is important is that the material is passivated (made less reactive) to ensure that materials do not adhere to the surface of the canister. Other editorial changes are included.

N-4a(1) Sample Canisters: Changes to this section remove the specification SUMMA® type canisters and changes the requirement to passivated canisters. Other editorial changes are included. The initial conditions (cleanliness and vacuum) are specified.

N-4a(2) Volatile Organic Compound Canister Samplers: This section is rewritten to accommodate the subatmospheric sampling process.

N-4a(3) Sample Tubing: The changes to this section are editorial.

N-4b Sample Collection: This section is rewritten to accommodate the subatmospheric sampling process and to make editorial corrections.

N-4c Sample Management: The changes to this section are editorial.

N-4d Sampler Maintenance: The changes to this section are editorial.

N-4e Analytical Procedures: The changes to this section are editorial.

N-5 Quality Assurance: The changes to this section are editorial.

N-5a(1) Evaluation of Laboratory Precision: The changes to this section are editorial.

N-5a(2) Evaluation of Field Precision: The changes to this section are editorial.

N-5a(3) Evaluation of Laboratory Accuracy: The changes to this section are editorial.

N-5a(4) Evaluation of Sensitivity: The changes to this section are editorial.

N-5d Data Reduction, Validation, and Reporting: The changes to this section are editorial.

N-5e Performance and System Audits: The changes to this section are editorial.

N-5f Preventive Maintenance: The changes to this section are editorial.

N-5g Corrective Actions: The changes to this section are editorial.

N-5h Records Management: The changes to this section are editorial.

N-6 Sampling and Analysis for Disposal Room VOC Monitoring in Filled Panels: This section is deleted since it is redundant with information now in Section N-3a(3) In addition, the term “grab samples” is being deleted from Attachment N because it no longer describes the shorter-duration samples (likely on the order of the 30 seconds to 15 minutes depending on conditions) used for ongoing disposal room monitoring in filled panels.

N-7 References: This section is updated to reflect current references.

Tables: Tables are updated to reflect the changes in the attachment.

Figures: Figures N-1 and N-2 are removed and other figures are updated.

4. 20.4.1.900 NMAC (incorporating 40 CFR 270.42 (c)(1)(iv)), requires the applicant to provide the applicable information required by 40 CFR 270.13 through 270.21, 270.62 and 270.63.

The attached regulatory crosswalk describes those portions of the Permit that are affected by this PMR. Where applicable, regulatory citations in this modification reference Title 20, Chapter 4, Part 1, NMAC, revised March 2009, incorporating the CFR, Title 40 (40 CFR Parts 264 and 270). 40 CFR §270.16 through §270.22, §270.62, §270.63 and §270.66 are not applicable at WIPP. Consequently, they are not listed in the regulatory crosswalk table. 40 CFR §270.23 is applicable to the WIPP Hazardous Waste Disposal Units (**HWDUs**) and the associated VOC monitoring programs.

5. 20.4.1.900 NMAC (incorporating 40 CFR 270.11(d)(1) and 40 CFR 270.30(k)), requires that any person signing under paragraph a and b must certify the document in accordance with 20.4.1.900 NMAC.

The transmittal letter for this PMR contains the signed certification statement in accordance with Permit Part 1, Section 1.9 of the Permit.

Regulatory Crosswalk

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the Permit or Permit Application	Yes	No
§270.13		Contents of Part A permit application	Attachment B, Part A		✓
§270.14(b)(1)		General facility description	Attachment A		✓
§270.14(b)(2)	§264.13(a)	Chemical and physical analyses	Attachment C		✓
§270.14(b)(3)	§264.13(b)	Development and implementation of waste analysis plan	Attachment C		✓
	§264.13(c)	Off-site waste analysis requirements	Attachment C		✓
§270.14(b)(4)	§264.14(a-c)	Security procedures and equipment	Part 2.6		✓
§270.14(b)(5)	§264.15(a-d)	General inspection requirements	Attachment E		✓
	§264.174	Container inspections	Attachment E		✓
§270.23(a)(2)	§264.602	Miscellaneous units inspections	Attachment E		✓
§270.14(b)(6)		Request for waiver from preparedness and prevention requirements of Part 264 Subpart C	NA		✓
§270.14(b)(7)	264 Subpart D	Contingency plan requirements	Attachment D		✓
	§264.51	Contingency plan design and implementation	Attachment D		✓
	§264.52 (a) & (c-f)	Contingency plan content	Attachment D		✓
	§264.53	Contingency plan copies	Attachment D		✓
	§264.54	Contingency plan amendment	Attachment D		✓
	§264.55	Emergency coordinator	Attachment D		✓
	§264.56	Emergency procedures	Attachment D		✓
§270.14(b)(8)		Description of procedures, structures or equipment for:	Part 2.10		✓
§270.14(b)(8) (i)		Prevention of hazards in unloading operations (e.g., ramps and special forklifts)	Part 2.10		✓
§270.14(b)(8) (ii)		Runoff or flood prevention (e.g., berms, trenches, and dikes)	Part 2.10		✓
§270.14(b)(8) (iii)		Prevention of contamination of water supplies	Part 2.10		✓
§270.14(b)(8) (iv)		Mitigation of effects of equipment failure and power outages	Part 2.10		✓
§270.14(b)(8) (v)		Prevention of undue exposure of personnel (e.g., personal protective equipment)	Part 2.10		✓
§270.14(b)(8) (vi) §270.23(a)(2)	§264.601	Prevention of releases to the atmosphere	Part Part 4 Attachment A2 Attachment N	✓	
	264 Subpart C	Preparedness and Prevention	Part 2.10		✓
	§264.31	Design and operation of facility	Part 2.10		✓
	§264.32	Required equipment	Part 2.10 Attachment D		✓
	§264.33	Testing and maintenance of equipment	Attachment E		✓
	§264.34	Access to communication/alarm system	Part 2.10		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the Permit or Permit Application	Yes	No
	§264.35	Required aisle space	Part 2.10		✓
	§264.37	Arrangements with local authorities	Attachment D		✓
§270.14(b)(9)	§264.17(a-c)	Prevention of accidental ignition or reaction of ignitable, reactive, or incompatible wastes	Part 2.10		✓
§270.14(b) (10)		Traffic pattern, volume, and controls, for example: Identification of turn lanes Identification of traffic/stacking lanes, if appropriate Description of access road surface Description of access road load-bearing capacity Identification of traffic controls	Attachment A4		✓
§270.14(b) (11)(i) and (ii)	§264.18(a)	Seismic standard applicability and requirements	Part B, Rev. 6 Chapter B		✓
§270.14(b) (11)(iii-v)	§264.18(b)	100-year floodplain standard	Part B, Rev. 6 Chapter B		✓
	§264.18(c)	Other location standards	Part B, Rev. 6 Chapter B		✓
§270.14(b) (12)	§264.16(a-e)	Personnel training program	Part 2 Attachment F		✓
§270.14(b) (13)	264 Subpart G	Closure and post-closure plans	Attachment G & H		✓
§270.14(b)(13)	§264.111	Closure performance standard	Attachment G		✓
§270.14(b)(13)	§264.112(a), (b)	Written content of closure plan	Attachment G		✓
§270.14(b)(13)	§264.112(c)	Amendment of closure plan	Attachment G		✓
§270.14(b)(13)	§264.112(d)	Notification of partial and final closure	Attachment G		✓
§270.14(b)(13)	§264.112(e)	Removal of wastes and decontamination/dismantling of equipment	Attachment G		✓
§270.14(b)(13)	§264.113	Time allowed for closure	Attachment G		✓
§270.14(b)(13)	§264.114	Disposal/decontamination	Attachment G		✓
§270.14(b)(13)	§264.115	Certification of closure	Attachment G		✓
§270.14(b)(13)	§264.116	Survey plat	Attachment G		✓
§270.14(b)(13)	§264.117	Post-closure care and use of property	Attachment H		✓
§270.14(b)(13)	§264.118	Post-closure plan; amendment of plan	Attachment H		✓
§270.14(b)(13)	§264.178	Closure/ containers	Attachment G		✓
§270.14(b)(13)	§264.601	Environmental performance standards-Miscellaneous units	Attachment G		✓
§270.14(b)(13)	§264.603	Post-closure care	Attachment G		✓
§270.14(b)(14)	§264.119	Post-closure notices	Attachment H		✓
§270.14(b)(15)	§264.142	Closure cost estimate	NA		✓
	§264.143	Financial assurance	NA		✓
§270.14(b)(16)	§264.144	Post-closure cost estimate	NA		✓
	§264.145	Post-closure care financial assurance	NA		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the Permit or Permit Application	Yes	No
§270.14(b)(17)	§264.147	Liability insurance	NA		✓
§270.14(b)(18)	§264.149-150	Proof of financial coverage	NA		✓
§270.14(b)(19)(i), (vi), (vii), and (x)		Topographic map requirements Map scale and date Map orientation Legal boundaries Buildings Treatment, storage, and disposal operations Run-on/run-off control systems Fire control facilities	Attachment B Part A		✓
§270.14(b)(19)(ii)	§264.18(b)	100-year floodplain	Attachment B Part A		✓
§270.14(b)(19)(iii)		Surface waters	Attachment B Part A		✓
§270.14(b)(19)(iv)		Surrounding Land use	Attachment B Part A		✓
§270.14(b)(19)(v)		Wind rose	Attachment B Part A		✓
§270.14(b)(19)(viii)	§264.14(b)	Access controls	Attachment B Part A		✓
§270.14(b)(19)(ix)		Injection and withdrawal wells	Attachment B Part A		✓
§270.14(b)(19)(xi)		Drainage on flood control barriers	Attachment B Part A		✓
§270.14(b)(19)(xii)		Location of operational units	Attachment B Part A		✓
§270.14(b)(20)		Other federal laws Wild and Scenic Rivers Act National Historic Preservation Act Endangered Species Act Coastal Zone Management Act Fish and Wildlife Coordination Act Executive Orders	Attachment B Part A		✓
§270.15	§264 Subpart I	Containers	Attachment A1		✓
	§264.171	Condition of containers	Attachment A1		✓
	§264.172	Compatibility of waste with containers	Attachment A1		✓
	§264.173	Management of containers	Attachment A1		✓
	§264.174	Inspections	Attachment E Attachment A1		✓
§270.15(a)	§264.175	Containment systems	Attachment A1		✓
§270.15(c)	§264.176	Special requirements for ignitable or reactive waste	Part 2		✓
§270..15(d)	§264.177	Special requirements for incompatible wastes	Part 2		✓
	§264.178	Closure	Attachment G		✓
§270.15(e)	§264.179	Air emission standards	Part 4 Attachment N	✓	
§270.23	264 Subpart X	Miscellaneous units	Attachment A2		✓

Regulatory Citation(s) 20.4.1.900 NMAC (incorporating 40 CFR Part 270)	Regulatory Citation(s) 20.4.1.500 NMAC (incorporating 40 CFR Part 264)	Description of Requirement	Added or Clarified Information		
			Section of the Permit or Permit Application	Yes	No
§270.23(a)	§264.601	Detailed unit description	Attachment A2		✓
§270.23(b)	§264.601	Hydrologic, geologic, and meteorologic assessments	Part 5 Attachment L		✓
§270.23(c)	§264.601	Potential exposure pathways	Part 4 Attachment A2 Attachment N	✓	
§270.23(d)		Demonstration of treatment effectiveness	NA		✓
	§264.602	Monitoring, analysis, inspection, response, reporting, and corrective action	Part 2 Part 4 Part 5 Attachment A2 Attachment N	✓	
	§264.603	Post-closure care	Attachment H Attachment H1		✓
	264 Subpart E	Manifest system, record keeping, and reporting	Part 2 Attachment C		✓

Appendix A
Table of Changes

Table of Changes

Affected Permit Section	Explanation of Change
Part 4, Section 4.4.1	Changed “each” to “the immediately adjacent”
Part 4, Table 4.4.1	Added “,” to “9625” to read “9,625” Deleted “Chlorobenzene 13000” Added “,” to “9930” to read “9,930” Deleted “1,1-Dichloroethylene 5490” Added “,” to “2400” to read “2,400” Deleted “Methylene Chloride 100000” Added “,” to “2960” to read “2,960” Deleted “Toluene 11000” Added “,” to “33700” to read “33,700” Added “Trichloroethylene 48,000”
Part 4, Section 4.4.2	Deleted “and emission rate”
Part 4, Section 4.4.3	Deleted “in Panels 3 Through 8” Changed “Panels 3 through 8 after completion of waste emplacement” to “a filled panel” Changed “the” to “an” Deleted “specified in Permit Attachment G1 (Detailed Design Report for an Operation Phase Panel Closure System)”
Part 4, Section 4.6.2.2	Deleted “semi-“ on “semi-annually” Deleted “April and”
Part 4, Section 4.6.2.3	Added “The Permittees shall calculate the total carcinogenic and the total non-carcinogenic risk to the surface worker using the methodology in Attachment N after each sampling event for the compounds in Table 4.6.2.3 using the approved EPA risk factors listed in Table 4.6.2.3.” Changed “concentration of any VOC specified in Table 4.4.1 exceeds the concentration of concern specified in Table 4.6.2.3 below.” to “total carcinogenic risk to the surface worker exceeds 10^{-5} or the total non-carcinogenic risk as measured by the hazard index exceeds 1.0.” Added “The Permittees shall calculate the running annual average carcinogenic and non-carcinogenic risk to the surface worker using the methodology in Attachment N after each sampling event for the compounds in Table 4.6.2.3 using the approved EPA risk factors listed in Table 4.6.2.3.” Changed “for any VOC specified in Table 4.4.1 exceeds the concentration of concern specified in Table 4.6.2.3 below” to “total carcinogenic risk to the surface worker exceeds 10^{-5} or the total non-carcinogenic risk as measured by the hazard index exceeds 1.0” Added “The Permittees shall review EPA risk factors and the tentatively identified compound list annually and update Table 4.6.2.3 as needed as a Class 1 permit modification notification whenever new analytes are identified to be added to the target analyte list through the tentatively identified compound process in Attachment N or whenever the EPA updates the risk factors shown in Table 4.6.2.3.”

Affected Permit Section	Explanation of Change
Part 4, Table 4.6.2.3	Changed “Concentrations of Concern” to “Toxicity Values” Changed “Drift E-300 Concentration" to "Recommended EPA Risk Factors” Changed “ug/m3” to “Carcinogenic IUR (ug/m^3)$^{-1}$” Changed “ppbv” to “Non-carcinogenic RfC (mg/m^3)” Changed “6040” to “6.0x10^{-6}” Changed “960” to “1.0x10^{-1}” Deleted “Chlorobenzene 1015 220” Changed “890” to “2.3x10^{-5}” Changed “180” to “9.8x10^{-2}” Deleted “1,1-Dichloroethene 410 100” Changed “175” to “2.6x10^{-5}" Changed “45” to “7.0x10^{-3}" Deleted “Methylene Chloride 6700 1930” Changed “350” to “5.8x10^{-5}” Change “50” to “N/A” Deleted “Toluene 715 190” Changed “3200” to “N/A” Changed “590” to “5.0” Added “Trichloroethylene 4.1x10^{-6} 2.0x10^{-3}” Added “IUR = Inhalation Unit Risk from EPA Integrated Risk Information System (IRIS) Database RfC = Reference Concentration from EPA IRIS Database N/A = not applicable (No value published in the IRIS Database)”
Part 4, Section 4.6.2.4	Changed “concentration for a” to “for the total carcinogenic risk due to releases of” Added “s” to “VOC” Changed “4.4.1“ to “4.6.2.3” Changed “the concentration of concern specified in Table 4.6.2.3,” to “10^{-5} or if the running annual average for the total non-carcinogenic hazard index due to releases of VOCs specified in Table 4.6.2.3 exceeds 1.0,” Added “Alternatively, prior to reaching the action level, the Permittees can propose an alternative remedial action to the Secretary for ensuring no individuals are exposed to concentrations in excess of the limits. The Permittees may implement such plans in lieu of closing the active room only after approval by the Secretary.” Changed “concentration for a” to “for the total carcinogenic risk due to releases of” Added “s” to “VOC” Changed “4.4.1” to “4.6.2.3” Changed “the concentration of concern specified in Table 4.6.2.3” to “10^{-5} or if the running annual average for the total non-carcinogenic hazard index due to releases of VOCs specified in Table 4.6.2.3 exceeds 1.0” Added “Alternatively, prior to reaching the action level, the Permittees can propose an alternative remedial action to the Secretary for ensuring no individuals are exposed to concentrations in excess of the limits. The Permittees may implement such plans in lieu of closing the active HWDU only after approval by the Secretary.”
Part 4, Section 4.6.3.2	Changed “writing, within seven calendar days of obtaining validated analytical results,” to “accordance with Permit Attachment N, Section N-3e(2)” Changed “any closed room in an active panel or in” to “an active open room or”

Affected Permit Section	Explanation of Change
Part 4, Table 4.6.3.2	Changed “Any” to “Active Open or Immediately Adjacent” Deleted “Chlorobenzene 6,500 12,350” Deleted “1,1-Dichloroethene 2,745 5,215” Deleted “Methylene Chloride 50,000 95,000” Deleted “Toluene 5,500 10,450” Added “Trichloroethylene 24,000 45,600”
Part 4, Section 4.6.3.3	Changed “of the closed rooms” to “active open room or the immediately adjacent closed room” Deleted “closed” Deleted “s” on “rooms” Deleted “in the closed room(s)” Added “Alternatively, upon reaching the “95% Action Level,” the Permittees can propose an alternative remedial action to the Secretary for ensuring no individuals are exposed to concentrations in excess of the limits. The Permittees may implement such plans in lieu of closing the active room.”
Attachment G, Section G-1d(1)	Changed “closure of that panel by installing the 12-foot explosion-isolation wall as described in Section G-1e(1) and submit a Class 1* permit modification request to extend closure of that panel, if necessary.” to “remedial actions as required by Permit Part 4, Section 4.6.3.3.”
Attachment N, Table of Contents	Changed “Volatile Organic Compound” to “VOC” Added “Sampling Locations for” Deleted “in Panels 3 through 8” Changed “SUMMA®” to “Sample” Changed “Volatile Organic Compound Canister Samplers” to “Sample Collection Units” Deleted “Sampler” Added “of Sample Collection Units”
Attachment N, List of Tables	Deleted “(Station VOC-A and VOC-B)” Added “(Station VOC-A)” Added “VOC”
Attachment N, List of Figures	Deleted “Figure N-1 Panel Area Flow” Deleted “Figure N-2 VOC Monitoring System Design” Changed “3” to “1” Added “Typical” Added “Locations” Changed “4” to “2” Changed “VOC” to “Disposal Room”

Affected Permit Section	Explanation of Change
Attachment N, Acronyms and Abbreviations	Added “,” after “ACRONYMS” Deleted “AND” Added “, AND UNITS” Added “ARA additional requested analyte” Deleted “BS/BSD blank spike/blank spike duplicate” Added “CAS# Chemical Abstracts Service registry number” Added “CFR Code of Federal Regulations” Change “Contact” to lower case “contact” Deleted “CLP Contract Laboratory Program” Deleted “COC” concentration of concern Added “EDD electronic data deliverable” Added “HI” hazard index Added “IRIS Integrated Risk Information System Added “IUR inhalation unit risk Added “L” liter Added “LCSD laboratory control sample duplicate” Added “mm” millimeter Deleted “(Permit Section 1.5.3)” Added “mtorr millitorr” Changed “Testing” to “Technology” Added “NMAC New Mexico Administrative Code” Added “NMED New Mexico Environment Department” Added “PASK passive air sampling kit” Added “ppmv parts per million by volume” Deleted “QAPD Quality Assurance Program Description” Added “QAPjP Quality Assurance Project Plan” Deleted “RCRA” Resource Conservation and Recovery Act Added “RfC reference concentration” Added “RH remote-handled” Added “RIDS” Records Inventory and Disposition Schedule Changed “Transuranic” to “transuranic”
Attachment N, Section N-1	Added “plan for disposal phase” Changed “plan for” to “of” Added “s” to “compound” Added “s” to “VOC” Changed “emissions from mixed waste that may be entrained in the exhaust air from” to “at” Deleted “Underground Hazardous Waste Disposal Units (HWDUs) during the disposal phase at the facility.” Added “Program” Changed “Table 4.6.2.3” to “ Permit Part 4, Section 4.6.2.3” Added “Program (includes ongoing disposal room voc monitoring)” Added “Permit Part 4,”

Affected Permit Section	Explanation of Change
Attachment N, Section N-1a	Changed “The Underground HWDUs are located 2,150 feet (ft) (655 meters [m]) below ground surface, in the WIPP underground.” to “The WIPP facility includes a mined geologic repository located approximately 2,150 feet (ft) (655 meters [m]) below ground surface within a bedded salt formation. The repository’s underground structures for disposal of transuranic (TRU) mixed waste that may contain VOCs include the Underground Hazardous Waste Disposal Units (Underground HWDUs).” Changed “transuranic (TRU)” to “TRU” Added “disposal” Changed “underground disposal rooms” to “Underground HWDUs” Added “s” to “location” Changed “of the ambient mine air monitoring stations” to “for sampling” Changed “The location of the monitoring stations” to “Sampling locations” Deleted “The implementation schedule for the” Changed “programs” to “schedule” Changed “The equipment used at the monitoring stations” to “Sampling equipment” Deleted “used” Deleted “if limits are approached” Changed “Monitoring” to “monitoring” Added “WIPP” Changed “WRES” to “Washington Regulatory and Environmental Services”
Attachment N, Section N-1b	Changed “Volatile Organic Compound” to “VOC” Added “may” Added “running” Changed “concentration of” to “risk to the surface worker due to” Changed “VOC concentrations of concern (COC)” to “risk limits” Changed “Table” to “Section” Added “and calculated from measured VOC concentrations and risk factors identified in Table 4.6.2.3” Changed “Table” to “Section” Added “of active waste panels” Added “immediately adjacent” Added “Part 4,” Added “original sample results are greater than or equal to the” Changed “Action Levels” to “action levels” Deleted “are reached” Added “VOCs released from waste containers will be monitored in Room 1 of a filled panel that requires monitoring as described in Section N-3a(3) to confirm that the concentration of VOCs in the air do not exceed the VOC disposal room limits identified in Permit Part 4, Table 4.4.1. Appropriate remedial action, as specified in Permit Part 4, Section 4.6.3.3 and Attachment G, Section G-1d(1), will be taken if the original sample results are greater than or equal to the levels specified in Permit Part 4, Table 4.6.3.2 and Permit Attachment G, Section G-1d(1).”

Affected Permit Section	Explanation of Change
Attachment N, Section N-2	Changed “Volatile Organic Compounds” to “VOCs” Changed “repository monitoring” to “Repository VOC Monitoring” Deleted “and VOC-B” Changed “disposal room monitoring” to “Disposal Room VOC Monitoring Programs” Changed “together” to “individually they represent more than one percent of the risk and collectively” Changed “approximately 99” to “over 97”
Attachment N, Section N-3	Changed “measure” to “monitor” Changed “Sampling equipment includes the WIPP VOC canister samplers” to “Subatmospheric sample collection units” Deleted “both” Deleted “and Disposal Room” Deleted “s” on “Programs” Added “are herein referred to as a passive air sampling kit (PASK). A subatmospheric sampling assembly is the sample collection unit for disposal room VOC monitoring. These sample collection units are described in greater detail in Section N-4a(2)”
Attachment N, Section N-3a	Added “WIPP facility”

Affected Permit Section	Explanation of Change
Attachment N, Section N-3a(1)	Changed “The initial configuration for the repository VOC monitoring stations is shown in Figure N-1. All mine” to “Mine” Changed “exhaust shaft” to Exhaust Shaft” Changed “two locations in the facility” to “VOC-A” Changed “airborne” to “VOCs in the ambient mine air (repository” Added “)” Changed “attributable to VOC” to “including” Changed “measured” to “monitored” Changed “one VOC monitoring station” to “Station VOC-A” Deleted “at VOC-A” Deleted “The second station (Station VOC-B) will always be located upstream from the open panel being filled with waste (starting with Panel 1 at monitoring Station VOC-B (Figure N-1). In this configuration, Station VOC-B will measure VOC concentrations attributable to releases from the upstream sources and other background sources of VOCs, but not releases attributable to open or closed panels. The location of Station VOC-B will change when disposal activities begin in the next panel. Station VOC-B will be relocated to ensure that it is always upstream of the open panel that is receiving TRU mixed waste.” Changed “also measure” to “collect the” Added “s” to “VOC” Deleted “concentrations measured at Station VOC-B,” Deleted “from each monitoring station” Added “a” Deleted “s” from “days” Deleted “For each quantified target VOC, the concentration measured at Station VOC-B will be subtracted from the concentration measured at Station VOC-A to assess the magnitude of VOC releases from closed and open panels.” Changed “locations were” to “location was” Deleted “In addition, because of the ventilation requirements of the underground facility and atmospheric dispersion characteristics, any VOCs that are released from open or closed panels may be difficult to detect and differentiate from other sources of VOCs at any underground or above ground location further downstream of Panel 1. By measuring VOC concentrations close to the potential source of release (i.e., at Station VOC-A), it will be possible to differentiate potential releases from background levels (measured at Station VOC-B).”

Affected Permit Section	Explanation of Change
Attachment N, Section N-3a(2)	Changed “A” to “Excluding Room 1,” Added “s” to “head” Changed “inside the” to “for each” Changed “exhaust drift bulkhead and” to “designated ventilation barrier” Added “exhaust and” Added “s” to “room” Added “For Room 1, a sample head will be installed only at the exhaust location.” Added “3. VOC monitoring will begin within two weeks of waste emplacement in an active room. (Figures N-1 and N-2)” Deleted “3. When the active disposal room is filled, another sample head will be installed to the inlet of the filled active disposal room. (Figure N-3 and N-4) 4. The exhaust drift bulkhead will be removed and re-installed in the next disposal room so disposal activities may proceed.” Changed “5” to “4” Changed “A” to “When an active room is filled, a” Deleted “where the bulkhead was located” Added “As required below, VOC monitoring will begin at the inlet side of the disposal room within two weeks of closure.” Changed “6” to “5” Deleted “Monitoring of VOCs will continue in the now closed disposal room.” Added “s” to “room” Changed “all” to “immediately adjacent” Added “as described in Permit Attachment G, Section G-1d(1)” Deleted “This sequence for installing sample locations will proceed in the remaining disposal rooms until the inlet air ventilation barrier is installed in Room 1. An inlet sampler will not be installed in Room 1 because disposal room sampling proceeds to the next panel.”
Attachment N, Section N-3a(3)	Added “Sampling Locations for” Deleted “in Panels 3 through 8” Changed “Panels 3 through 8 after completion of waste emplacement” to “a filled panel”
Attachment N, Section N-3b	Deleted “nine” Added “VOC” Changed “compounds” to “target analytes” Added “(i.e., non-target VOCs)” Added “also” Changed “investigated” to “monitored” Added “Some non-targets may be included on the laboratory’s target analyte list as additional requested analytes (ARAs) to gain a better understanding of potential concentrations and associated risk.” Added “calibrate for ARAs when requested and” Changed “all of these compounds” to “other non-target VOCs” Changed “Tentatively Identified Compounds” to lower case to read as “tentatively identified compounds” Added “if tentative identification can be made. The evaluation of TICs in original samples will include those concentrations that are ≥10 percent of the relative internal standard. The evaluation of ARAs only includes concentrations that are ≥ the method reporting limit (MRL). The required MRLs for ARAs will be U.S. Environmental Protection Agency (EPA)-specified levels of quantitation proposed for EPA contract laboratories that analyze

Affected Permit Section	Explanation of Change
	canister samples by gas chromatography/mass spectrometry (GC/MS) (EPA, 1991).” Changed “TICs” to “Non-targets classified as ARAs or TICs that meet the following criteria: (1) are VOCs listed in Appendix VIII of 40 Code of Federal Regulations (CFR) Part 261 (incorporated by reference in 20.4.1.200 New Mexico Administrative Code (NMAC), and (2) are” Changed “%” to “percent” Added “original” Deleted “(exclusive of those collected from Station VOC-B) that are VOCs listed in Appendix VIII of 20.4.1.200 NMAC (incorporating 40 CFR §261)” Deleted “running” Added “, as applicable,” Added “analytical laboratory” Added “Non-target VOCs reported as “unknown” by the analytical laboratory are not evaluated due to indeterminate identifications.” Added “Additional requested analytes and” Added “New Mexico Environmental Department (” Added “)” Changed “the Semi-Annual VOC Monitoring Report” to “annual reports” Added “Part 4,” Added “As applicable, the Permittees will also report the justification for exclusion from the target analyte list(s) (e.g., the compound does not contribute to more than one percent of the risk). If new targets are required the Permittees will submit a Class 1 Permit Modification Notification annually in accordance with 20.4.1.900 NMAC (incorporating 40 CFR 270.42(a)) to update Table 4.6.2.3 to include the new analyte and associated recommended EPA risk values for the inhalation unit risk (IUR) and reference concentration (RfC). Added compounds will be included in the risk assessment described in Section N-3e(1).”
Attachment N, Section N-3c	Deleted “for VOC measurements” Added “sampling” Added “s” to “method” Added “repository and disposal room” Changed “sampling is” to “monitoring are” Changed “pressurized” to “subatmospheric” Deleted “Environmental Protection Agency (” Deleted “)” Deleted “SUMMA®” Deleted “(or equivalent)” Added “24-hour time” Added “or time-weighted average” Changed “each sample location” to “Station VOC-A and shorter duration samples for disposal room VOC monitoring” Changed “gas chromatography/mass spectrometry (GC/MS)” to “GC/MS” Changed “integrated samples, or grab” to “subatmospheric” Deleted “,” after “samples” Deleted “The sampling system can be operated unattended but requires detailed operator training.” Added “also” Changed “The field sampling systems will be operated” to “Sample collection units operate”

Affected Permit Section	Explanation of Change
	Changed “pressurized” to “subatmospheric” Changed “In this mode, air is drawn through the inlet and sampling system with a pump. The air is pumped into” to “A sample is collected into” Deleted “SUMMA®” Deleted “(or equivalent)” Changed “by the sampler, which regulates the rate and duration of sampling. The treatment of tubing and canisters used for VOC sampling effectively seals the inner walls and prevents compounds from being retained on the surfaces of the equipment. By the end of each sampling period, the canisters will be pressurized to about two atmospheres absolute. In the event of shortened sampling periods or other sampling conditions, the final pressure in the canister may be less than two atmospheres absolute. Sampling duration will be approximately six hours, so that a complete sample can be collected during a single work shift.” to “. When the canister is opened to the atmosphere, the differential pressure causes the sample to flow into the canister. Flow rate and duration are regulated with a flow-restrictive inlet and/or mechanical or electronic flow controllers. The air will pass through two particulate filters installed in dual in-line filter holders to prevent sample and equipment contamination and for radiation assessment of sampling equipment, as needed. The use of passive tubing and canisters for VOC sampling inhibits adsorption of compounds on the surfaces of the equipment.” Changed “The canister sampling system and GC/MS analytical method are particularly appropriate for the VOC Monitoring Programs because a relatively large sample volume is collected, and multiple dilutions and reanalyses can occur to ensure identification and quantification of target VOCs within the working range of the method. The “ to “For repository VOC monitoring, the” Deleted “for Repository Monitoring” Deleted “nine” Changed “compounds” to “VOCs” Deleted “.” after “GC/MS” Added “(EPA, 1991). The CRQLs for disposal room VOC monitoring are 500 (ppbv) (0.5 parts per million-volume (ppmv)) to allow for sub-ppmv quantitation.” Changed “method reporting limits (**MRL**)” to “MRL” Deleted “The MRL for Disposal Room Monitoring is 500 ppbv or less for the nine target compounds.” Deleted “system in open panels” Changed “the same canister sampling method as used in the repository VOC monitoring” to “sample collection units that will provide a subatmospheric sample within a short duration” Changed “the individual sampler” to “a sampling manifold” Changed “the access drift to the disposal panel. The air will pass through dual particulate filters to prevent sample and equipment contamination” to “an area accessible to sampling personnel”
Attachment N, Section N-3d	Deleted “The Permittees will evaluate whether the monitoring systems and analytical methods are functioning properly. The assessment period will be determined by the Permittees.”
Attachment N, Section N-3d(1)	Deleted “s” on “Stations” Changed “and VOC-B will begin” to “began” Changed “sampling” to “collection of a 24-hour time-integrated sample” Changed “two times” to “once”

<table>
<tr><th>Affected Permit Section</th><th>Explanation of Change</th></tr>
<tr><td>Attachment N, Section N-3d(2)</td><td>Changed “The disposal” to “Disposal”
Changed “sampling” to “VOC monitoring”
Added “Part 4,”
Changed “Beginning with Panel 3,” to “Ongoing”
Changed “sampling” to “VOC monitoring”
Deleted “each filled”
Added “s requiring monitoring”</td></tr>
<tr><td>Attachment N, Section N-3e(1)</td><td>Added “original Repository VOC Monitoring sample obtained during an”
Changed “COCs. The COCs for each of the nine target VOCs are presented” to “risk limits”
Changed “Table” to “Section”
Changed “micrograms per cubic meter (µg/m^3) and ppbv” to “risk of excess cancer death for compounds believed to be carcinogenic and hazard index (HI) for non-carcinogens”
Changed “COCs” to “risk and HI are calculated as follows:”
Added “Determine the concentration at Station VOC-A in mg/m^3 for each VOC. This measurement represents the emissions from all closed and open panels and is $C_{E\text{-}300VOCj}$ in equation (N-1).
Calculate the concentration at the top of the Exhaust Shaft based on the ratio of actual flow rate at Station VOC-A and the total Exhaust Flow Rate;
$C_{ES_{VOC_j}} = C_{E-300_{VOC_j}} \times \frac{V_{E-300}}{V_{ES}}$ (N-1)
Where:
$C_{ES_{VOC_j}}$ = Concentration of VOC$_j$ at the top of the Exhaust Shaft in mg/m^3
$C_{E-300_{VOC_j}}$ = Concentration of VOC$_j$ at E - 300 in mg/m^3
$V_{E\text{-}300}$ = E - 300 ventilation flow rate in ft^3/min
V_{ES} = Exhaust Shaft ventilation flow rate in ft^3/min
Apply the Air Dispersion Factor (0.0114) to determine the concentration at the receptor:
$Conc_{VOC_j} = C_{ES_{VOC_j}} \times 0.0114$ (N-2)
Where:
$Conc_{VOC_j}$ = Concentration VOC$_j$ at the receptor (mg/m^3)
Calculate the carcinogenic risk (for each VOC) using the following equation:
$R_{VOC_j} = \frac{Conc_{VOC_j} \times EF \times ED \times IUR_{VOC_j} \times 1000}{AT}$ (N-3)
Where:
R_{VOC_j} = Risk due to exposure to VOC$_j$
$Conc_{VOC_j}$ = Concentration VOC$_j$ at the receptor (mg/m^3)
EF = Exposure frequency (hours/year), = 1,920 hours per year
ED = Exposure duration, years, = 10 years
IUR_{VOC_j} = Inhalation risk factor from EPA Integrated Risk Information System (IRIS) database (ug/m^3)$^{-1}$ (from Table 4.6.2.3)</td></tr>
</table>

Affected Permit Section	Explanation of Change
	AT = Averaging time for carcinogens, = 613,200 hours based on 70 years 1,000 = ug/mg The total risk is then the sum of the risk due to each carcinogenic VOC: $$\text{Total Risk} = \sum_{j=1}^{m} R_{VOC_j}$$ (N-4) Where: Total Risk must be less than 10^{-5} m = the number of carcinogenic VOCs The formula for non-carcinogenic hazard is similar: $$HI_{VOC_j} = \frac{Conc_{VOC_j} \times EF \times ED}{AT \times RfC_{VOC_j}}$$ (N-5) Where: HI_{VOC_j} = Hazard Index for exposure to VOC_j $Conc_{VOC_j}$ = Concentration VOC_j at the receptor (mg/m^3) EF = Exposure frequency (hours/year), = 1,920 hours per year ED = Exposure duration, years, = 10 years RfC_{VOC_j} = Reference concentration from EPA IRIS database (mg/m^3) AT = Averaging time for non-carcinogens, = 87,600 hours, based on exposure duration The total hazard is then the sum of the hazard index due to each non-carcinogenic VOC: $$\text{Hazard Index} = \sum_{j=1}^{m} HI_{VOC_j}$$ (N-6) Where: Hazard Index must be less than 1.0 m = the number of non-carcinogenic VOCs" Deleted "were calculated assuming typical operational conditions for ventilation rates in the mine. The typical operational conditions were assumed to be an overall mine ventilation rate of 425,000 standard cubic feet per minute and a flow rate through the E-300 Drift at Station VOC-A of 130,000 standard cubic feet per minute. Since the mine ventilation rates at the time the air samples are collected may be different than the mine ventilation rates during typical operational conditions, the Permittees will measure and/or record the overall mine ventilation rate and the ventilation rate in the E-300 Drift at Station VOC-A that are in use during each sampling event. The Permittees shall also measure and record temperature and pressure conditions during the sampling event to allow all ventilation rates to be converted to standard flow rates. If the air samples were collected under the typical mine ventilation rate conditions, then the analytical data will be used without further manipulation. The concentration of each target VOC detected at Station VOC-B will be subtracted from the concentration detected at Station VOC-A. The resulting VOC concentration represents the concentration of VOCs being emitted from the open and closed Underground HWDUs upstream of Station VOC-A (or the Underground HWDU VOC emission concentration). If the air samples were not collected under typical mine ventilation rate operating conditions, the air monitoring analytical results from both Station VOC-A and Station VOC-B will be normalized to the typical operating conditions. This will be accomplished using the mine ventilation rates in use during the sampling event and the following equation:

Affected Permit Section	Explanation of Change
	$$NVOC_{AB} = VOC_{AB} * \left(\frac{425{,}000_{scfm} / 130{,}000_{scfm}}{V_{O\,scfm} / V_{E-300\,scfm}} \right) \qquad \text{(N-1)}$$ Where: $NVOC_{AB}$ = Normalized target VOC concentration from Stations VOC-A or VOC-B VOC_{AB} = Concentration of the target VOC detected at Station VOC-A or VOC-B under non-typical mine ventilation rates scfm = Standard cubic feet per minute Vo = Sampling event overall mine ventilation rate (in standard cubic feet per minute) VE-300 = Sampling event mine ventilation rate through the E-300 Drift (in standard cubic feet per minute) The normalized concentration of each target VOC detected at Station VOC-B will be subtracted from the normalized concentration detected at Station VOC-A. The resulting concentration represents the Underground HWDU VOC emission concentration." Added "summed risk and HI calculated from the" Added "s" to "concentration" Deleted "for each target VOC that is calculated for each sampling event" Changed "its COC listed in" to "the limits in" Changed "Table" to "Section" Changed "COCs" to "risk and HI limits" Changed "concentrations of any target VOC listed in" to "risk or HI" Changed "concentration of concern" to "limits" Changed "Table" to "Section" Changed "For the first year of air sampling, the running annual average concentration for each target VOC will be calculated using all of the previously collected data." to "The risk and HI at the location of the surface worker will be calculated using the methodology above for the running annual average concentrations." Changed "concentration" to "risk or HI" Deleted "for any target VOC" Changed "concentration of concern" to "limits" Changed "Table" to "Section"
Attachment N, Section N-3e(2)	Changed "5a" to "5d" Changed "any closed room, the" to "an" Changed ", or" to "and" Changed "exceeded the Action Levels" to "are greater than or equal to the action levels" Changed "Disposal Room Monitoring" to lowercase to read "disposal room monitoring" Changed "exceeds" to "is greater than or equal to" Added "Remedial action will be taken as specified in Section N-1b." Changed "submit" to "report disposal room VOC monitoring results" Changed "the Semi-Annual VOC Monitoring Report" to "in the annual reports as" Added "Part 4," Deleted "that also includes results from disposal room VOC monitoring"

Affected Permit Section	Explanation of Change
Attachment N, Section N-4a	Changed “SUMMA®” to “passivated” Changed “VOC canister samplers, treated” to “sample collection units, passivated” Changed “stainless steel” to “stainless-steel” Deleted “a” Added “in-line stainless steel” Changed “housing” to “holders”
Attachment N, Section N-4a(1)	Changed “SUMMA®” to “Sample” Deleted “SUMMA®” Changed “gas” to “disposal room” Added “(batch certification acceptable)” Changed “the required reporting limits for the VOC analytical method” to “0.2 ppbv” Deleted “(see Table N-2)” Changed “samplers” to “canisters” Changed “at the sampler” to “as adequate” Added “as described in standard operating procedures (SOPs). The sample canisters are initially evacuated at the analytical laboratory to <0.05 mm Hg (50 mtorr)”
Attachment N, Section N-4a(2)	Changed “Volatile Organic Compound Canister Samplers” to “Sample Collection Units” Changed “A conceptual diagram of a VOC sample collection unit is provided in Figure N-2. Such units will be used at monitoring Stations VOC-A and VOC-B and at sampling locations for disposal room measurements. The sampling unit consists of a sample pump, flow controller, sample inlet, inlet filters in series to remove particulate matter, vacuum/pressure gauge, electronic timer, inlet purge vent, two sampling ports, and sufficient collection canisters so that any delays attributed to laboratory turnaround time and canister cleaning and certification will not result in canister shortages. Knowledge of sampler flow rates and duration of sampling will allow calculation of sample volume. The set point flow rate will be verified before and after sample collection from the mass flow indication. Prior to their initial use and annually thereafter, the sample collection units will be tested and certified to demonstrate that they are free of contamination above the reporting limits of the VOC analytical method (see Section N-5). Ultra-high purity humidified zero air will be pumped through the inlet line and sampling unit and collected in previously certified canisters as sampler blanks for analysis. The cleaning and certification procedure is derived from concepts contained in the EPA Compendium Method TO-15 (EPA, 1999).” to “The sample collection unit for Station VOC-A samples is a commercially available sample train (herein referred as PASK) comprised of components that regulate the rate and duration of sampling into a sample canister. It can be operated unattended using a programmable timer or manually using canister valves. The sample collection unit for disposal room VOC monitoring samples is a designed subatmospheric sampling assembly that regulates the rate and duration of sampling into a sample canister. The design of the subatmospheric sampling assembly also allows for purging of sample lines to ensure that a representative sample is collected. Sample collection units will use passivated components for the sample flow path. This effectively seals the inner walls and prevents sample constituents from being retained on the surfaces of the equipment. When sample canisters installed on sample collection units are opened to the atmosphere, the differential pressure causes the sample to flow into the canister at a regulated rate. By the end of each sampling period, the canisters will be near atmospheric pressure. Additional detail on sample collection will be given in SOPs.”
Attachment N, Section N-4a(3)	Changed “Treated” to “Passivated” Changed “stainless steel” to read as “stainless-steel” Changed “treated” to “passivated” Changed “absorbing contaminants” to “absorbing sample constituents”

Affected Permit Section	Explanation of Change
Attachment N, Section N-4b	Added “Sample collection for VOCs in the WIPP repository will be conducted in accordance with written standard operating procedures (**SOPs**) that are kept on file at the facility. These SOPs will specify the steps necessary to assure the collection of samples that are of acceptable quality to meet the applicable data quality objectives in Section 5 of this Attachment.” Changed “Six” to “Samples collected from Station VOC-A will be 24” Added “time-” Changed “will be collected on” to “for” Changed “sample day” to “sampling event” Changed “experimental” to “assessment” Added “and to meet the data quality objectives” Deleted “The VOC canister sampler at each location will sample ambient air on the same programmed schedule. The sample pump will be programmed to sample continuously over a six-hour period during the workday. The units will sample at a nominal flow rate of 33.3 actual milliliters per minute over a six-hour sample period. This schedule will yield a final sample volume of approximately 12 L. Flow rates and sampling duration may be modified as necessary for experimental purposes and to meet the data quality objectives.” Added “for PASK” Changed “checked each sample day” to “set” Changed “Testing” to “Technology” Changed “Upon initiation of waste disposal activities in Panel 1, samples” to “Samples” Changed “twice” to “once” Deleted “(“ Deleted “s” after “Stations” Deleted “and VOC-B)” Deleted “by the sample sampler” Changed “from” to “for” Changed “sampling station” to “VOC monitoring program” Deleted “(Stations VOC-A and VOC-B) during the first sampling event and” Added “at least” Deleted “thereafter” Deleted “the” Deleted “The repository samples do not require this action due to the short lengths of tubing required at these locations.”

Affected Permit Section	Explanation of Change
Attachment N, Section N-4c	Changed “to document the sampler conditions under which” to “for” Deleted “is” Deleted “and to maintain this record in sample logbooks” Changed “The program team leader” to “A cognizant individual” Added “and the completed data sheets will be maintained in with the departmental Record Inventory and Disposition Schedule (RIDS)” Deleted “Prior to leaving the underground for analysis, sample containers may undergo radiological screening. No potentially contaminated samples or equipment will be transported to the surface.” Changed “sealed to ensure a tamper free shipment” to “custody maintained” Deleted “completed” Changed “time,” to “sample collection” Added “(s)” after “individual” Changed “Deviations from procedure will be considered variances. Variances must be preapproved by the program manager and recorded in the project files. Unintentional deviations, sampler malfunctions, and other problems are nonconformances. Nonconformances must be documented and recorded in the project files. All field logbooks/data sheets must be incorporated into WIPP’s records management program.” to “Unintentional procedure deviations, equipment malfunctions, and other problems that do not conform to established requirements are nonconformances. The disposition and documentation of nonconformances will be handled according to QA requirements.”
Attachment N, Section N-4d	Deleted “Sampler” Added “of Sample Collection Units” Changed “canister samplers” to “sample collection units” Changed “during each cleaning cycle” to “as needed” Changed “will” to “may” Changed “, but not be limited to,” to “cleaning,” Changed “sampler” to “sample collection unit” Added “and” Deleted “, and instrument calibration” Added “sample collection” Changed “sampler” to “equipment” Deleted “At a minimum, canister samplers will be certified for cleanliness initially and annually thereafter upon initial use, after any parts that are included in the sample flow path are replaced, or any time analytical results indicate potential contamination. All sample canisters will be certified prior to each usage.”
Attachment N, Section N-4e	Changed “Analysis of samples will be performed by a certified laboratory.” to “Analysis of samples shall be performed by a laboratory that the Permittees select and approve through established QA processes.” Changed “Methods” to “Analytical methods” Changed “the Permittees” to “cognizant individuals” Changed “report” to “records”
Attachment N, Section N-5	Deleted “EPA” Deleted “Preparing” Changed “standard operating procedures employed” to “SOPs used” Added “’” after “Permittees” Changed “standard operating procedures” to “SOPs” Changed “standard operating procedures to “SOPs”

Affected Permit Section	Explanation of Change
Attachment N, Section N-5a	Changed “2” to “7” Added “Note: Vertical lines in the formula above indicate absolute value of A-B.” Changed “BFB” to “bromofluorobenzene Chemical Abstract Service (CAS# 460-00-4)” Changed “contaminants” to “constituents” Changed “Code of Federal Regulations §” to “CFR Part” Added “(Appendix B)” Added “at least” Added “required to be” Added “inability to collect the required samples,”
Attachment N, Section N-5a(1)	Changed “blank spike/blank spike” to “laboratory control sample/laboratory control sample” Changed “BS/BSD” to “LCS/LCSD” Changed “1994” to “1991” Changed “BS/BSD” to “LCS/LCSD” Added “by the analytical laboratory” Changed “BS/BSD” to “LC/LCSD” Changed “BS/BSD” to “LC/LCSD”
Attachment N, Section N-5a(2)	Added “at least” Changed “both” to “each VOC” Changed “locations” to “program” Added “field”
Attachment N, Section N-5a(3)	Changed “laboratory control samples (**LCS**)” to “LCS” Changed “criteria” to “criterion” Added “minimum” Deleted “5-point” Added “$\leq$“ before “30” Changed “compound” to “VOC” Added “n” to read as “An” at the beginning of the sentence Deleted “blank spike or” Added “or ultra-high purity nitrogen” Changed “1994” to “1991” Changed “into” to “with”
Attachment N, Section N-5a(4)	Changed “intake manifold of the sampling systems” to “sample inlet of the sample collection units” Added “Two filters inert to VOCs will be installed in dual in-line filter holders in the sample flow path to minimize particulate interference.” Deleted “nine” Changed “compounds” to “VOCs” Changed “annual” to “subsequent” Added “s” to “evaluation” Changed “Code of Federal Regulations §” to “CFR Part” Added “(Appendix B)” Deleted “EPA/530-SW-90-021, as revised and retitled, “Quality Assurance and Quality Control” (“ Deleted “)” Added “EPA,”

Affected Permit Section	Explanation of Change
Attachment N, Section N-5a(5)	Changed “90” to “95”
Attachment N, Section N-5d	Changed “A dedicated logbook will be maintained by the operators. This logbook” to “Field sampling data sheets” Deleted “Sample collection conditions, maintenance, and calibration activities will be included in this logbook.” Added “barometric” Changed “etc.” to “and relative humidity” Changed “forms and sampling logbooks will be checked” to “sheets” Deleted “routinely” Added “analytical laboratory” Added “analytical” Added “at a frequency of at least 10 percent” Changed “Data Deliverables” to read as “data deliverables” Added “Permit Part 4,” Added “VOC” Changed “concentrations of concern in Table” to “the action levels specified in Permit Part 4, Section” Deleted “or concentrations”
Attachment N, Section N-5e	Added “certifications for” Added “s” to “canister” Changed “sampler certification” to “measurement and test equipment” Deleted “and sampler” Changed “certification” to read as “certifications” Added “and measurement and test equipment” Deleted “Field logs, logbooks, and data sheets will be reviewed weekly.” Added “Quality Assurance Project Plan (“ Added “)”
Attachment N, Section N-5f	Changed “Sampler maintenance” to “Maintenance of sample collection units” Added a period to the end of the first sentence Added “laboratory”
Attachment N, Section N-5g	Added “≥“ before “95” Changed “recertification and cleaning” to “maintenance” Changed “samplers” to “sample collection units” Added “measurement and” Changed “less than” to “≤“ Added “laboratory”
Attachment N, Section N-5h	Added “Management and Operating Contractor (“ Added “)” Changed “Original and duplicate or backup records of project activities will be maintained at the WIPP site.” to “Electronic records that cannot be altered by the user and capable of producing a paper copy shall be deemed to be a written record. Records of project activities will be maintained at or readily accessible from the WIPP site.”
Attachment N, Section N-6	Deleted Section

Affected Permit Section	Explanation of Change
Attachment N, Section N-7	Changed “7” to “6” Added “40 CFR Part 136, “Guidelines Establishing Test Procedures for the Analysis of Pollutants.” Section 310 of Public Law 108-447 of the Consolidated Appropriations Act of 2005. U.S. Environmental Protection Agency, 1991. Contract Laboratory Program, Volatile Organics Analysis of Ambient Air in Canisters (Draft), EPA540/R-94-085, December 1991, Washington, D.C.” Changed “3rd” to “Third” Changed the space between “Specially” and “Prepared” to “-” Changed “Mas” to “Mass” Added “(GC/MS)” Deleted “U.S. Environmental Protection Agency. 2000. *Guidance for the Data Quality Objectives Process*, QA/G-4. EPA 600/R-96/055, August 2000, Washington, D.C.” Changed “Guidance” to “Requirements” Changed “G” to “R-5” Changed “EPA Requirements” to “Guidance” Deleted “Preparing” Changed “R” to “G” Changed “01” to “02” Changed “2004” to “2003”
Attachment N, Table N-1	Deleted “(Station VOC-A And VOC-B)” Added “(Station VOC-A)” Added “VOC” Deleted “Chlorobenzene” Deleted “1,1-Dichloroethylene” Deleted “Methylene chloride” Deleted “Toluene” Added “Trichloroethylene”
Attachment N, Table N-2	Changed “Compound” to “Target VOC” Deleted “Chlorobenzene 60 to 140 25 35 2 500 95” Deleted “1,1-Dichloroethylene 60 to 140 25 35 5 500 95” Deleted “Methylene chloride 60 to 140 25 35 5 500 95” Deleted “Toluene 60 to 140 25 35 5 500 95” Added “Trichloroethylene 60 to 140 25 35 5 500 95” Added “, allowances for conditions that may produce non-representative RPD values will be specified in SOPs.”
Attachment N, Figure N-1	Deleted figure
Attachment N, Figure N-2	Deleted figure
Attachment N, Figure N-3	Changed “3” to “1” Added “Typical” Added “Locations”
Attachment N, Figure N-4	Changed “4” to “2” Changed “VOC” to “Disposal Room”

Appendix B
Proposed Revised Permit Text

Proposed Revised Permit Text:

4.4 VOLATILE ORGANIC COMPOUND LIMITS

The Permittees shall limit releases to the air of volatile organic compound waste constituents (**VOCs**) as specified by the following conditions, as required by 20.4.1.500 NMAC (incorporating 40 CFR §264.601(c)):

4.4.1 Room-Based Limits

The measured concentration of VOCs in any open (active) room and in the immediately adjacent~~each~~ closed room in active panels within an Underground HWDU shall not exceed the limits specified in Table 4.4.1 below:

Table 4.4.1 - VOC Room-Based Limits	
Compound	**VOC Room-Based Concentration Limit (PPMV)**
Carbon Tetrachloride	9,625
~~Chlorobenzene~~	~~13000~~
Chloroform	9,930
~~1,1-Dichloroethylene~~	~~5490~~
1,2-Dichloroethane	2,400
~~Methylene Chloride~~	~~100000~~
1,1,2,2-Tetrachloroethane	2,960
~~Toluene~~	~~11000~~
1,1,1-Trichloroethane	33,700
Trichloroethylene	48,000

There are no maximum concentration limits for other VOCs.

4.4.2 Determination of VOC Room-Based Limits

The Permittees shall confirm the VOC concentration ~~and emission rate limits~~ identified in Permit Section 4.4.1 using the VOC Monitoring Plan specified in Permit Attachment N (Volatile Organic Compound Monitoring Plan). The Permittees shall conduct monitoring of VOCs as specified in Permit Sections 4.6.2 and 4.6.3.

4.4.3 Ongoing Disposal Room VOC Monitoring~~ in Panels 3 Through 8~~

The Permittees shall continue disposal room VOC monitoring in Room 1 of a filled panel~~Panels 3 through 8 after completion of waste emplacement~~ until final panel closure unless thean explosion-isolation wall specified in Permit Attachment G1 (Detailed Design Report for an Operation Phase Panel Closure System) is installed in the panel.

4.6.2.2 Reporting Requirements

The Permittees shall report to the Secretary semi-annually in April and October the data and analysis of the VOC Monitoring Plan.

4.6.2.3 Notification Requirements

The Permittees shall calculate the total carcinogenic and the total non-carcinogenic risk to the surface worker using the methodology in Attachment N after each sampling event for the compounds in Table 4.6.2.3 using the approved EPA risk factors listed in Table 4.6.2.3.

The Permittees shall notify the Secretary in writing, within seven calendar days of obtaining validated analytical results, whenever the total carcinogenic risk to the surface worker exceeds 10^{-5} or the total non-carcinogenic risk as measured by the hazard index exceeds 1.0.concentration of any VOC specified in Table 4.4.1 exceeds the concentration of concern specified in Table 4.6.2.3 below.

The Permittees shall calculate the running annual average carcinogenic and non-carcinogenic risk to the surface worker using the methodology in Attachment N after each sampling event for the compounds in Table 4.6.2.3 using the approved EPA risk factors listed in Table 4.6.2.3.

The Permittees shall notify the Secretary in writing, within seven calendar days of obtaining validated analytical results, whenever the running annual average concentration (calculated after each sampling event) total carcinogenic risk to the surface worker exceeds 10^{-5} or the total non-carcinogenic risk as measured by the hazard index exceeds 1.0for any VOC specified in Table 4.4.1 exceeds the concentration of concern specified in Table 4.6.2.3 below.

The Permittees shall post a link to any exceedance notice transmittal letter on the WIPP Home Page and inform those on the e-mail notification list as specified in Permit Section 1.11.

The Permittees shall review EPA risk factors and the tentatively identified compound list annually and update Table 4.6.2.3 as needed as a Class 1 permit modification notification whenever new analytes are identified to be added to the target analyte list through the tentatively identified compound process in Attachment N or whenever the EPA updates the risk factors shown in Table 4.6.2.3.

Table 4.6.2.3 - VOC Toxicity ValuesConcentrations of Concern		
Compound	Drift E-300 ConcentrationRecommended EPA Risk Factors ug/m3 Carcinogenic IUR $(ug/m^3)^{-1}$	ppbvNon-carcinogenic RfC (mg/m^3)
Carbon Tetrachloride	6040$6.0\times10^{-6}$	960$1.0\times10^{-1}$
Chlorobenzene	1015	220
Chloroform	890$2.3\times10^{-5}$	180$9.8\times10^{-2}$
1,1-Dichloroethylene	410	100
1,2-Dichloroethane	175$2.6\times10^{-5}$	45$7.0\times10^{-3}$
Methylene Chloride	6700	1930
1,1,2,2-Tetrachloroethane	350$5.8\times10^{-5}$	50N/A
Toluene	715	190
1,1,1-Trichloroethane	3200N/A	5905.0
Trichloroethylene	4.1×10^{-6}	2.0×10^{-3}

IUR = Inhalation Unit Risk from EPA Integrated Risk Information System (IRIS) Database

RfC = Reference Concentration from EPA IRIS Database

N/A = not applicable (No value published in the IRIS Database)

4.6.2.4 Remedial Action

If the running annual average concentration for afor the total carcinogenic risk due to releases of VOCs specified in Table 4.6.2.34.4.1 exceeds the concentration of concern specified in Table 4.6.2.3$10^{-5}$ or if the running annual average for the total non-carcinogenic hazard index due to releases of VOCs specified in Table 4.6.2.3 exceeds 1.0, the Permittees shall cease disposal in the active CH disposal room and install ventilation barriers as specified in Permit Section 4.5.3.3. Alternatively, prior to reaching the action level, the Permittees can propose an alternative remedial action to the Secretary for ensuring no individuals are exposed to concentrations in excess of the limits. The Permittees may implement such plans in lieu of closing the active room only after approval by the Secretary.

If the running annual average concentration for afor the total carcinogenic risk due to releases of VOCs specified in Table 4.6.2.34.4.1 exceeds 10^{-5} or if the running annual average for the total non-carcinogenic hazard index due to releases of VOCs specified in Table 4.6.2.3 exceeds 1.0the concentration of concern specified in

~~Table 4.6.2.3~~ for six consecutive months, the Permittees shall close the affected Underground HWDU as specified in Permit Section 4.9.1. Alternatively, prior to reaching the action level, the Permittees can propose an alternative remedial action to the Secretary for ensuring no individuals are exposed to concentrations in excess of the limits. The Permittees may implement such plans in lieu of closing the active HWDU only after approval by the Secretary.

4.6.3.2 Notification Requirements

The Permittees shall notify the Secretary in accordance with Permit Attachment N, Section N-3e(2)~~writing, within seven calendar days of obtaining validated analytical results,~~ whenever the concentration of any VOC specified in Table 4.4.1 in any closed room in an active panel or in the immediately adjacent closed room exceeds the action levels specified in Table 4.6.3.2 below. The Permittees shall post a link to the exceedance notice transmittal letter on the WIPP Home Page and inform those on the e-mail notification list as specified in Permit Section 1.11.

Table 4.6.3.2 - Action Levels for Disposal Room Monitoring

Compound	**50% Action Level for VOC Constituents of Concern in ~~Any~~Active Open or Immediately Adjacent Closed Room, ppmv**	**95% Action Level for VOC Constituents of Concern in Active Open or Immediately Adjacent Closed Room, ppmv**
Carbon Tetrachloride	4,813	9,145
~~Chlorobenzene~~	~~6,500~~	~~12,350~~
Chloroform	4,965	9,433
~~1,1-Dichloroethylene~~	~~2,745~~	~~5,215~~
1,2-Dichloroethane	1,200	2,280
~~Methylene Chloride~~	~~50,000~~	~~95,000~~
1,1,2,2-Tetrachloroethane	1,480	2,812
~~Toluene~~	~~5,500~~	~~10,450~~
1,1,1-Trichloroethane	16,850	32,015
Trichloroethylene	24,000	45,600

4.6.3.3 Remedial Action

Upon receiving validated analytical results that indicate one or more of the VOCs specified in Table 4.4.1 in any active open room or the immediately adjacent closed roomof the closed rooms in an active panel has reached the "50% Action Level" in Table 4.6.3.2, the sampling frequency for such closed rooms will increase to once per week. The once per week sampling will continue either until the concentrations in the closed room(s) fall below the "50% Action Level" in Table 4.6.3.2, or until closure of Room 1 of the panel, whichever occurs first. If one or more of the VOCs in Table 4.4.1 in the active open room or immediately adjacent closed room reaches the "95% Action Level" in Table 4.6.3.2, another sample will be taken to confirm the existence of such a condition. If the second sample confirms that one or more of VOCs in the immediately adjacent closed room have reached the "95% Action Level" in Table 4.6.3.2, the active open room will be abandoned, ventilation barriers will be installed as specified in Permit Section 4.5.3.3, waste emplacement will proceed in the next open room, and monitoring of the subject closed room will continue at a frequency of once per week until commencement of panel closure. Alternatively, upon reaching the "95% Action Level," the Permittees can propose an alternative remedial action to the Secretary for ensuring no individuals are exposed to concentrations in excess of the limits. The Permittees may implement such plans in lieu of closing the active room.

G-1d(1) Schedule for Panel Closure

To ensure continued protection of human health and the environment, the Permittees will initially block ventilation through Panels 3 through 7 as described in Permit Attachment A2, Section A2-2a(3), after waste disposal in each panel has been completed. The Permittees shall continue VOC monitoring in such panels until final panel closure. If the measured concentration, as confirmed by a second sample, of any VOC in a panel exceeds the “95% Action Level” in Permit Part 4, Table 4.6.3.2, the Permittees will initiate remedial actions as required by Permit Part 4, Section 4.6.3.3. ~~closure of that panel by installing the 12-foot explosion-isolation wall as described in Section G-1e(1) and submit a Class 1* permit modification request to extend closure of that panel, if necessary.~~ Regardless of the outcome of disposal room VOC monitoring, final closure of Panels 3 through 7 will be completed as specified in this Permit no later than January 31, 2016.

ATTACHMENT N

VOLATILE ORGANIC COMPOUND MONITORING PLAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS, ~~AND~~ ABBREVIATIONS, AND UNITS

ARA	additional requested analyte
~~BS/BSD~~	~~blank spike/blank spike duplicate~~
CAS#	Chemical Abstracts Service registry number
CFR	Code of Federal Regulations
CH	~~C~~contact-handled
~~CLP~~	~~Contract Laboratory Program~~
~~COC~~	~~concentration of concern~~
CRQL	contract-required quantitation limit
DOE	U.S. Department of Energy
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
ft	feet
GC/MS	gas chromatography/mass spectrometry
HI	hazard index
HWDU	Hazardous Waste Disposal Unit
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
L	liter
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
m	meter
MDL	method detection limit
mm	millimeter
MOC	Management and Operating Contractor ~~(Permit Section 1.5.3)~~
MRL	method reporting limit
mtorr	millitorr
NIST	National Institute of Standards and ~~Testing~~Technology
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
PASK	passive air sampling kit
ppbv	parts per billion by volume
ppmv	parts per million by volume
QA	quality assurance
~~QAPD~~	~~Quality Assurance Program Description~~
QAPjP	Quality Assurance Project Plan
QC	quality control

~~RCRA~~	~~Resource Conservation and Recovery Act~~
RfC	reference concentration
RH	remote-handled
RIDS	Records Inventory and Disposition Schedule
RPD	relative percent difference
SOP	standard operating procedure
TIC	tentatively identified compound
TRU	~~T~~transuranic
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant

ATTACHMENT N

VOLATILE ORGANIC COMPOUND MONITORING PLAN

N-1 Introduction

This Permit Attachment describes the plan for disposal phase monitoring ~~plan for~~of volatile organic compounds (**VOCs**) ~~emissions from mixed waste that may be entrained in the exhaust air from~~at the U.S. Department of Energy (**DOE**) Waste Isolation Pilot Plant (**WIPP**) ~~Underground Hazardous Waste Disposal Units (**HWDUs**) during the disposal phase at the facility~~. The purpose of VOC monitoring is to ensure compliance with the VOC limits specified in Permit Part 4. This VOC monitoring plan consists of two programs as follows; (1) Repository VOC Monitoring Program, which assesses compliance with the environmental performance standards in ~~Table 4.6.2.3~~ Permit Part 4, Section 4.6.2.3; and (2) Disposal Room VOC Monitoring Program (includes ongoing disposal room VOC monitoring), which assesses compliance with the disposal room performance standards in Permit Part 4, Table 4.6.3.2. This plan includes the monitoring design, a description of sampling and analysis procedures, quality assurance (**QA**) objectives, and reporting activities.

N-1a Background

The WIPP facility includes a mined geologic repository located approximately 2,150 feet (ft) (655 meters [m]) below ground surface within a bedded salt formation. The repository's underground structures for disposal of transuranic (**TRU**) mixed waste that may contain VOCs include the Underground Hazardous Waste Disposal Units (Underground **HWDUs**).~~The Underground HWDUs are located 2,150 feet (ft) (655 meters [m]) below ground surface, in the WIPP underground.~~ As defined for this Permit, an Underground HWDU is a single excavated panel consisting of seven rooms and two access drifts designated for disposal of contact-handled (**CH**) and remote-handled (**RH**) ~~transuranic (**TRU**)~~TRU mixed waste. Each disposal room is approximately 300 ft (91 m) long, 33 ft (10 m) wide, and 13 ft (4 m) high. Access drifts connect the rooms and have the same cross section. The Permittees shall dispose of TRU mixed waste in Underground HWDUs designated as Panels 1 through 8.

This plan addresses the following elements:

1. Rationale for the design of the VOC monitoring programs, based on:

    - Possible pathways from WIPP during the active life of the facility
    - Demonstrating compliance with the disposal room performance standards by monitoring VOCs in ~~underground disposal rooms~~Underground HWDUs
    - VOC sampling operations at WIPP
    - Optimum locations for sampling~~of the ambient mine air monitoring stations~~

2. Descriptions of the specific elements of the VOC monitoring programs, including:

    - The type of monitoring conducted
    - ~~The location of the monitoring stations~~Sampling locations
    - The monitoring interval

- The specific hazardous constituents monitored
- ~~The implementation schedule for the~~ VOC monitoring ~~programs~~schedule
- ~~The equipment used at the monitoring stations~~Sampling equipment
- Sampling and analytical techniques ~~used~~
- Data recording/reporting procedures
- Action levels for remedial action ~~if limits are approached~~

The technical basis for Disposal Room VOC ~~Monitoring~~ monitoring is discussed in detail in the Technical Evaluation Report for WIPP Room-Based VOC Monitoring (~~WRES~~Washington Regulatory and Environmental Services, 2003).

N-1b Objectives of the ~~Volatile Organic Compound~~VOC Monitoring Plan

The CH and RH TRU mixed waste disposed in the WIPP Underground HWDUs may contain VOCs which could be released from WIPP during the disposal phase of the project. This plan describes how:

- VOCs released from waste panels will be monitored to confirm that the running annual average ~~concentration of~~ risk to the surface worker due to VOCs in the air emissions from the Underground HWDUs do not exceed the ~~VOC concentrations of concern (**COC**)~~risk limits identified in Permit Part 4, ~~Table~~ Section 4.6.2.3 and calculated from measured VOC concentrations and risk factors identified in Table 4.6.2.3. Appropriate remedial action, as specified in Permit Section 4.6.2.4, will be taken if the limits in Permit Part 4, ~~Table~~ Section 4.6.2.3 are reached.

- VOCs released from waste containers in disposal rooms of active waste panels will be monitored to confirm that the concentration of VOCs in the air of immediately adjacent closed and active rooms in active panels do not exceed the VOC disposal room limits identified in Permit Part 4, Table 4.4.1. Appropriate remedial action, as specified in Permit Part 4, Section 4.6.3.3, will be taken if the original sample results are greater than or equal to the ~~Action Levels~~action levels in Permit Part 4, Table 4.6.3.2 ~~are reached~~.

- VOCs released from waste containers will be monitored in Room 1 of a filled panel that requires monitoring as described in Section N-3a(3) to confirm that the concentration of VOCs in the air do not exceed the VOC disposal room limits identified in Permit Part 4, Table 4.4.1. Appropriate remedial action, as specified in Permit Part 4, Section 4.6.3.3 and Attachment G, Section G-1d(1), will be taken if the original sample results are greater than or equal to the levels specified in Permit Part 4, Table 4.6.3.2 and Permit Attachment G, Section G-1d(1).

N-2 Target ~~Volatile Organic Compounds~~VOCs

The target VOCs for ~~repository monitoring~~ Repository VOC Monitoring (Station VOC-A ~~and VOC-B~~) and ~~disposal room monitoring~~ Disposal Room VOC Monitoring Programs are presented in Table N-1.

These target VOCs were selected because individually they represent more than one percent of the risk and collectively ~~together~~ they represent ~~approximately 99~~over 97 percent of the risk due to air emissions.

N-3 Monitoring Design

Detailed design features of this plan are presented in this section. This plan uses available sampling and analysis techniques to ~~measure~~ monitor VOC concentrations in air. ~~Sampling equipment includes the WIPP VOC canister samplers~~ Subatmospheric sample collection units used in ~~both~~ the Repository ~~and Disposal Room~~ VOC Monitoring Program~~s~~ are herein referred to as a passive air sampling kit (**PASK**). A subatmospheric sampling assembly is the sample collection unit for disposal room VOC monitoring. These sample collection units are described in greater detail in Section N-4a(2).

N-3a Sampling Locations

Air samples will be collected in the WIPP facility underground to quantify airborne VOC concentrations as described in the following sections.

N-3a(1) Sampling Locations for Repository VOC Monitoring

~~The initial configuration for the repository VOC monitoring stations is shown in Figure N-1. All mine~~Mine ventilation air which could potentially be impacted by VOC emissions from the Underground HWDUs identified as Panels 1 through 8 will pass monitoring Station VOC-A, located in the E-300 drift as it flows to the ~~exhaust shaft~~Exhaust Shaft. Air samples will be collected at ~~two locations in the facility~~VOC-A to quantify ~~airborne~~ VOCs in the ambient mine air (repository VOC concentrations). VOC concentrations ~~attributable to VOC~~including emissions from open and closed panels containing TRU mixed waste will be ~~measured~~ monitored by placing ~~one VOC monitoring station~~Station VOC-A just downstream from Panel 1 ~~at VOC-A~~. The location of Station VOC-A will remain the same throughout the term of this Permit. ~~The second station (Station VOC-B) will always be located upstream from the open panel being filled with waste (starting with Panel 1 at monitoring Station VOC-B (Figure N-1). In this configuration, Station VOC-B will measure VOC concentrations attributable to releases from the upstream sources and other background sources of VOCs, but not releases attributable to open or closed panels. The location of Station VOC-B will change when disposal activities begin in the next panel. Station VOC-B will be relocated to ensure that it is always upstream of the open panel that is receiving TRU mixed waste.~~ Station VOC-A will ~~also measure~~collect the upstream VOCs ~~concentrations measured at Station VOC-B,~~ plus any additional VOC concentrations resulting from releases from the closed and open panels. A sample will be collected ~~from each monitoring station~~ on a designated sample day~~s~~. ~~For each quantified target VOC, the concentration measured at Station VOC-B will be subtracted from the concentration measured at Station VOC-A to assess the magnitude of VOC releases from closed and open panels.~~

The sampling ~~locations were~~location was selected based on operational considerations. There are several different potential sources of release for VOCs into the WIPP mine ventilation air. These sources include incoming air from above ground and facility support operations, as well as open and closed waste panels. ~~In addition, because of the ventilation requirements of the underground facility and atmospheric dispersion characteristics, any VOCs that are released from open or closed panels may be difficult to detect and differentiate from other sources of VOCs at any underground or above ground location further downstream of Panel 1. By measuring VOC concentrations close to the potential source of release (i.e., at Station VOC-A), it will be possible to differentiate potential releases from background levels (measured at Station VOC-B).~~

N-3a(2) Sampling Locations for Disposal Room VOC Monitoring

For purposes of compliance with Section 310 of Public Law 108-447, the VOC monitoring of airborne VOCs in underground disposal rooms in which waste has been emplaced will be performed as follows:

1. ~~A~~Excluding Room 1, sample heads will be installed ~~inside the~~for each disposal room behind the ~~exhaust drift bulkhead and~~ designated ventilation barrier at the exhaust and inlet side of the disposal rooms. For Room 1, a sample head will be installed only at the exhaust location.

2. TRU mixed waste will be emplaced in the active disposal room.

3. VOC monitoring will begin within two weeks of waste emplacement in an active room. (Figures N-1 and N-2)

~~3. When the active disposal room is filled, another sample head will be installed to the inlet of the filled active disposal room. (Figure N-3 and N-4)~~

~~4. The exhaust drift bulkhead will be removed and re-installed in the next disposal room so disposal activities may proceed.~~

~~5~~4. When an active room is filled, a~~A~~ ventilation barrier will be installed ~~where the bulkhead was located~~ in the active disposal room's exhaust drift. Another ventilation barrier will be installed in the active disposal room's air inlet drift, thereby closing that active disposal room. As required below, VOC monitoring will begin at the inlet side of the disposal room within two weeks of closure.

~~6~~5. ~~Monitoring of VOCs will continue in the now closed disposal room.~~ Monitoring of VOCs will occur in the active disposal rooms and ~~all~~ immediately adjacent closed disposal rooms in which waste has been emplaced until commencement of panel closure activities (i.e., completion of ventilation barriers in Room 1) as described in Permit Attachment G, Section G-1d(1).

~~This sequence for installing sample locations will proceed in the remaining disposal rooms until the inlet air ventilation barrier is installed in Room 1. An inlet sampler will not be installed in Room 1 because disposal room sampling proceeds to the next panel.~~

N-3a(3) Sampling Locations for Ongoing Disposal Room VOC Monitoring ~~in Panels 3 through 8~~

The Permittees shall continue VOC monitoring in Room 1 of ~~Panels 3 through 8 after completion of waste emplacement~~a filled panel until final panel closure unless an explosion-isolation wall is installed in the panel.

N-3b Analytes to Be Monitored

The ~~nine~~ VOCs that have been identified for repository and disposal room VOC monitoring are listed in Table N-1. The analysis will focus on routine detection and quantification of these ~~compounds~~ target analytes in collected samples. As part of the analytical evaluations, the presence of other compounds (i.e., non-target VOCs) will also be ~~investigated~~ monitored.

Some non-targets may be included on the laboratory's target analyte list as additional requested analytes (**ARAs**) to gain a better understanding of potential concentrations and associated risk. The analytical laboratory will be directed to calibrate for ARAs when requested and classify and report all of these compoundsother non-target VOCs as Ttentatively Iidentified Ccompounds (**TICs**) if tentative identification can be made. The evaluation of TICs in original samples will include those concentrations that are ≥10 percent of the relative internal standard. The evaluation of ARAs only includes concentrations that are ≥ the method reporting limit (**MRL**). The required MRLs for ARAs will be U.S. Environmental Protection Agency (**EPA**)-specified levels of quantitation proposed for EPA contract laboratories that analyze canister samples by gas chromatography/mass spectrometry (**GC/MS**) (EPA, 1991).

TICs Non-targets classified as ARAs or TICs that meet the following criteria: (1) are VOCs listed in Appendix VIII of 40 Code of Federal Regulations (**CFR**) Part 261 (incorporated by reference in 20.4.1.200 New Mexico Administrative Code (**NMAC**), and (2) are detected in 10% percent or more of any original VOC monitoring samples (exclusive of those collected from Station VOC-B) that are VOCs listed in Appendix VIII of 20.4.1.200 NMAC (incorporating 40 CFR §261), collected over a running 12-month timeframe, will be added, as applicable, to the analytical laboratory target analyte lists for both the repository and disposal room VOC monitoring programs, unless the Permittees can justify the exclusion from the target analyte list(s). Non-target VOCs reported as "unknown" by the analytical laboratory are not evaluated due to indeterminate identifications.

Additional requested analytes and TICs detected in the repository and disposal room VOC monitoring programs will be placed in the WIPP Operating Record and reported to New Mexico Environment Department (**NMED**) in the Semi-Annual VOC Monitoring Reportannual reports as specified in Permit Part 4, Section 4.6.2.2. As applicable, the Permittees will also report the justification for exclusion from the target analyte list(s) (e.g., the compound does not contribute to more than one percent of the risk). If new targets are required the Permittees will submit a Class 1 Permit Modification Notification annually in accordance with 20.4.1.900 NMAC (incorporating 40 CFR 270.42(a)) to update Table 4.6.2.3 to include the new analyte and associated recommended EPA risk values for the inhalation unit risk (**IUR**) and reference concentration (**RfC**). Added compounds will be included in the risk assessment described in Section N-3e(1).

N-3c Sampling and Analysis Methods

The VOC monitoring programs include a comprehensive VOC monitoring program established at the facility; equipment, training, and documentation for VOC measurements are already in place.

The sampling methods used for repository and disposal room VOC sampling is monitoring are based on the concept of pressurized subatmospheric sample collection contained in the U.S. Environmental Protection Agency (EPA) Compendium Method TO-15 (EPA, 1999). The TO-15 sampling concept uses 6-liter SUMMA® passivated (or equivalent) stainless-steel canisters to collect 24-hour time integrated or time-weighted average air samples at each sample location Station VOC-A and shorter duration samples for disposal room VOC monitoring. This conceptual method will be used as a reference for collecting the samples at WIPP. The samples will be analyzed using gas chromatography/mass spectrometry (**GC/MS**)GC/MS under an established QA/quality control (**QC**) program. Laboratory analytical procedures have been developed based on the concepts contained in both TO-15 and 8260B. Section N-5 contains additional QA/QC information for this project.

The TO-15 method is an EPA-recognized sampling concept for VOC sampling and speciation. It can be used to provide subatmospheric~~integrated samples, or grab~~ samples~~,~~ and compound quantitation for a broad range of concentrations. ~~The sampling system can be operated unattended but requires detailed operator training.~~ This sampling technique is also viable for use while analyzing the sample using other EPA methods such as 8260B.

Sample collection units operate~~The field sampling systems will be operated~~ in the subatmospheric ~~pressurized~~ mode. ~~In this mode, air is drawn through the inlet and sampling system with a pump. The air is pumped into~~ A sample is collected into an initially evacuated ~~SUMMA®~~ passivated ~~(or equivalent)~~ canister. When the canister is opened to the atmosphere, the differential pressure causes the sample to flow into the canister. Flow rate and duration are regulated with a flow-restrictive inlet and/or mechanical or electronic flow controllers. The air will pass through two particulate filters installed in dual in-line filter holders to prevent sample and equipment contamination and for radiation assessment of sampling equipment, as needed. The use of passive tubing and canisters for VOC sampling inhibits adsorption of compounds on the surfaces of the equipment. ~~by the sampler, which regulates the rate and duration of sampling. The treatment of tubing and canisters used for VOC sampling effectively seals the inner walls and prevents compounds from being retained on the surfaces of the equipment. By the end of each sampling period, the canisters will be pressurized to about two atmospheres absolute. In the event of shortened sampling periods or other sampling conditions, the final pressure in the canister may be less than two atmospheres absolute. Sampling duration will be approximately six hours, so that a complete sample can be collected during a single work shift.~~

~~The canister sampling system and GC/MS analytical method are particularly appropriate for the VOC Monitoring Programs because a relatively large sample volume is collected, and multiple dilutions and reanalyses can occur to ensure identification and quantification of target VOCs within the working range of the method. The~~ For repository VOC monitoring, the contract-required quantitation limits (**CRQL**) ~~for Repository Monitoring~~ are 5 parts per billion by volume (**ppbv**) or less for the ~~nine~~ target ~~compounds~~VOCs. Consequently, low concentrations can be measured. CRQLs are the EPA-specified levels of quantitation proposed for EPA contract laboratories that analyze canister samples by GC/MS~~.~~ (EPA, 1991). The CRQLs for disposal room VOC monitoring are 500 (ppbv) (0.5 parts per million-volume (ppmv)) to allow for sub-ppmv quantitation. For the purpose of this plan, the CRQLs will be defined as the ~~method reporting limits (**MRL**)~~MRL. The MRL is a function of instrument performance, sample preparation, sample dilution, and all steps involved in the sample analysis process. ~~The MRL for Disposal Room Monitoring is 500 ppbv or less for the nine target compounds.~~

Disposal room VOC monitoring ~~system in open panels~~ will employ ~~the same canister sampling method as used in the repository VOC monitoring~~ sample collection units that will provide a subatmospheric sample within a short duration. Passivated or equivalent sampling lines will be installed in the disposal room as described in Section N-3a(2) and maintained once the room is closed until the panel associated with the room is closed. The independent lines will run from the sample inlet point to a sampling manifold ~~the individual sampler~~ located in ~~the access drift to the disposal panel. The air will pass through dual particulate filters to prevent sample and equipment contamination~~ an area accessible to sampling personnel.

N-3d Sampling Schedule

~~The Permittees will evaluate whether the monitoring systems and analytical methods are functioning properly. The assessment period will be determined by the Permittees.~~

N-3d(1) Sampling Schedule for Repository VOC Monitoring

Repository VOC sampling at Stations VOC-A and VOC-B will begin began with initial waste emplacement in Panel 1. Sampling will continue until the certified closure of the last Underground HWDU. Routine collection of a 24-hour time-integrated sample sampling will be conducted two timesonce per week.

N-3d(2) Sampling Schedule for Disposal Room VOC Monitoring

The disposalDisposal room sampling VOC monitoring in open panels will occur once every two weeks, unless the need to increase the frequency to weekly occurs in accordance with Permit Part 4, Section 4.6.3.3.

Beginning with Panel 3, Ongoing disposal room sampling VOC monitoring in filled panels will occur monthly until final panel closure unless an explosion-isolation wall is installed. The Permittees will sample VOCs in Room 1 of each filled panels requiring monitoring.

N-3e Data Evaluation and Reporting

N-3e(1) Data Evaluation and Reporting for Repository VOC Monitoring

When the Permittees receive laboratory analytical data from an air sampling event, the data will be validated as specified in Section N-5d. After obtaining validated data from an original Repository VOC Monitoring sample obtained during an air sampling event, the data will be evaluated to determine whether the VOC emissions from the Underground HWDUs exceed the COCs. The COCs for each of the nine target VOCs are presentedrisk limits in Permit Part 4, Table Section 4.6.2.3. The values are presented in terms of micrograms per cubic meter (µg/m^3) and ppbv risk of excess cancer death for compounds believed to be carcinogenic and hazard index (**HI**) for non-carcinogens.

The COCs risk and HI are calculated as follows:

Determine the concentration at Station VOC-A in mg/m^3 for each VOC. This measurement represents the emissions from all closed and open panels and is $C_{E\text{-}300VOCj}$ in equation (N-1).

Calculate the concentration at the top of the Exhaust Shaft based on the ratio of actual flow rate at Station VOC-A and the total Exhaust Flow Rate;

$$C_{ES_{VOC_j}} = C_{E-300_{VOC_j}} \times \frac{V_{E-300}}{V_{ES}} \qquad \text{(N-1)}$$

Where:

$C_{ES_{VOC_j}}$ = *Concentration of VOC$_j$ at the top of the Exhaust Shaft in mg/m^3*

$C_{E-300_{VOC_j}}$ = *Concentration of VOC$_j$ at E- 300 in mg/m^3*

$V_{E\text{-}300}$ = E – 300 ventilation flow rate in ft^3/min

V_{ES} = Exhaust Shaft ventilation flow rate in ft^3/min

Apply the Air Dispersion Factor (0.0114) to determine the concentration at the receptor:

$$Conc_{VOC_j} = C_{ES_{VOC_j}} \times 0.0114 \qquad \text{(N-2)}$$

Where:

$Conc_{VOC_j}$ = Concentration VOC_j at the receptor (mg/m^3)

Calculate the carcinogenic risk (for each VOC) using the following equation:

$$R_{VOCj} = \frac{Conc_{VOCj} \times EF \times ED \times IUR_{VOCj} \times 1000}{AT} \qquad \text{(N-3)}$$

Where:

R_{VOCj} = *Risk due to exposure to* VOC_j

$Conc_{VOC_j}$ = *Concentration* VOC_j *at the receptor* (mg/m^3)

EF = Exposure frequency (hours/year), = 1,920 hours per year
ED = Exposure duration, years, = 10 years
IUR_{VOCj} = *Inhalation risk factor from EPA Integrated Risk Information System (**IRIS**) database* $(ug/m^3)^{-1}$ *(from Table 4.6.2.3)*
AT = Averaging time for carcinogens, = 613,200 hours based on 70 years
1,000 = ug/mg

The total risk is then the sum of the risk due to each carcinogenic VOC:

$$\text{Total Risk} = \sum_{j=1}^{m} R_{VOC_j} \qquad \text{(N-4)}$$

Where:

Total Risk must be less than 10^{-5}
m = the number of carcinogenic VOCs

The formula for non-carcinogenic hazard is similar:

$$HI_{VOC_j} = \frac{Conc_{VOC_j} \times EF \times ED}{AT \times RfC_{VOC_j}} \qquad \text{(N-5)}$$

Where:

HI_{VOC_j} = *Hazard Index for exposure to VOC_j*

$Conc_{VOC_j}$ = *Concentration VOC_j at the receptor (mg/m^3)*

EF = Exposure frequency (hours/year), = 1,920 hours per year
ED = Exposure duration, years, = 10 years

RfC_{VOC_j} = *Reference concentration from EPA IRIS database (mg/m^3)*

AT = Averaging time for non-carcinogens, = 87,600 hours, based on exposure duration

The total hazard is then the sum of the hazard index due to each non-carcinogenic VOC:

$$\text{Hazard Index} = \sum_{j=1}^{m} HI_{VOC_j} \qquad \text{(N-6)}$$

Where:

Hazard Index must be less than 1.0
m = the number of non-carcinogenic VOCs

were calculated assuming typical operational conditions for ventilation rates in the mine. The typical operational conditions were assumed to be an overall mine ventilation rate of 425,000 standard cubic feet per minute and a flow rate through the E-300 Drift at Station VOC-A of 130,000 standard cubic feet per minute.

Since the mine ventilation rates at the time the air samples are collected may be different than the mine ventilation rates during typical operational conditions, the Permittees will measure and/or record the overall mine ventilation rate and the ventilation rate in the E-300 Drift at Station VOC-A that are in use during each sampling event. The Permittees shall also measure and record temperature and pressure conditions during the sampling event to allow all ventilation rates to be converted to standard flow rates.

If the air samples were collected under the typical mine ventilation rate conditions, then the analytical data will be used without further manipulation. The concentration of each target VOC detected at Station VOC-B will be subtracted from the concentration detected at Station VOC-A. The resulting VOC concentration represents the concentration of VOCs being emitted from the open and closed Underground HWDUs upstream of Station VOC-A (or the Underground HWDU VOC emission concentration).

If the air samples were not collected under typical mine ventilation rate operating conditions, the air monitoring analytical results from both Station VOC-A and Station VOC-B will be normalized to the typical operating conditions. This will be accomplished using the mine ventilation rates in use during the sampling event and the following equation:

$$NVOC_{AB} = VOC_{AB} * \left(\frac{425{,}000_{scfm} / 130{,}000_{scfm}}{V_{O\,scfm} / V_{E-300\,scfm}} \right) \qquad \text{(N-1)}$$

~~Where: $NVOC_{AB}$ = Normalized target VOC concentration from Stations VOC-A or VOC-B~~

~~VOC_{AB} = Concentration of the target VOC detected at Station VOC-A or VOC-B under non-typical mine ventilation rates~~

~~scfm = Standard cubic feet per minute~~

~~Vo = Sampling event overall mine ventilation rate (in standard cubic feet per minute)~~

~~VE-300 = Sampling event mine ventilation rate through the E-300 Drift (in standard cubic feet per minute)~~

~~The normalized concentration of each target VOC detected at Station VOC-B will be subtracted from the normalized concentration detected at Station VOC-A. The resulting concentration represents the Underground HWDU VOC emission concentration.~~

The summed risk and HI calculated from the Underground HWDU VOC emission concentrations ~~for each target VOC that is calculated for each sampling event~~ will be compared directly to ~~its COC listed in~~in the limits in Permit Part 4, ~~Table~~ Section 4.6.2.3. This will establish whether any of the concentrations of VOCs in the emissions from the Underground HWDUs exceeded the ~~COCs~~ risk and HI limits at the time of the sampling.

As specified in Permit Part 4, the Permittees shall notify the Secretary in writing, within seven calendar days of obtaining validated analytical results, whenever the ~~concentrations of any target VOC listed in~~ risk or HI exceeds the ~~concentration of concern~~limits specified in Permit Part 4, ~~Table~~ Section 4.6.2.3.

The Underground HWDU VOC emission concentration for each target VOC that is calculated for each sampling event will then be averaged with the Underground HWDU VOC emission concentrations calculated for the air sampling events conducted during the previous 12 months. This will be considered the running annual average concentration for each target VOC. ~~For the first year of air sampling, the running annual average concentration for each target VOC will be calculated using all of the previously collected data.~~ The risk and HI at the location of the surface worker will be calculated using the methodology above for the running annual average concentrations.

As specified in Permit Part 4, the Permittees shall notify the Secretary in writing, within seven calendar days of obtaining validated analytical results, whenever the running annual average ~~concentration~~ risk or HI (calculated after each sampling event) ~~for any target VOC~~ exceeds the ~~concentration of concern~~limits specified in Permit Part 4, ~~Table~~ Section 4.6.2.3.

If the results obtained from an individual air sampling event do not trigger the notification requirements of Permit Part 4, then the Permittees will maintain a database with the VOC air sampling data and the results will be reported to the Secretary as specified in Permit Part 4.

N-3e(2) Data Evaluation and Reporting for Disposal Room VOC Monitoring

When the Permittees receive laboratory analytical data from an air sampling event, the data will be validated as specified in Section N-~~5a~~5d, within 14 calendar days of receiving the laboratory analytical data. After obtaining validated data from an air sampling event, the data will be evaluated to determine whether the VOC concentrations in the air of ~~any closed room, the~~an active open room~~, or~~ and the immediately adjacent closed room are greater than or equal to the action levels~~exceeded the Action Levels~~ for ~~D~~disposal ~~R~~room ~~M~~monitoring specified in Permit Part 4, Table 4.6.3.2.

The Permittees shall notify the Secretary in writing, within seven calendar days of obtaining validated analytical results, whenever the concentration of any VOC specified in Permit Part 4, Table 4.4.1 is greater than or equal to ~~exceeds~~ the action levels specified in Permit Part 4, Table 4.6.3.2. Remedial action will be taken as specified in Section N-1b.

The Permittees shall report disposal room VOC monitoring results ~~submit~~ to the Secretary ~~the Semi-Annual VOC Monitoring Report~~ in the annual reports as specified in Permit Part 4, Section 4.6.2.2 ~~that also includes results from disposal room VOC monitoring~~.

N-4 Sampling and Analysis Procedures

This section describes the equipment and procedures that will be implemented during sample collection and analysis activities for VOCs at WIPP.

N-4a Sampling Equipment

The sampling equipment that will be used includes the following: 6-liter (L) stainless-steel ~~SUMMA®~~-passivated canisters, ~~VOC canister samplers, treated~~ sample collection units, passivated stainless~~-~~-steel tubing, and ~~a~~ dual in-line stainless-steel filter ~~housing~~holders. A discussion of each of these items is presented below.

N-4a(1) ~~SUMMA®~~ Sample Canisters

Six-liter, stainless-steel canisters with ~~SUMMA®~~-passivated interior surfaces will be used to collect and store all ambient air and ~~gas~~ disposal room samples for VOC analyses collected as part of the monitoring processes. These canisters will be cleaned and certified (batch certification acceptable) prior to their use, in a manner similar to that described by Compendium Method TO-15. The canisters will be certified clean to below ~~the required reporting limits for the VOC analytical method~~0.2 ppbv for the target VOCs ~~(see Table N-2)~~. The vacuum of certified clean ~~samplers~~ canisters will be verified ~~at the sampler~~ as adequate upon initiation of a sample cycle as described in standard operating procedures (**SOPs**). The sample canisters are initially evacuated at the analytical laboratory to <0.05 mm Hg (50 mtorr).

N-4a(2) Sample Collection Units~~Volatile Organic Compound Canister Samplers~~

The sample collection unit for Station VOC-A samples is a commercially available sample train (herein referred as PASK) comprised of components that regulate the rate and duration of sampling into a sample canister. It can be operated unattended using a programmable timer or manually using canister valves.

The sample collection unit for disposal room VOC monitoring samples is a designed subatmospheric sampling assembly that regulates the rate and duration of sampling into a sample canister. The design of the subatmospheric sampling assembly also allows for purging of sample lines to ensure that a representative sample is collected.

Sample collection units will use passivated components for the sample flow path. This effectively seals the inner walls and prevents sample constituents from being retained on the surfaces of the equipment. When sample canisters installed on sample collection units are opened to the atmosphere, the differential pressure causes the sample to flow into the canister at a regulated rate. By the end of each sampling period, the canisters will be near atmospheric pressure. Additional detail on sample collection will be given in SOPs.

A conceptual diagram of a VOC sample collection unit is provided in Figure N-2. Such units will be used at monitoring Stations VOC-A and VOC-B and at sampling locations for disposal room measurements. The sampling unit consists of a sample pump, flow controller, sample inlet, inlet filters in series to remove particulate matter, vacuum/pressure gauge, electronic timer, inlet purge vent, two sampling ports, and sufficient collection canisters so that any delays attributed to laboratory turnaround time and canister cleaning and certification will not result in canister shortages. Knowledge of sampler flow rates and duration of sampling will allow calculation of sample volume. The set point flow rate will be verified before and after sample collection from the mass flow indication. Prior to their initial use and annually thereafter, the sample collection units will be tested and certified to demonstrate that they are free of contamination above the reporting limits of the VOC analytical method (see Section N-5). Ultra-high purity humidified zero air will be pumped through the inlet line and sampling unit and collected in previously certified canisters as sampler blanks for analysis. The cleaning and certification procedure is derived from concepts contained in the EPA Compendium Method TO-15 (EPA, 1999).

N-4a(3) Sample Tubing

Treated Passivated stainless--steel tubing is used as a sample path, from the desired sample point to the sample collection unit. This tubing is treated passivated to prevent the inner walls from absorbing contaminantsadsorbing sample constituents when they are pulled from the sample point to the sample collection unit.

N-4b Sample Collection

Sample collection for VOCs in the WIPP repository will be conducted in accordance with written standard operating procedures (**SOPs**) that are kept on file at the facility. These SOPs will specify the steps necessary to assure the collection of samples that are of acceptable quality to meet the applicable data quality objectives in Section 5 of this Attachment.

Six Samples collected from Station VOC-A will be 24-hour time-integrated samples will be collected onfor each sample daysampling event. Alternative sampling durations may be defined for experimental assessment purposes and to meet the data quality objectives. The VOC canister sampler at each location will sample ambient air on the same programmed schedule. The sample pump will be programmed to sample continuously over a six-hour period during the workday. The units will sample at a nominal flow rate of 33.3 actual milliliters per minute over a six-hour sample period. This schedule will yield a final sample volume of approximately 12 L. Flow rates and sampling duration may be modified as necessary for experimental purposes and to meet the data quality objectives.

Sample flow for PASK will be checked each sample dayset using an in-line mass flow controller. The flow controllers are initially factory-calibrated and specify a typical accuracy of better than 10 percent full scale. Additionally, each air flow controller is calibrated at a manufacturer-specified frequency using a National Institute of Standards and Testing Technology (**NIST**) primary flow standard.

~~Upon initiation of waste disposal activities in Panel 1, samples~~Samples will be collected ~~twice~~ once each week ~~(~~at Stations VOC-A ~~and VOC-B)~~. Samples collected at the panel locations should represent the same matrix type (i.e., elevated levels of salt aerosols). To verify the matrix similarity and assess field sampling precision, field duplicate samples will be collected (two canisters filled simultaneously ~~by the same sampler~~) ~~from~~ for each ~~sampling station~~VOC monitoring program ~~(Stations VOC-A and VOC-B) during the first sampling event and~~ at an overall frequency of at least 5 percent ~~thereafter~~ (see Section N-5a).

Prior to collecting ~~the~~ active open disposal room and closed room samples, the sample lines are purged to ensure that the air collected is not air that has been stagnant in the tubing. This is important in regard to the disposal room sample particularly because of the long lengths of tubing associated with these samples. ~~The repository samples do not require this action due to the short lengths of tubing required at these locations.~~

N-4c Sample Management

Field sampling data sheets will be used ~~to document the sampler conditions under which~~for each sample ~~is~~ collected. These data sheets have been developed specifically for VOC monitoring at the WIPP facility. The individuals assigned to collect the specific samples will be required to fill in all of the appropriate sample data ~~and to maintain this record in sample logbooks~~. ~~The program team leader~~ A cognizant individual will review these forms for each sampling event and the completed data sheets will be maintained in with the departmental Records Inventory and Disposition Schedule (**RIDS**).

All sample containers will be marked with identification at the time of collection of the sample. A Request-for-Analysis Form will be completed to identify the sample canister number(s), sample type and type of analysis requested.

All samples will be maintained, and shipped if necessary, at ambient temperatures. Collected samples will be transported in appropriate containers. ~~Prior to leaving the underground for analysis, sample containers may undergo radiological screening. No potentially contaminated samples or equipment will be transported to the surface.~~ No samples will be accepted by the receiving laboratory personnel unless they are properly labeled and ~~sealed to ensure a tamper free shipment~~custody maintained.

An important component of the sampling program is a demonstration that collected samples were obtained from the locations stated and that they reached the laboratory without alteration. To satisfy this requirement, evidence of collection, shipment, laboratory receipt, and custody will be documented with a ~~completed~~ Chain-of-Custody Form. Chain-of-custody procedures will be followed closely, and additional requirements imposed by the laboratory for sample analysis will be included as necessary.

Individuals collecting samples will be responsible for the initiation of custody procedures. The chain of custody will include documentation as to the canister certification, location of sampling event, ~~time,~~ sample collection date, and individual(s) handling the samples. Unintentional procedure deviations, equipment malfunctions, and other problems that do not conform to established requirements are nonconformances. The disposition and documentation of nonconformances will be handled according to QA requirements. ~~Deviations from procedure will be considered variances. Variances must be preapproved by the program manager and recorded in the project files. Unintentional deviations, sampler malfunctions, and other problems~~

~~are nonconformances. Nonconformances must be documented and recorded in the project files. All field logbooks/data sheets must be incorporated into WIPP's records management program.~~

N-4d ~~Sampler~~ Maintenance of Sample Collection Units

Periodic maintenance for sample collection units~~canister samplers~~ and associated equipment will be performed as needed~~during each cleaning cycle~~. This maintenance ~~will~~ may include~~, but not be limited to,~~ cleaning, replacement of damaged or malfunctioning parts without compromising the integrity of the ~~sampler~~ sample collection unit, and leak testing~~, and instrument calibration~~. Additionally, complete spare sample collection units will be maintained on-site to minimize downtime because of ~~sampler~~ equipment malfunction. ~~At a minimum, canister samplers will be certified for cleanliness initially and annually thereafter upon initial use, after any parts that are included in the sample flow path are replaced, or any time analytical results indicate potential contamination. All sample canisters will be certified prior to each usage.~~

N-4e Analytical Procedures

Analytical procedures used in the analysis of VOC samples from canisters are based on concepts contained in Compendium Method TO-15 (EPA, 1999) and in SW-846 Method 8260B (EPA, 1996).

Analysis of samples shall be performed by a laboratory that the Permittees select and approve through established QA processes. ~~Analysis of samples will be performed by a certified laboratory.~~ Analytical ~~M~~methods will be specified in procurement documents and will be selected to be consistent with Compendium Method TO-15 (EPA, 1999) or EPA recommended procedures in SW-846 (EPA, 1996). Additional detail on analytical techniques and methods will be given in laboratory SOPs.

The Permittees will establish the criteria for laboratory selection, including the stipulation that the laboratory follow the procedures specified in the appropriate Air Compendium or SW-846 method and that the laboratory follow EPA protocols. The selected laboratory shall demonstrate, through laboratory SOPs, that it will follow appropriate EPA SW-846 requirements and the requirements specified by the EPA Air Compendium protocols. The laboratory shall also provide documentation to the Permittees describing the sensitivity of laboratory instrumentation. This documentation will be retained in the facility operating record and will be available for review upon request by NMED.

The SOPs for the laboratory currently under contract will be maintained in the operating record by the Permittees. The Permittees will provide NMED with an initial set of applicable laboratory SOPs for information purposes, and provide NMED with any updated SOPs on an annual basis.

Data validation will be performed by cognizant individuals~~the Permittees~~. Copies of the data validation ~~report~~ records will be kept on file in the operating record for review upon request by NMED.

N-5 Quality Assurance

The QA activities for the VOC monitoring programs will be conducted in accordance with the documents: *~~EPA~~ Guidance for Quality Assurance Project Plans QA/G-5* (EPA, 2002) and the *EPA Requirements for ~~Preparing~~ Quality Assurance Project Plans, QA/R-5* (EPA, 2001). The

QA criteria for the VOC monitoring programs are listed in Table N-2. This section addresses the methods to be used to evaluate the components of the measurement system and how this evaluation will be used to assess data quality. The QA limits for the sampling procedures and laboratory analysis shall be in accordance with the limits set forth in the specific EPA Method referenced in standard operating procedures employedSOPs used by either the Permittees or the laboratory. The Permittees' standard operating procedures SOPs will be in the facility Operating Record and available for review by NMED at anytime. The laboratory standard operating proceduresSOPs will also be in the facility Operating Record and will be supplied to the NMED as indicated in Section N-4e.

N-5a Quality Assurance Objectives for the Measurement of Precision, Accuracy, Sensitivity, and Completeness

QA objectives for this plan will be defined in terms of the following data quality parameters.

Precision. For the duration of this program, precision will be defined and evaluated by the RPD values calculated between field duplicate samples and between laboratory duplicate samples.

$$RPD = \left(\frac{(A - B)}{(A + B)/2} \right) * 100 \qquad \text{(N-27)}$$

where: A = Original sample result

B = Duplicate sample result

Note: Vertical lines in the formula above indicate absolute value of A-B.

Accuracy. Analytical accuracy will be defined and evaluated through the use of analytical standards. Because recovery standards cannot reliably be added to the sampling stream, overall system accuracy will be based on analytical instrument performance evaluation criteria. These criteria will include performance verification for instrument calibrations, laboratory control samples, sample surrogate recoveries (when required by method or laboratory SOPs), and sample internal standard areas. Use of the appropriate criteria as determined by the analytical method performed, will constitute the verification of accuracy for target analyte quantitation (i.e., quantitative accuracy). Evaluation of standard ion abundance criteria for BFB bromofluorobenzene Chemical Abstract Service (CAS# 460-00-4) will be used to evaluate the accuracy of the analytical system in the identification of targeted analytes, as well as the evaluation of unknown contaminants constituents (i.e., qualitative accuracy).

Sensitivity. Sensitivity will be defined by the required MRLs for the program. Attainment of required MRLs will be verified by the performance of statistical method detection limit (**MDL**) studies in accordance with 40 *Code of Federal RegulationsCFR* §Part 136 (Appendix B). The MDL represents the minimum concentration that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. An MDL study will be performed by the program analytical laboratory prior to sampling and analysis, and at least annually thereafter.

Completeness. Completeness will be defined as the percentage of the ratio of the number of valid sample results received (i.e., those which meet data quality objectives) versus the total number of samples required to be collected. Completeness may be affected, for example, by sample loss or destruction during shipping, by laboratory sample handling errors, inability to collect the required samples, or by rejection of analytical data during data validation.

N-5a(1) Evaluation of Laboratory Precision

Laboratory sample duplicates and ~~blank spike/blank spike~~ laboratory control sample/laboratory control sample duplicates (**~~BS~~LCS**/**~~BSD~~LCSD**) will be used to evaluate laboratory precision. QA objectives for laboratory precision are listed in Table N-2, and are based on precision criteria proposed by the EPA for canister sampling programs (EPA, ~~1994~~1991). These values will be appropriate for the evaluation of samples with little or no matrix effects. Because of the potentially high level of salt-type aerosols in the WIPP underground environment, the analytical precision achieved for WIPP samples may vary with respect to the EPA criteria. RPDs for ~~BS/BSD~~LCS/LCSD analyses will be tracked by the analytical laboratory through the use of control charts. RPDs obtained for laboratory sample duplicates will be compared to those obtained for LCS/LCSD~~BS/BSD~~s to ascertain any sample matrix effects on analytical precision. LCS/LCSD~~BS/BSD~~s and laboratory sample duplicates will be analyzed at a frequency of 10 percent, or one per analytical lot, whichever is more frequent.

N-5a(2) Evaluation of Field Precision

Field duplicate samples will be collected at a frequency of at least 5 percent for ~~both~~ each VOC monitoring ~~locations~~program. The data quality objective for field precision is 35 percent for each set of field duplicate samples.

N-5a(3) Evaluation of Laboratory Accuracy

Quantitative analytical accuracy will be evaluated through performance criteria on the basis of (1) relative response factors generated during instrument calibration, (2) analysis of ~~laboratory control samples (**LCS**)~~ LCS, and (3) recovery of internal standard compounds. The ~~criteria~~ criterion for the initial calibration (minimum 5-point calibration) is $\leq$ 30 percent relative standard deviation for target analytes. After the successful completion of the ~~5-point~~ calibration, it is sufficient to analyze only a midpoint standard for every 24 hours of operation. The midpoint standard will pass a $\leq$30 percent difference acceptance criterion for each target ~~compound~~ VOC before sample analysis may begin.

An ~~blank spike or~~ LCS is an internal QC sample generated by the analytical laboratory by spiking a standard air matrix (humid zero air or ultra-high purity nitrogen) with a known amount of a certified reference gas. The reference gas will contain the target VOCs at known concentrations. Percent recoveries for the target VOCs will be calculated for each LCS relative to the reference concentrations. Objectives for percent recovery are listed in Table N-2, and are based on accuracy criteria proposed by the EPA for canister sampling programs (EPA, ~~1994~~1991). LCSs will be analyzed at a frequency of 10 percent, or one per analytical lot, whichever is more frequent.

Internal standards will be introduced ~~into~~ with each sample analyzed, and will be monitored as a verification of stable instrument performance. In the absence of any unusual interferences, areas should not change by more than 40 percent over a 24-hour period. Deviations larger than 40 percent are an indication of a potential instrument malfunction. If an internal standard area in a given sample changes by more than 40 percent, the sample will be reanalyzed. If the 40 percent criterion is not achieved during the reanalysis, the instrument will undergo a performance check and the midpoint standard will be reanalyzed to verify proper operation.

Response and recovery of internal standards will also be compared between samples, LCSs, and calibration standards to identify any matrix effects on analytical accuracy.

N-5a(4) Evaluation of Sensitivity

The presence of aerosol salts in underground locations may affect the MDL of the samples collected in those areas. The sample inlet of the sample collection units~~intake manifold of the sampling systems~~ will be protected sufficiently from the underground environment to minimize salt aerosol interference. Two filters inert to VOCs will be installed in dual in-line filter holders in the sample flow path to minimize particulate interference.

The MDL for each of the ~~nine~~ target ~~compounds~~ VOCs will be evaluated by the analytical laboratories before sampling begins. The initial and ~~annual~~ subsequent MDL evaluations will be performed in accordance with 40 ~~*Code of Federal Regulations*~~*CFR* §Part 136 (Appendix B) and with ~~EPA/530-SW-90-021, as revised and retitled, "Quality Assurance and Quality Control"~~ ~~(~~Chapter 1 of SW-846~~)~~ (EPA, 1996).

N-5a(5) Completeness

The expected completeness for this program is greater than or equal to ~~95~~ 90 percent. Data completeness will be tracked monthly.

N-5b Sample Handling and Custody Procedures

Sample packaging, shipping, and custody procedures are addressed in Section N-4c.

N-5c Calibration Procedures and Frequency

Calibration procedures and frequencies for analytical instrumentation are listed in Section N-4e.

N-5d Data Reduction, Validation, and Reporting

~~A dedicated logbook will be maintained by the operators. This logbook~~ Field sampling data sheets will contain documentation of all pertinent data for the sampling. ~~Sample collection conditions, maintenance, and calibration activities will be included in this logbook.~~ Additional data collected by other groups at WIPP, such as ventilation airflow, temperature, barometric pressure,~~ etc.~~ and relative humidity, will be obtained to document the sampling conditions.

Data validation procedures will include at a minimum, a check of all field data sheets ~~forms and sampling logbooks will be checked~~ for completeness and correctness. Sample custody and analysis records will be reviewed ~~routinely~~ by the analytical laboratory QA officer and the analytical laboratory supervisor at a frequency of at least 10 percent.

Electronic ~~D~~data ~~D~~deliverables (**EDDs**) are provided by the laboratory prior to receipt of hard copy data packages. EDDs will be evaluated within five calendar days of receipt to determine if VOC concentrations are at or above action levels in Permit Part 4, Table 4.6.3.2 for disposal room VOC monitoring data or the action levels ~~concentrations of concern in Table~~ specified in Permit Part 4, Section 4.6.2.3 for repository monitoring data. If the EDD indicates that VOC concentrations are at or above these action levels~~ or concentrations~~, the hard copy data package will be validated within five calendar days as opposed to the fourteen (14) calendar day time frame provided by Section N-3e(2).

Data will be reported as specified in Section N-3(e) and Permit Part 4.

Acceptable data for this VOC monitoring plan will meet stated precision and accuracy criteria. The QA objectives for precision, accuracy, and completeness as shown in Table N-2 can be achieved when established methods of analyses are used as proposed in this plan and standard sample matrices are being assessed.

N-5e Performance and System Audits

System audits will initially address start-up functions for each phase of the project. These audits will consist of on-site evaluation of materials and equipment, review of certifications for canisters and ~~sampler certification~~ measurement and test equipment, review of laboratory qualification and operation and, at the request of the QA officer, an on-site audit of the laboratory facilities. The function of the system audit is to verify that the requirements in this plan have been met prior to initiating the program. System audits will be performed at or shortly after to the initiation of the VOC monitoring programs and on an annual basis thereafter.

Performance audits will be accomplished as necessary through the evaluation of analytical QC data by performing periodic site audits throughout the duration of the project, and through the introduction of third-party audit cylinders (laboratory blinds) into the analytical sampling stream. Performance audits will also include a surveillance/review of data associated with canister ~~and sampler~~ certifications and measurement and test equipment, a project-specific technical audit of field operations, and a laboratory performance audit. ~~Field logs, logbooks, and data sheets will be reviewed weekly.~~ Blind-audit canisters will be introduced once during the sampling period. Details concerning scheduling, personnel, and data quality evaluation are addressed in the Quality Assurance Project Plan (**QAPjP**).

N-5f Preventive Maintenance

~~Sampler maintenance~~ Maintenance of sample collection units is described briefly in Section N-4d. Maintenance of analytical equipment will be addressed in the analytical laboratory SOP.

N-5g Corrective Actions

If the required completeness of valid data (≥ 95 percent) is not maintained, corrective action may be required. Corrective action for field sampling activities may include ~~recertification and cleaning~~ maintenance of ~~samplers~~sample collection units, reanalysis of samples, additional training of personnel, modification to field and laboratory procedures, and recalibration of measurement and test equipment.

Laboratory corrective actions may be required to maintain data quality. The laboratory continuing calibration criteria indicate the relative response factor for the midpoint standard will be ~~less than~~ ≤30 percent different from the mean relative response factor for the initial calibration. Differences greater than 30 percent will require recalibration of the instrument before samples can be analyzed. If the internal standard areas in a sample change by more than 40 percent, the sample will be reanalyzed. If the 40 percent criterion is not achieved during the reanalysis, the instrument will undergo a performance check and the midpoint standard reanalyzed to verify proper operation. Deviations larger than 40 percent are an indication of potential instrument malfunction.

The laboratory results for samples, laboratory duplicate analyses, LCSs, and blanks should routinely be within the QC limits. If results exceed control limits, the reason for the nonconformances and appropriate corrective action must be identified and implemented.

N-5h Records Management

The VOC Monitoring Programs will require administration of record files (both laboratory and field data collection files). The records control systems will provide adequate control and retention for program-related information. Records administration, including QA records, will be conducted in accordance with applicable DOE, Management and Operating Contractor (MOC), and WIPP requirements.

Unless otherwise specified, VOC monitoring plan records will be retained as lifetime records. Temporary and permanent storage of QA records will occur in facilities that prevent damage from temperature, fire, moisture, pressure, excessive light, and electromagnetic fields. Access to stored VOC Monitoring Program QA Records will be controlled and documented to prevent unauthorized use or alteration of completed records.

Revisions to completed records (i.e., as a result of audits or data validation procedures) may be made only with the approval of the responsible program manager and in accordance with applicable QA procedures. ~~Original and duplicate or backup records of project activities will be maintained at the WIPP site.~~ Electronic records that cannot be altered by the user and capable of producing a paper copy shall be deemed to be a written record. Records of project activities will be maintained at or readily accessible from the WIPP site. Documentation will be available for inspection by internal and external auditors.

~~N-6 Sampling and Analysis Procedures for Disposal Room VOC Monitoring in Filled Panels~~

~~Disposal room VOC samples in filled panels will be collected using the subatmospheric pressure grab sampling technique described in Compendium Method TO-15 (EPA, 1999). This method uses an evacuated SUMMA® passivated canister (or equivalent) that is under vacuum (0.05 mm Hg) to draw the air sample from the sample lines into the canister. The sample lines will be purged prior to sampling to ensure that a representative sample is collected. The passivation of tubing and canisters used for VOC sampling effectively seals the inner walls and prevents compounds from being retained on the surfaces of the equipment. By the end of each sampling period, the canisters will be near atmospheric pressure.~~

~~The analytical procedures for disposal room VOC monitoring in filled panels are the same as specified in Section N-4e.~~

N-~~7~~6 References

40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants"

Section 310 of Public Law 108-447 of the Consolidated Appropriations Act of 2005

U.S. Environmental Protection Agency, 1991. Contract Laboratory Program, Volatile Organics Analysis of Ambient Air in Canisters (Draft), EPA540/R-94-085, December 1991, Washington, D.C.

U.S. Environmental Protection Agency. 1996. SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*. 3rd Third Edition. Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. Environmental Protection Agency. 1999 *Compendium Method TO-15: Determination of Volatile Organic Compounds (VOCs) In Air Collected in Specially--Prepared Canisters and Analyzed by Gas Chromatography/MasMass Spectrometry (GC/MS)*, EPA 625/R-96/010b. Center for Environmental Research Information, Office of Research and Development, Cincinnati, OH, January 1999.

U.S. Environmental Protection Agency. 2000. *Guidance for the Data Quality Objectives Process*, QA/G-4. EPA 600/R-96/055, August 2000, Washington, D.C.

U.S. Environmental Protection Agency. 2001. *EPA Guidance Requirements for Quality Assurance Project Plans, QA/GR-5*, EPA 240/B-01/003, March 2001, Washington, D.C.

U.S. Environmental Protection Agency. 2002. *EPA RequirementsGuidance for Preparing Quality Assurance Project Plans*, QA/RG-5*,* EPA 240/R-0102/009, December 2002, Washington, D.C.

Washington Regulatory and Environmental Services, 20042003. *Technical Evaluation Report for WIPP Room-Based VOC Monitoring*.

Table N-1
Target Analytes and Methods for Repository VOC (Station VOC-A and VOC-B) Monitoring (Station VOC-A) and Disposal Room VOC Monitoring

Target Analyte	EPA Standard Analytical Method
Carbon tetrachloride	EPA TO-15[a] EPA 8260B[b]
Chlorobenzene	
Chloroform	
1,1-Dichloroethylene	
1,2-Dichloroethane	
Methylene chloride	
1,1,2,2 -Tetrachloroethane	
Toluene	
1,1,1- Trichloroethane	
Trichloroethylene	

[a] U.S. Environmental Protection Agency, 1999, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air- Second Edition, http://www.epa.gov/ttn/amtic/airtox.html

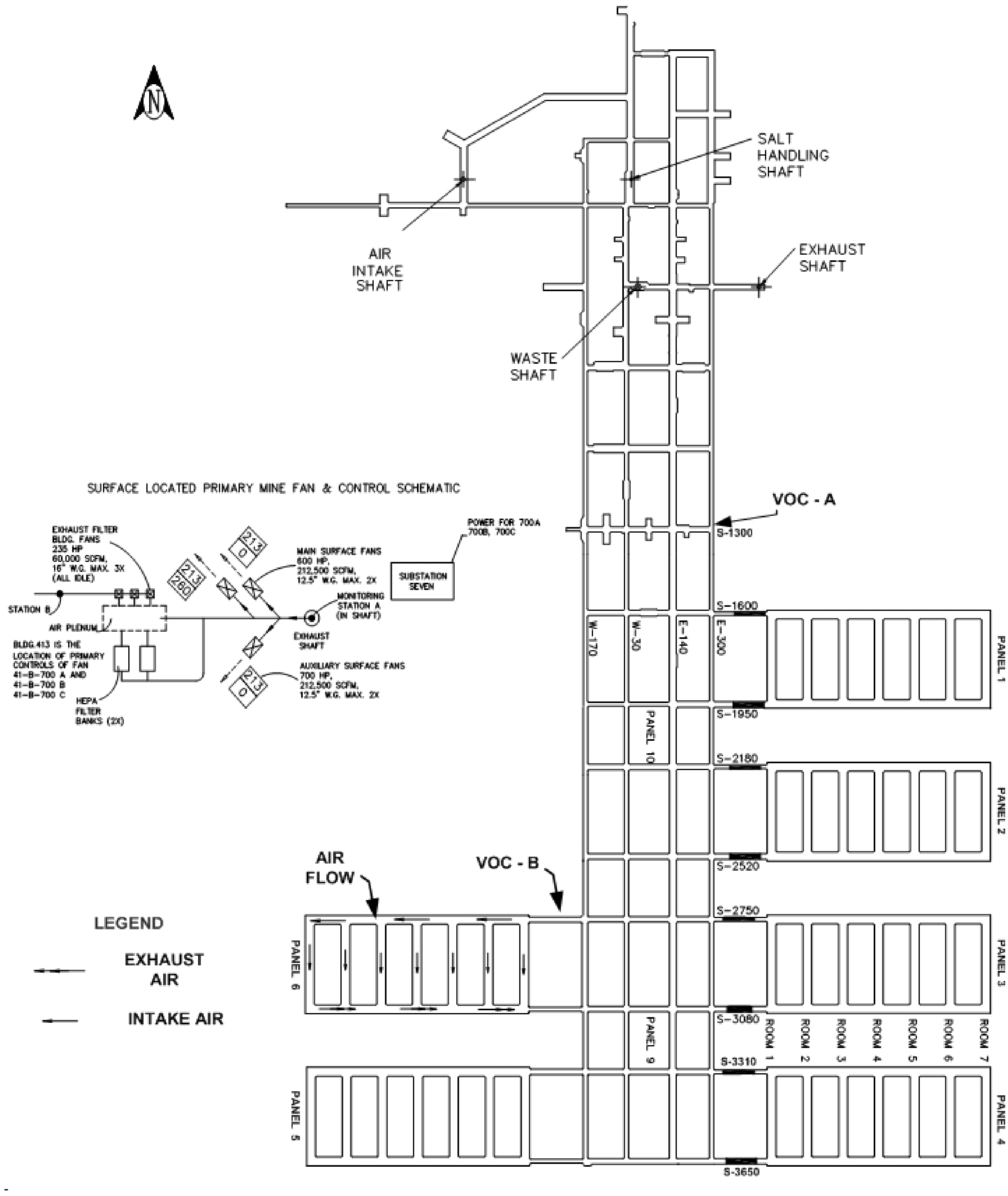
[b] U.S. Environmental Protection Agency, SW-846 Test Methods for Evaluation Solid Wastes, Chemical and Physical Methods, http://www.epa.gov/epaoswer/hazwaste/test/main.htm

Table N-2
Quality Assurance Objectives for Accuracy, Precision, Sensitivity, and Completeness

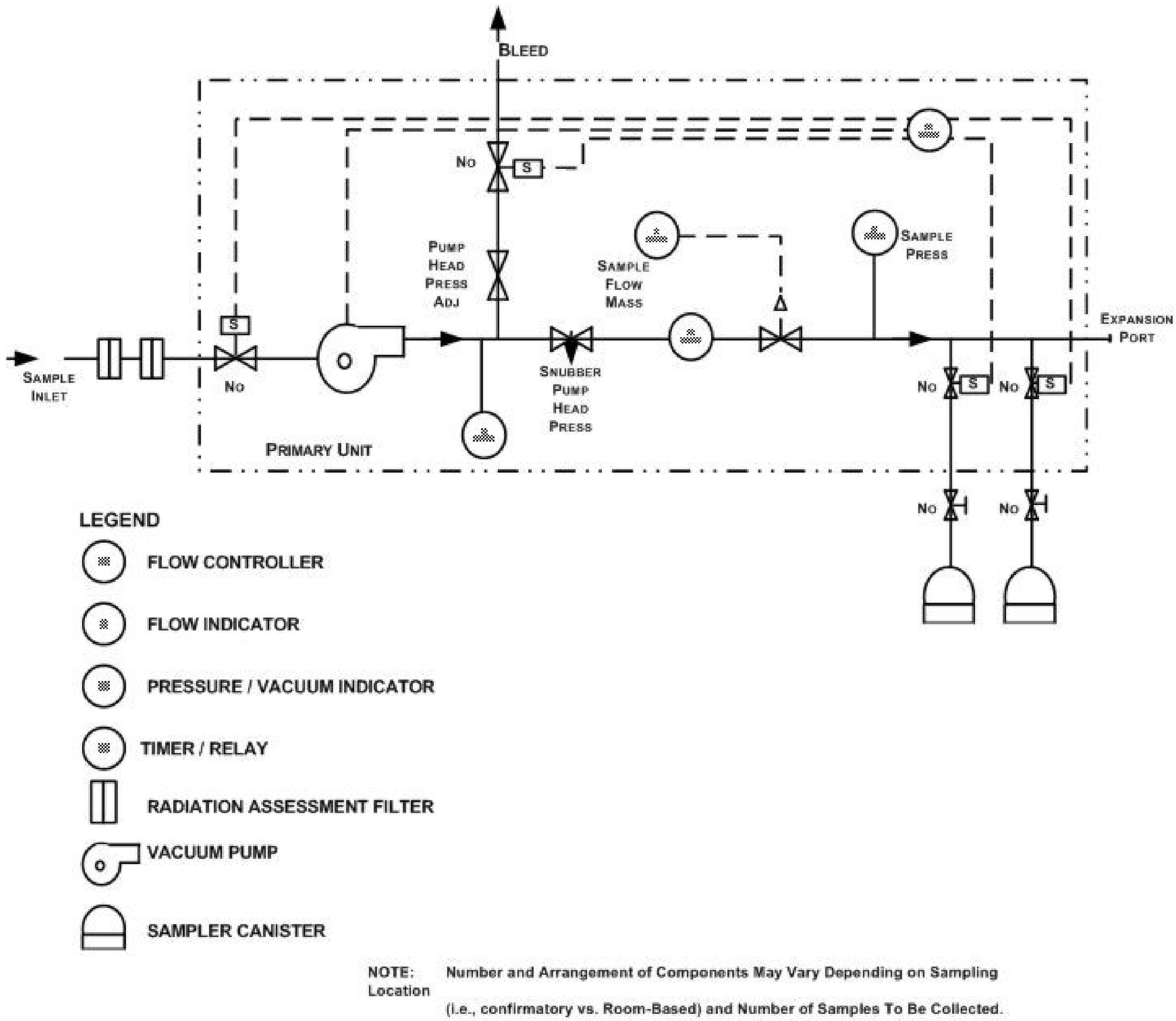
Target VOCCompound	Accuracy (Percent Recovery)	Precision (RPD) Laboratory	Field	Required Repository Monitoring MRL (ppbv)	Required Disposal Room MRL (ppbv)	Completeness (Percent)
Carbon tetrachloride	60 to 140	25	35	2	500	95
Chlorobenzene	60 to 140	25	35	2	500	95
Chloroform	60 to 140	25	35	2	500	95
1,1-Dichloroethylene	60 to 140	25	35	5	500	95
1,2-Dichloroethane	60 to 140	25	35	2	500	95
Methylene chloride	60 to 140	25	35	5	500	95
1,1,2,2-Tetrachloroethane	60 to 140	25	35	2	500	95
Toluene	60 to 140	25	35	5	500	95
1,1,1-Trichloroethane	60 to 140	25	35	5	500	95
Trichloroethylene	60 to 140	25	35	5	500	95

MRL maximum method reporting limit for undiluted samples

RPD relative percent difference, allowances for conditions that may produce non-representative RPD values will be specified in SOPs.



~~Figure N-1~~
~~Panel Area Flow~~



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~~Figure N-2~~
~~VOC Monitoring System Design~~

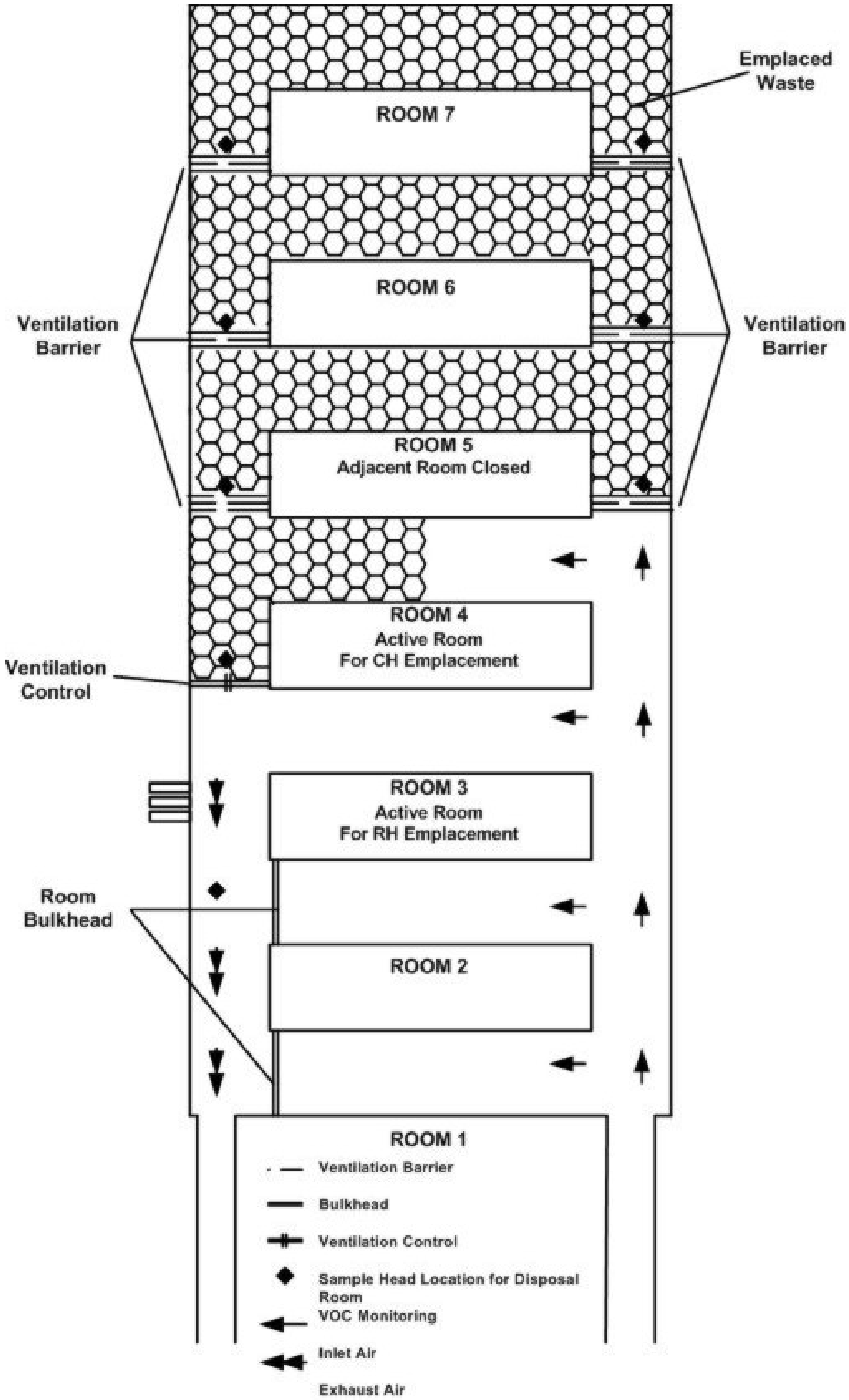

Figure N-13
Typical Disposal Room VOC Monitoring Locations

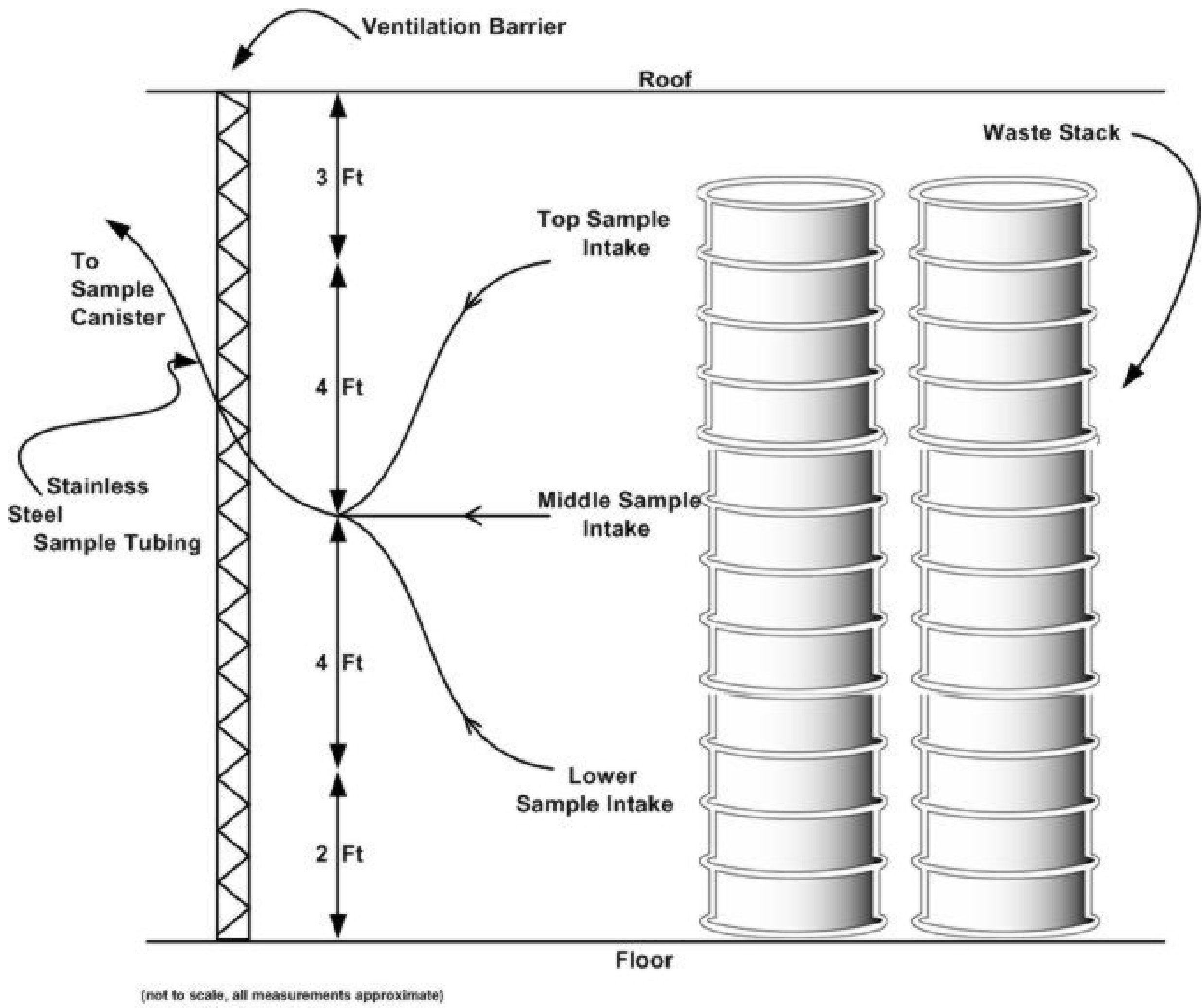

Figure N-~~2~~4
~~VOC~~Disposal Room Sample Head Arrangement

Appendix C
Human Health Protectiveness Evaluation
VOC Releases to Atmosphere
Waste Isolation Pilot Plant

PROFESSIONAL ENGINEER'S CERTIFICATION

I, Steven Geiger, as a qualified Professional Engineer per 20.4.1.101 NMAC, hereby certify that I have reviewed the Human Health Protectiveness Evaluation for VOCs Released to the Atmosphere—Waste Isolation Pilot Plant (WIPP), as completed for Washington True Solutions/D.O.E., and confirm that it has been prepared in accordance with good engineering, environmental, and risk assessment practices. The approach and intent of calculations contained herein reasonably meet the requirements of the WIPP Hazardous Waste Permit as regulated under 20.4.1 NMAC (incorporating 40 CFR §260.10).

Information provided to support the air dispersion modeling and risk assessment has been gathered from the USEPA, WIPP documentation, and interviews with WIPP employees and contractors. All information in this report has been reviewed for accuracy and completeness by WIPP.

July 14, 2010

Date

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HUMAN HEALTH PROTECTIVENESS EVALUATION VOC RELEASES TO ATMOSPHERE WASTE ISOLATION PILOT PLANT

CARLSBAD, NEW MEXICO

Prepared for
Washington TRU Solutions/ U.S. DOE

July 2010

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Project No. 41009467

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Attachments

The goal of this analysis is to re-evaluate potential human health risks associated with volatile organic compound (VOC) emissions from the WIPP facility to above-ground receptors, based on current information. Carbon tetrachloride is of particular concern, as emission levels of carbon tetrachloride have been increasing in recent years as the waste stream entering the mine has changed over time. In addition to changes in the levels of carbon tetrachloride releases, a number of site conditions and regulatory changes have occurred since the approval of the last version of the RCRA Part B Permit. As such, this re-evaluation is warranted to ensure that air emissions are still health-protective, and to develop updated air emission limits for the exhaust shaft monitoring station to reflect current conditions, updated toxicity data, and regulatory requirements.

A re-evaluation of air emission limits for underground mine workers (i.e., room-based limits) is not included as part of this analysis. In addition, this analysis does not attempt to correlate health-based limits for above-ground receptors with underground room-based limits or with Lower Explosive Limits (LEL) or Immediately Dangerous to Life or Health (IDLH) levels that the room-based limits are based on.

As part of this analysis, the following technical components of the original air emission limit derivation approach were re-evaluated:

- Chemical toxicity. As part of standard USEPA protocol, USEPA regularly reviews the current scientific toxicology literature of chemicals it regulates. As a result of these reviews, USEPA has subsequently revised the toxicity values for several of the VOCs since issuance of the permit.
- Chemical releases from the mine. The original exhaust shaft air emission limits were developed to address cancer risks and non-cancer hazards associated with nine VOCs that were found in waste container head space. The concentrations and relative proportions of VOC releases from the mine have changed significantly since the permit was originally issued.
- Air modeling. Air modeling was performed to predict air concentrations at various on-site and off-site receptor points, based on dispersion of air releases from the exhaust shaft. The USEPA air models have been substantially refined since the original modeling was performed.
- Receptor locations. The Air Dispersion Factors (ADFs) derived during the original air modeling were based on the locations of maximum impact, regardless of whether receptor populations were present at those locations. The revised air modeling evaluated the locations of maximum impact, as well as specific receptor locations, such as off-site residences.
- Exhaust vent configuration. Two exhaust vents were used to vent the exhaust shaft at the time of the original permit application. Air dispersion modeling in support of the permit assumed that both fans were in continuous operation year round. Since the time of the original permit application, a third exhaust vent has been added, allowing the facility to alternate which two vents are in use at any one time. A sensitivity analysis was conducted on vent use and configuration to help identify conditions that would minimize impacts on site air concentrations.
- Receptor populations. The original permit limits were based on potential risks to a full-time, on-site worker who was not OSHA-trained, and thus not protected under OSHA. An

alternative scenario has been evaluated for employees attending classes at the Training Building in the Property Protection Area (PPA).

- Regulatory requirements for derivation of risk-based values. NMED approved the current permit limits using a risk-based approach for establishing the numeric limits. NMED guidance was reviewed to determine if the target allowable risk values used in the permit (1E-5 for workers, 1E-6 for residents) were still the recommended values.

Using an approach similar to that used in the original permit, updated to reflect current toxicity values, state-of-the-practice air modeling, and current emissions from the facility, risks to surface receptors were re-calculated and alternative risk-based exhaust shaft limits were derived.

The nine waste-related VOCs listed in Table 1 below are of particular concern at the WIPP facility. As identified in the original permit, head space gas sampling of waste drums indicated that these 9 chemicals would contribute approximately 99% of the overall inhalation cancer risks and non-cancer hazard indices from waste-derived VOC emissions. Inhalation Unit Risk Factors (URFs) are chemical-specific toxicity values used to quantify cancer risks, and Reference Concentrations (RfCs) are chemical-specific toxicity values used to quantify non-cancer hazard quotients. Table 1 lists the URFs and RfCs for the nine VOCs of concern.

Table 1. Inhalation Unit Risk Factors and Reference Concentrations for the VOCs of Concern

Chemical	As used in Developing the RCRA Permit		Current USEPA Toxicity Values	
	URF $(ug/m^3)^{-1}$	RfC (mg/m^3)	URF $(ug/m^3)^{-1}$	RfC (mg/m^3)
Carbon Tetrachloride	1.5E-5	NE	6.0E-6	1.0E-1
Chlorobenzene	NA	2.0E-2	NA	5.0E-2
Chloroform	2.3E-5	NE	2.3E-5	9.8E-2
1,1-Dichloroethene	5.0E-5	NE	NA	2.0E-1
1,2-Dichloroethane	2.6E-5	NE	2.6E-5	2.4E+0
Methylene Chloride	4.7E-7	NE	4.7E-7	1.0E+0
1,1,2,2-Tetrachloroethane	5.8E-5	NE	5.8E-5	NA
Toluene	NA	4.0E-1	NA	5.0E+0
1,1,1-Trichloroethane	NA	7.0E-1	NA	5.0E+0

NA – No applicable toxicity value
NE – Not evaluated for non-cancer effects in the permit.
Bold – Current toxicity values that differ from those presented in the permit.

For some carcinogenic chemicals, both URF and RfC values are available, reflecting both the potential carcinogenicity and the systemic toxicity associated with these chemicals. For those chemicals with both URF and RfC values, NMED based the permit limits on the cancer effects only; non-cancer effects were not evaluated for those chemicals. This was appropriate, as limits based on URF values are lower (more protective) than limits that would have been based on RfC values for these specific chemicals.

As shown in Table 1, toxicity values for 5 VOCs have been revised by USEPA since the original permit was issued. Of particular note, USEPA recently reduced[1] the URF for carbon tetrachloride from 1.5E-5 to 6.0E-6 $(ug/m^3)^{-1}$ (2.5x reduction), indicating that USEPA now believes carbon tetrachloride is not as potent a carcinogen as previously thought. Given that carbon tetrachloride emissions are the primary contributor to risk, this change is significant. The changes for the other 4 VOCs are also significant. The URF for 1,1-dichloroethene has been

[1] USEPA posted the new URF for carbon tetrachloride on the Integrated Risk Information System (IRIS) database on March 31, 2010. A new RfC for carbon tetrachloride was also posted to IRIS on that date.

withdrawn; USEPA now evaluates inhalation effects for this chemical based on the RfC only. In addition, the RfC values for chlorobenzene, toluene, and 1,1,1-trichloroethane have all been increased, indicating that they are not considered as toxic as previously.

As shown in Table 2, recent data collected at the E-300 Drift monitoring station, which is the monitoring station used to monitor permit compliance, indicates that the current concentrations and proportions of VOCs being released differ substantially from those assumed when the permit limits were established. Of the carcinogenic VOCs regulated under the permit, only three (carbon tetrachloride, chloroform and methylene chloride) are currently present in site emissions, with carbon tetrachloride being the primary contributor to risk.

Table 2. Permit Limits vs Current Measured Concentrations

Chemical	As Specified in RCRA Part B Permit		Current Conditions Year Ending 12/22/09	
	Permit Limit (ppbv)	Percent of Total Cancer Risk	Measured Concentrations (ppbv)	Percent of Total Cancer Risk[2]
Carbon Tetrachloride	165	18.7	108.73	77.7
Chlorobenzene	220	0	0	0
Chloroform	180	24.2	10.46	22.2
1,1-Dichloroethene	100	23.8	0	0
1,2-Dichloroethane	45	5.7	0	0
Methylene Chloride	1930	3.8	1.99	0.06
1,1,2,2-Tetrachloroethane	50	23.9	0	0
Toluene	190	0	0.01	0

[2] The relative percent cancer risk contribution of carbon tetrachloride under current conditions includes a recent change in toxicity value from USEPA.

The Long-Term Version of USEPA's Industrial Source Complex (ISCLT3) model was used in the original permit application to develop the ADFs that were used to evaluate risks and back-calculate allowable emission limits. USEPA air models have been substantially refined since the original modeling was performed, and the ISCLT3 model is no longer supported by EPA. Although the short-term version of the ISC modeling system, ISCST3, may be used for certain applications including evaluations of annual impact concentrations, it is now considered to be an alternative model rather than a preferred model. The air dispersion modeling presented in this report was performed using USEPA's preferred dispersion model, which is the American Meteorological Society / USEPA Regulatory Model (AERMOD) version 09292, to predict air concentrations at various on-site and off-site receptor points, resulting from dispersion of air releases from the exhaust shafts. The model was run with five years of meteorological data, much of which was derived from data collected at the WIPP on-site meteorological monitoring station. A detailed description of the implementation of the model is presented in *Attachment A*.

The Air Dispersion Factors (ADFs) were derived for the on-site Property Protection Area (PPA), Livingstone Ridge Allotment, Antelope Ridge Allotment, and off-property. The original modeling conducted for the permit used the locations of maximum impact from each of these areas to derive the ADFs that were used when setting limits. In the case of the PPA, the location of maximum impact was a street near the exhaust vents. For the off-property ADF, the location of maximum impact was identified at the property boundary. Neither of the locations of maximum impact corresponds to the receptor locations of concern. For the PPA, the receptor location of concern is the Training Building. For the off-property location, the receptors of concern are local residents. The revised air modeling evaluated the locations of maximum impact, as well as actual receptor locations at the Training Building, the Mills Ranch and the Smith Ranch. All receptor locations are shown in *Attachment A* figures A-1 and A-2.

The addition of a third exhaust vent provides flexibility, as typically only two vents are in use at any one time. The model was run on an annual basis assuming that only two vents are operating at any given time during the year. The two older vents were labeled V1 and V2 in the model, and the newer vent (labeled V3) is located about 160 feet to the west of the older vents. The following scenarios were evaluated:

- Scenario 1: V1 and V2 operate continuously
- Scenario 2: V1 and V3 operate continuously
- Scenario 3: V2 and V3 operate continuously
- Mixed Scenario: V1 and V2 operate concurrently (Scenario 1) for 20% of the year and highest impacting of Scenarios 2 or 3 operates for the other 80% of the year.

Scenario 1, which assumes that both of the older vents emit continuously throughout the year, is consistently the highest impacting scenario but also the most unlikely based on current operating practices at the WIPP facility. The more realistic Mixed Scenario allows for both of the old vents to emit concurrently for a maximum of 1752 hours per year (20% of the year) while any combination of Scenarios 2 or 3 may operate during the other 7008 hour per year (80% of the year).

Currently, all vents have a release height of 33.2 feet above the ground and are oriented at a 45 degree angle from vertical. A sensitivity analysis was performed to determine the effect of vent height, vent orientation, and use of different combinations of vents on the resultant ADFs. Tables 3a – 3d show the predicted Air Dispersion Factors that would result from the current vent configuration, as well as the ADFs that would result from raising the vent height up to 50 feet above the current height as well as re-orienting the stack so that it emits vertically upward, rather than at an angle. Raising the vent release heights and re-orienting the stacks so that they are directed vertically upward will give the emitted plume greater dispersion characteristics, which will reduce modeled impact concentrations on and near the WIPP site.

Table 3a. ADFs Resulting from the Highest Impacts of Scenarios 1, 2, and 3 Assuming Vent Stacks Oriented at 45° Angle

Area / Receptor	Maximum Modeled ADFs (Unitless)					
	@ Current Vent Height	@ Current Vent Height + 10 ft	@ Current Vent Height + 20 ft	@ Current Vent Height + 30 ft	@ Current Vent Height + 40 ft	@ Current Vent Height + 50 ft
All Modeled Receptors	1.54E-02	5.12E-03	2.97E-03	1.82E-03	1.20E-03	8.37E-04
Property Protection Area	1.54E-02	5.12E-03	2.97E-03	1.82E-03	1.20E-03	8.37E-04
Exclusive Use Area	2.92E-03	1.95E-03	1.74E-03	1.39E-03	1.08E-03	8.11E-04
Off Limits Area	6.79E-04	5.94E-04	5.16E-04	4.58E-04	4.01E-04	3.43E-04
Site Boundary - Off Property	8.81E-05	6.08E-05	5.45E-05	5.13E-05	4.60E-05	4.15E-05
Antelope Ridge	6.79E-04	5.94E-04	5.16E-04	4.58E-04	4.01E-04	3.43E-04
Livingston Ridge	1.77E-04	1.58E-04	1.58E-04	1.32E-04	1.27E-04	1.09E-04
Building 489: Training Bldg.	8.72E-03	4.84E-03	2.75E-03	1.34E-03	5.76E-04	2.16E-04
Resident - Mills Ranch	1.64E-05	1.64E-05	1.30E-05	1.12E-05	7.69E-06	6.99E-06
Resident - Smith Ranch	2.14E-05	1.47E-05	1.34E-05	1.14E-05	9.71E-06	9.45E-06

Table 3b. ADFs Resulting from the Highest Impacts of Scenarios 1, 2, and 3 Assuming Vent Stacks Oriented Vertically Upward

Area / Receptor	Maximum Modeled ADFs (Unitless)					
	@ Current Vent Height	@ Current Vent Height + 10 ft	@ Current Vent Height + 20 ft	@ Current Vent Height + 30 ft	@ Current Vent Height + 40 ft	@ Current Vent Height + 50 ft
All Modeled Receptors	5.22E-03	2.69E-03	1.82E-03	1.21E-03	8.46E-04	6.15E-04
Property Protection Area	5.22E-03	2.69E-03	1.82E-03	1.21E-03	8.46E-04	6.12E-04
Exclusive Use Area	1.97E-03	1.56E-03	1.35E-03	1.06E-03	8.12E-04	6.15E-04
Off Limits Area	6.24E-04	5.21E-04	4.56E-04	4.00E-04	3.47E-04	2.96E-04
Site Boundary - Off Property	8.65E-05	5.79E-05	5.07E-05	4.65E-05	4.16E-05	3.75E-05
Antelope Ridge	6.24E-04	5.21E-04	4.56E-04	4.00E-04	3.47E-04	2.96E-04
Livingston Ridge	1.68E-04	1.45E-04	1.46E-04	1.26E-04	1.17E-04	9.68E-05
Building 489: Training Bldg.	4.99E-03	2.44E-03	1.47E-03	6.95E-04	2.74E-04	9.55E-05
Resident - Mills Ranch	1.56E-05	1.57E-05	1.22E-05	1.08E-05	7.26E-06	6.47E-06
Resident - Smith Ranch	2.11E-05	1.43E-05	1.28E-05	1.09E-05	9.18E-06	8.90E-06

Table 3c. ADFs Resulting from the Highest Impacts of the Mixed Scenario Assuming Vent Stacks Oriented at 45° Angle

Area / Receptor	Maximum Modeled ADFs (Unitless)					
	@ Current Vent Height	@ Current Vent Height + 10 ft	@ Current Vent Height + 20 ft	@ Current Vent Height + 30 ft	@ Current Vent Height + 40 ft	@ Current Vent Height + 50 ft
All Modeled Receptors	1.14E-02	4.71E-03	2.69E-03	1.70E-03	1.14E-03	8.08E-04
Property Protection Area	1.14E-02	4.71E-03	2.69E-03	1.70E-03	1.14E-03	8.08E-04
Exclusive Use Area	2.78E-03	1.91E-03	1.64E-03	1.32E-03	1.03E-03	7.82E-04
Off Limits Area	6.72E-04	5.88E-04	5.10E-04	4.53E-04	3.97E-04	3.40E-04
Site Boundary - Off Property	8.78E-05	6.07E-05	5.44E-05	5.11E-05	4.58E-05	4.14E-05
Antelope Ridge	6.72E-04	5.88E-04	5.10E-04	4.53E-04	3.97E-04	3.40E-04
Livingston Ridge	1.76E-04	1.57E-04	1.53E-04	1.31E-04	1.25E-04	1.09E-04
Building 489: Training Bldg.	6.83E-03	3.86E-03	2.01E-03	1.02E-03	4.61E-04	1.96E-04
Resident - Mills Ranch	1.63E-05	1.64E-05	1.30E-05	1.12E-05	7.68E-06	6.99E-06
Resident - Smith Ranch	2.13E-05	1.47E-05	1.33E-05	1.14E-05	9.70E-06	9.44E-06

Table 3d. ADFs Resulting from the Highest Impacts of the Mixed Scenario Assuming Vent Stacks Oriented Vertically Upward

Area / Receptor	Maximum Modeled ADFs (Unitless)					
	@ Current Vent Height	@ Current Vent Height + 10 ft	@ Current Vent Height + 20 ft	@ Current Vent Height + 30 ft	@ Current Vent Height + 40 ft	@ Current Vent Height + 50 ft
All Modeled Receptors	4.70E-03	2.64E-03	1.68E-03	1.15E-03	8.15E-04	5.97E-04
Property Protection Area	4.70E-03	2.64E-03	1.68E-03	1.15E-03	8.15E-04	5.97E-04
Exclusive Use Area	1.92E-03	1.55E-03	1.28E-03	1.01E-03	7.81E-04	5.97E-04
Off Limits Area	6.17E-04	5.16E-04	4.52E-04	3.97E-04	3.44E-04	2.94E-04
Site Boundary - Off Property	8.62E-05	5.78E-05	5.06E-05	4.62E-05	4.14E-05	3.74E-05
Antelope Ridge	6.17E-04	5.16E-04	4.52E-04	3.97E-04	3.44E-04	2.94E-04
Livingston Ridge	1.68E-04	1.44E-04	1.42E-04	1.26E-04	1.14E-04	9.66E-05
Building 489: Training Bldg.	3.91E-03	1.96E-03	1.07E-03	5.17E-04	2.16E-04	8.69E-05
Resident - Mills Ranch	1.56E-05	1.57E-05	1.22E-05	1.08E-05	7.25E-06	6.47E-06
Resident - Smith Ranch	2.11E-05	1.43E-05	1.28E-05	1.09E-05	9.17E-06	8.89E-06

Consistent with the approach used in the current permit, risks were evaluated at the points of maximum impact for the following receptor populations:

- Full-time, non-waste surface workers in the PPA, assuming this worker population is not protected under OSHA
- Ranch workers in the Livingston Ridge Ranch Allotment
- Ranch workers in the Antelope Ridge Ranch Allotment
- Off-property residents who live at the property boundary

It should be noted that the points of maximum impact for the non-waste surface worker and off-property resident do not correspond to locations where these receptors are likely to be present on a full-time basis. The point of maximum impact at the PPA does not overlap any of the occupied site buildings; the permit assumes that this point reflects concentrations at the Training Building. The point of maximum impact for the off-property resident occurs at the property boundary; the permit assumes that a residence is present at this location.

As part of the current evaluation, risks were also calculated for the following three scenarios, which are thought to represent more realistic exposure conditions at the PPA and off-property locations:

- Site employees who attend training courses in the Training Building. Site information indicates that, on average, employees attend training classes in this building about 1 day every other week. Under this scenario it was assumed that the trainee was the non-OSHA trained receptor with the greatest potential for exposure at the PPA.
- A resident at the Mills Ranch.
- A resident at the Smith Ranch.

For development of air emission limits, the current permit identifies target cumulative risk levels of 1E-5 for on-site workers, and 1E-6 for ranch workers and off-property residents. NMED guidance was reviewed to determine if the target allowable risk values used in the permit (1E-5 for workers, 1E-6 for residents) were still the recommended values. The use of a risk-based approach for developing permit limits appears to be atypical, as the NMED Air Quality Bureau does not usually consider specific risk levels when setting air emission limits. In contrast, the NMED Hazardous Waste Bureau, which does not set permitted air emission limits, regulates chemical exposure using a per chemical target risk of 1E-5, both for industrial and residential scenarios.

The NMED established emission limits as environmental performance standards under the RCRA Miscellaneous Unit Rules (40 CFR 264, Subpart X). NMED considers these worker-based standards protective of human health and the environment for chemicals released into the air exhaust stream as a result of waste disposal in the WIPP repository.

Use of a per chemical 1E-5 target risk for all scenarios would 1) allow higher allowable air emission levels for each chemical, and 2) would make it less likely that the off-property residential scenario could be the limiting factor in deriving limits.

Cancer risks and non-cancer hazard indices were calculated for each receptor population, based on current emission levels from the exhaust shaft. *Attachment B* documents the risk calculation process. The risk results presented in Table 4 reflect two alternative sets of calculations intended to bracket risks under different operating assumptions.

The column labeled "current permit approach" is intended to present risks using an approach similar to that used in the current permit, updated to reflect current conditions. Assumptions included:

- Current emission concentrations were assumed (based on the information in Table 2).
- No modifications of exhaust vents, relative to height or angle of vent orientation, were assumed.
- Two of the three vents were assumed to be in use at any one time. Usage assumed vent 1 and vent 2 operate concurrently (vent scenario 1) for 20% of the year and highest impacting of vent scenarios 2 or 3 operates for the other 80% of the year.
- ADFs were based on current modeling runs; ADFs from the permit were not used.
- ADFs were based on the points of maximum impact in each area, regardless of whether those points corresponded to actual receptor locations.
- For the PPA, a full-time worker was identified as the most exposed individual for calculation of risk, assuming these workers are not protected under OSHA (i.e., the acceptable risk level is 10^{-5}).
- Current URFs and RfCs were used.
- Hazard indices were calculated for all chemicals with published RfCs, including carcinogenic chemicals.

The column labeled "best-case approach" presents risks based on alternative exposure conditions, assuming that the exhaust vents are optimized to minimize ground-level impacts. Assumptions included:

- Current emission concentrations were assumed (based on the information in Table 2).
- Exhaust vents were assumed to be modified to minimize exposure to ground-level receptors, including an increase in stack height of 50 feet, and a change in angle of vent orientation from 45 degrees to vertical.
- Two of the three vents were assumed to be in use at any one time. Usage assumed vent 1 and vent 2 operate concurrently (vent scenario 1) for 20% of the year and highest impacting of vent scenarios 2 or 3 operates for the other 80% of the year.
- ADFs were based on current modeling runs; ADFs from the permit were not used.
- ADFs were based on actual receptor locations. For the PPA, ADFs were based on the location of the Training Building. For the off-property residents, ADFs were based on the location of the Mills and Smith ranches. For the Antelope Ridge Allotment and Livingston Ridge Allotment scenarios, ADFs remained at the points of maximum impact.

- For the PPA, a part-time trainee was identified as the most exposed individual for calculation of risk, assuming fulltime workers who may also be present are fully trained and protected under OSHA.
- Current URFs and RfCs were used.
- Hazard indices were calculated for all chemicals with published RfCs, including carcinogenic chemicals.

Table 4. Sensitivity of Risk Results to Different Calculation Approaches

Receptor	Current Permit Approach			Best Case Approach		
	ADF	Cancer Risk	Hazard Index	ADF	Cancer Risk	Hazard Index
Non-waste Surface Worker	1.14E-2	5.8E-7	4.2E-4	NA	NA	NA
Trainee	NA	NA	NA	8.69E-5	4.4E-10	3.2E-7
Antelope Ridge Rancher	6.72E-4	1.3E-7	2.7E-5	2.94E-4	5.6E-8	1.2E-5
Livingston Ridge Rancher	1.76E-4	3.4E-8	7.0E-6	9.66E-5	1.9E-8	3.8E-6
Resident at Property Boundary	8.78E-5	7.1E-8	1.5E-5	NA	NA	NA
Mills Ranch Resident	NA	NA	NA	6.47E-6	5.2E-9	1.1E-6
Smith Ranch Resident	NA	NA	NA	8.89E-6	7.2E-9	1.5E-6

At current emission rates, all cancer risks and hazard indices are at acceptable levels. Using the current permit approach, the highest cancer risks were 5.8E-7 for non-waste surface workers, considerably lower than the target risk level of 1E-5. Hazard indices were very low for all receptors, with the highest hazard index of 4.2E-4 for non-waste surface workers. Compared to a target hazard of 1.0, these values are essentially negligible. Current emission rates would need to increase more than 1000x before non-cancer effects would pose a hazard to the most-exposed receptor.

Alternative air emission limits were calculated for each of the 4 receptors originally identified in the Permit, using the assumptions described above under “current permit approach”. The calculation process is described in *Attachment B*. For the non-waste surface worker scenario, target cumulative risks were set at 1E-5. For the Antelope Ridge Allotment ranch worker, Livingston Ridge Allotment ranch worker, and off-property resident scenarios, target cumulative risks were set at 1E-6. Per chemical target risks were apportioned to reflect the relative contribution of each chemical to overall risk based on current emission rates, as identified in Table 2. Table 5 presents the alternative air emission limits for each of these scenarios. Two of the five carcinogenic compounds are not included in Table 5 because they are not currently detected in the emissions from the WIPP facility at this time. Because of this and because the values are based on conservative exposure assumptions, they are intended for discussion purposes only. Other limits can readily be calculated if more realistic exposure assumptions are used, if an on-site trainee is used instead of a non-waste surface worker, if alternative target risk levels are used, if modifications are made to the current vent system, or if a portion of the risk is assigned to the non-detected compounds.

Table 5. Alternative Air Emission Limits (E-300 Concentrations of Concern)

Receptor	ADF	Alternative Limit (ppbv)		
		Carbon Tetrachloride	Chloroform	Methylene Chloride
Non-waste Surface Worker	1.14E-2	1885	181	35
Antelope Ridge Rancher	6.72E-4	843	81	15
Livingstone Ridge Rancher	1.76E-4	3220	310	59
Off-Property Resident	8.78E-5	1533	147	28

Of the four scenarios evaluated, the Antelope Ridge Allotment Rancher scenario has the lowest alternative air emission limits. However, consistent with the approach used in the current permit, the recommended limits would be based on the non-waste surface worker instead of the Antelope Ridge Allotment Rancher. There are several reasons for this. First, the Antelope Ridge Rancher is a hypothetical individual at a hypothetical location that is not known to actually exist. Furthermore, it is totally within the authority of the DOE to limit entry to this area if necessary to protect the public. Second, the next highest risk is the off-property resident who is also a hypothetical (fence line) case. The lands adjacent to the WIPP site boundary are public lands with little opportunity for a permanent resident.

This evaluation demonstrates that risks associated with current emissions at WIPP do not pose an unacceptable risk to any on-site or off-site receptor populations. Example calculations of alternative air emission limits in *Attachment B* indicate that, even using conservative, technically defensible assumptions, air emission limits could be raised and still be health-protective.

Attachment A – AERMOD Air Dispersion Modeling

Overview of Dispersion Modeling Process

The calculations and model runs were performed in support of the No-Migration Variance Petition (NMVP) and the Resource Conservation and Recovery Act (RCRA) Part B Permit Renewal Application for WIPP. The EPA guidance on the air pathway assessment for NMVPs has specific requirements related to the air dispersion modeling for NMVPs. The model runs should:

- estimate annual average concentrations using ***ISCLT3***;
- use five years of preferable on-site meteorological data, evaluate one year at a time, and use the run that produces the maximum boundary concentration;
- include receptors up to 328 feet (100 meters) beyond the unit boundary to verify that the maximum concentration occurs at the boundary;
- include a fine receptor grid in the maximum concentration area;
- use Cartesian receptor grids;
- correct for the vertical wind profile, if the source is at ground level; and
- specify receptor heights at 5 feet (1.5 meters) (inhalation height).

All of these criteria were included in the dispersion modeling analysis for the WIPP site, with the exception of the first bulleted item above. USEPA air models have been substantially refined since the NMVP guidance was issued, and the ISCLT3 model is no longer supported by EPA. Although the short term version of the ISC modeling system, ISCST3, may be used for certain applications including evaluations of annual impact concentrations, it is now considered to be an alternative model rather than a preferred model. The air dispersion modeling presented in this application was performed using EPA's preferred dispersion model which is the American Meteorological Society / EPA Regulatory Model (AERMOD) version 09292 to predict air pollutant concentrations at various on-site and off-site receptor points, based on the dispersion of air releases from the exhaust shafts. The model was run with five years of meteorological data, much of which was derived from data collected at the WIPP on-site meteorological monitoring station.

The AERMOD modeling system has a number of components. There are several preprocessor programs:

- AERMAP, which generates receptor elevations and other terrain related information;
- AERSURFACE, which generates land use characteristic values of albedo, bowen ratio, and surface roughness length for use with AERMET, and;
- AERMET, which takes meteorological data from the on-site monitors and National Weather Service surface and upper air data, as well as the land use data from AERSURFACE to create meteorological data files that are compatible with AERMOD.

After all the required preprocessors have been run, the AERMOD model may then be setup and run. AERMOD uses Gaussian dispersion algorithms in conjunction with meteorological data, terrain data, and building downwash parameters to estimate impact concentrations downwind of the sources. In the case of the WIPP project modeling, some additional post processing was necessary, which was accomplished with a series of Excel workbooks.

Development of ADFs

The purpose of the dispersion modeling part of the analysis was to estimate air dispersion factors (ADFs), which are then used in the risk assessment calculations as described in Attachment B. These values represent the maximum impact concentrations of any gaseous airborne hazardous constituent per unit concentration emitted from the mine air exhaust system during WIPP disposal operations. AERMOD was used to predict maximum impact concentrations in $\mu g/m^3$, given an arbitrary input gas concentration of 10,000 $\mu g/m^3$. The ADF was then calculated using the following ratio:

$$\text{Air Dispersion Factor} = \frac{\text{Maximum Impact Concentration } (\mu g/m^3)}{\text{Release Concentration } (\mu g/m^3)} \qquad \text{(Eqn. A-1)}$$

In the NMVP petition, the Department of Energy (DOE) must demonstrate that there will be no migration of hazardous constituents above heath-based levels (HBL) beyond the unit boundary.

Given a concentration of volatile organic compounds (VOC) in air released from the mine ventilation exhaust ducts, the air dispersion factor determines the resulting maximum concentration for the NMVP. This concentration is then compared to HBLs to demonstrate no-migration. In the permit application the DOE must demonstrate that there will be no release that may have an adverse effect on human health and the environment due to migration of waste constituents in the air. For the permit renewal application, the maximum concentration is used to calculate the long-term risk to the public, and then compared to acceptable risk levels. Occupational exposure is also required to be assessed in the application.

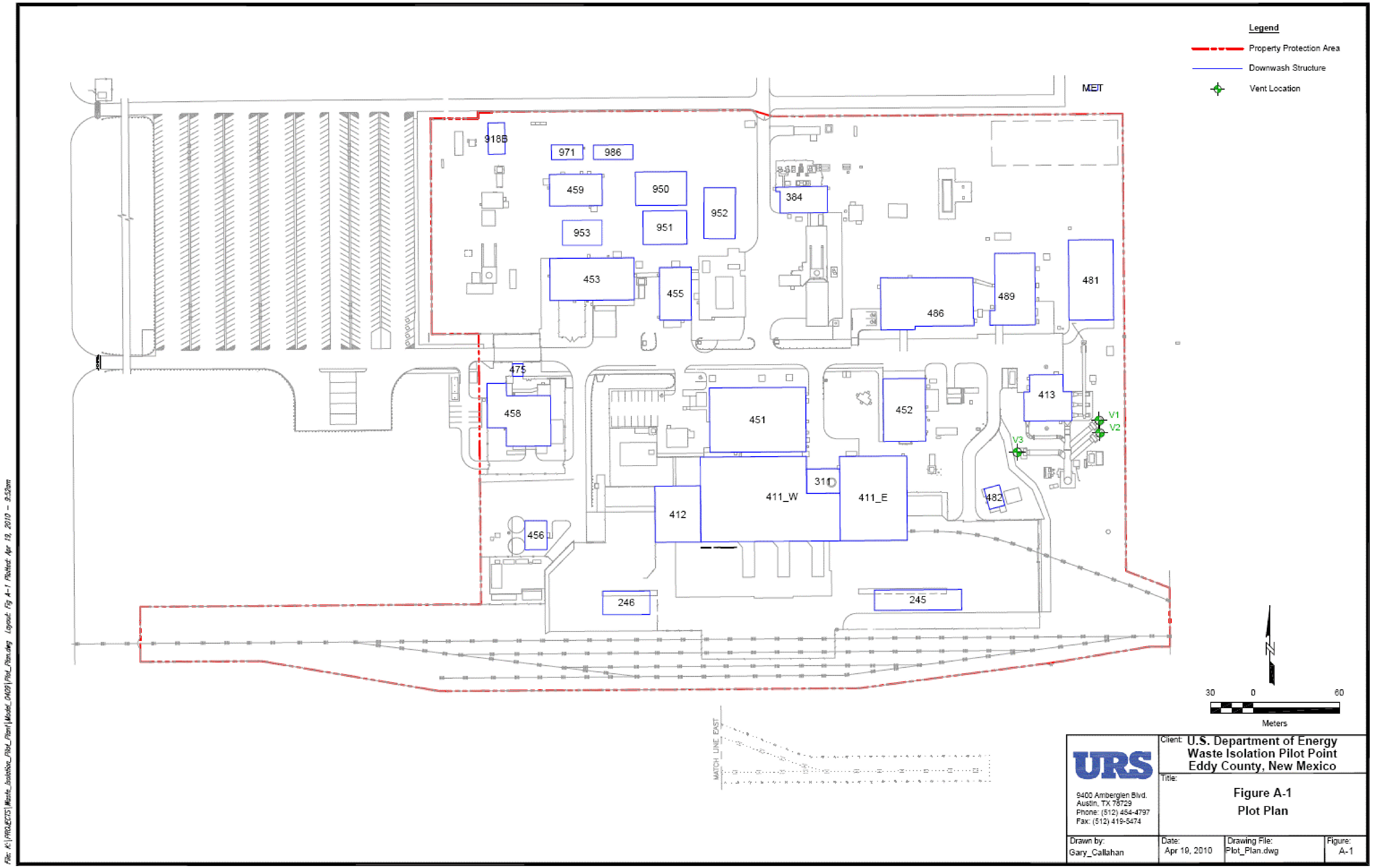
To perform the assessments above, a number of ADFs were determined including

- The maximum ADFs estimated anywhere (which were in the property protection area)
- The maximum ADFs estimated in the training building (which is the nearest structure to the vents where worker exposure would be significant)
- The maximum ADFs estimated in the Exclusive Use Area
- The maximum ADFs estimated in the Off Limits Area
- The maximum ADFs estimated within the Antelope Ridge Allotment
- The maximum ADFs estimated within the Livingston Ridge Allotment
- The maximum ADFs estimated along and 100 meters beyond the property boundary, and
- The ADFs estimated at the nearest residences

Please note that a set of ADFs was generated for each scenario described on page 6.

Site Plan and Area Map

Figure A-1 is a site plan of the WIPP facility that identifies the buildings included in the model as well as the locations of the vents. Figure A-2 is an area map that shows the designations of each component of the WIPP property (including the agricultural allotments) as well as the property boundary and nearest residents.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Downwash Structure
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481
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URS
9400 Amberglen Blvd.
Austin, TX 78729
Phone: (512) 454-4797
Fax: (512) 419-5474
Client: U.S. Department of Energy
Waste Isolation Pilot Point
Eddy County, New Mexico
Title:
Figure A-1
Plot Plan
Drawn by:
Gary_Callahan
Date:
Apr 19, 2010
Drawing File:
Plot_Plan.dwg
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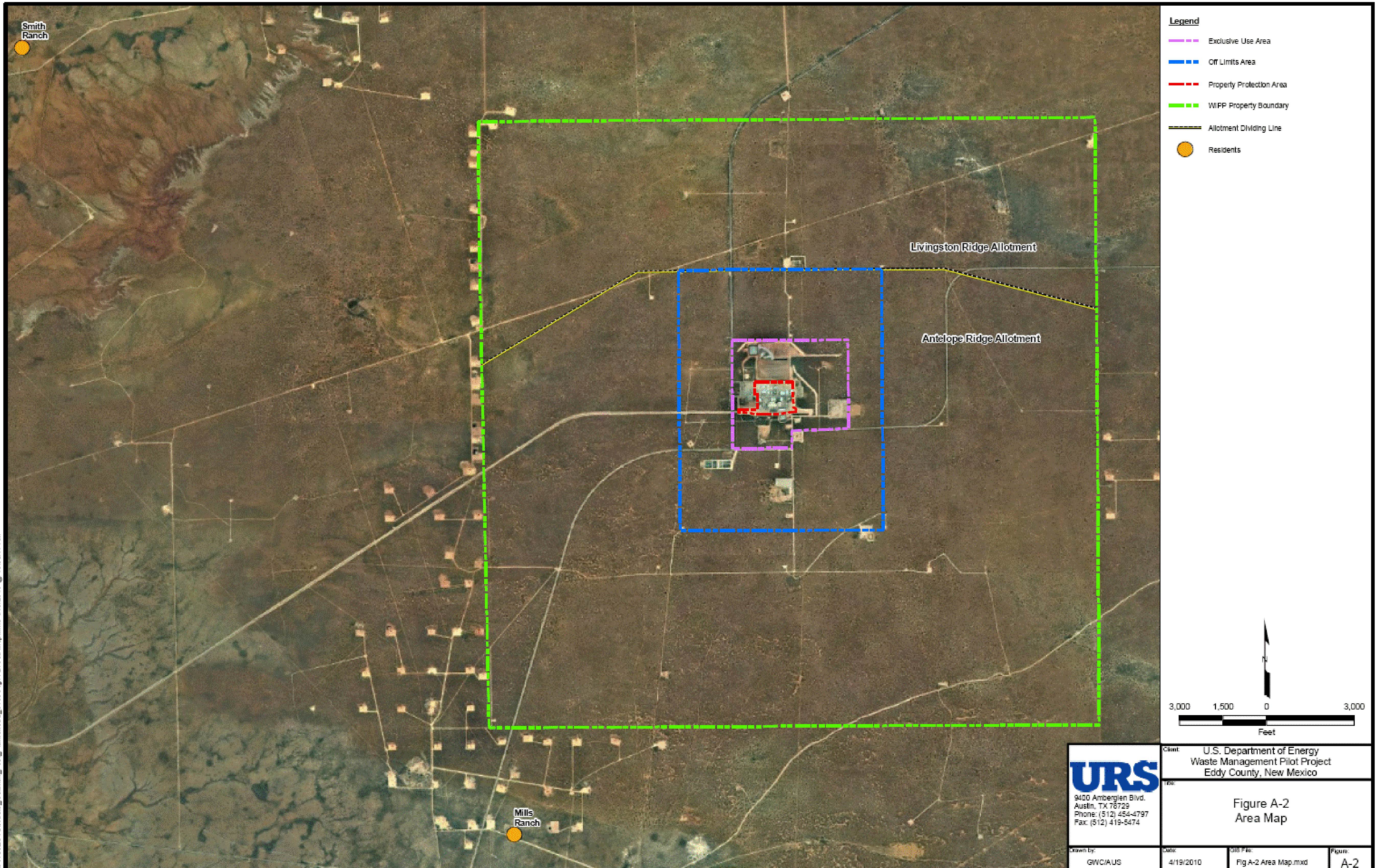

K:\PROJECTS\Waste_Isolation_Pilot_Plant\Model_0409\Fig A-2 Area Map.mxd 4/19/2010 @ 10:35:11 AM

Sensitivity Analysis: Vent Configurations and Operating Scenarios

The modeling analysis was designed to generate ADFs for a variety of operating conditions and vent configurations.

Operating Conditions

Although there are three vents available to release exhaust from the mine, typically only two vents are in use at any one time. The two older vents were labeled V1 and V2 in the model, and the newer vent (labeled V3) is located about 160 feet to the west of the older vents. The following scenarios were evaluated:

- Scenario 1: V1 and V2 operate continuously
- Scenario 2: V1 and V3 operate continuously
- Scenario 3: V2 and V3 operate continuously
- Mixed Scenario: V1 and V2 operate concurrently (Scenario 1) for 20% of the year and highest impacting of Scenarios 2 or 3 operates for the other 80% of the year.

Scenario 1, which represents a situation that allows both of the older vents to emit continuously during the year, is consistently the highest impacting scenario but also the most unlikely. The more realistic Mixed Scenario allows for both of the old vents to emit concurrently for a maximum of 20% of each year while any combination of Scenarios 2 or 3 may operate during the other 80% of each year.

Vent Configurations

Currently, all vents have a release height of 33.2 feet above the ground and are oriented at a 45° angle from vertical. However any potential change in vent height or vent orientation could affect predicted impact concentrations and ADFs. Part of the sensitivity analysis was to evaluate the effect of vent height and vent orientation on the resultant ADFs. The vents were modeled in the following configurations:

- Vents oriented at a 45° angle, with a release height of 33.2 feet (current configuration)
- Vents oriented at a 45° angle, with a release height of 43.2 feet
- Vents oriented at a 45° angle, with a release height of 53.2 feet
- Vents oriented at a 45° angle, with a release height of 63.2 feet
- Vents oriented at a 45° angle, with a release height of 73.2 feet
- Vents oriented at a 45° angle, with a release height of 83.2 feet
- Vents oriented vertically upward, with a release height of 33.2 feet
- Vents oriented vertically upward, with a release height of 43.2 feet
- Vents oriented vertically upward, with a release height of 53.2 feet
- Vents oriented vertically upward, with a release height of 63.2 feet
- Vents oriented vertically upward, with a release height of 73.2 feet
- Vents oriented vertically upward, with a release height of 83.2 feet

Raising the vent release heights and re-orienting the vents so that they are directed vertically upward gives the emitted plume greater dispersion characteristics, which reduce modeled impact concentrations and ADFs. Although the change in ADF values with different vent configurations is significant for receptors close to the vents (in the Property Protection Area, in particular), the differences in ADF values for far away receptors is slight.

For each receptor, and ADF value was generated for each of 4 operating scenarios × 12 vent configurations = 48 possible operating conditions.

Emission Rates and Source Parameters

For modeling purposes, the pollutant concentration in each vent was given an arbitrary value of 10,000 μg/m^3 (0.01 g/m^3). The maximum volumetric air flow rate through the mine shafts is 425,000 ft^3/min (200.6 m^3/s). This volumetric flow rate is divided in half as the flow is directed to each of the two open vents. The air flow rate through any single vent is 100.3 m^3/s. Therefore, the generic pollutant emission rate for each individual vent is the concentration multiplied by the volumetric flow rate, which is:

$$0.01 \text{ g/m}^3 \times 100.3 \text{ m}^3\text{/s} = \mathbf{1.003 \text{ g/s}}$$

0.02

For each vent the model requires the source parameters of release height, exit temperature, stack diameter, and exit velocity. The rationale for these model selections is provided below.

Release Height. The current vent release height is 33.2 feet. Other potential vent configurations include the vent release height at 43.2 ft, 53.2 ft, 63.2 ft, 73.2 ft, and 83.2 ft.

Exit Temperature. The minimum recorded duct temperature between March 2009 and February 2010 of 58 °F was selected as the exit temperature for the analysis. In actuality, the temperature varies throughout the day and from season to season. However, for low exit temperatures, plume dispersion characteristics are poor. In this case the plume remains concentrated, which leads to higher impact concentrations. The selection of an exceedingly low exit temperature is a conservative model selection.

Stack Diameter. The shape of the opening of each vent is square, and all vents are identical. In order to approximate the "diameter" of the vent opening, the area of each opening was calculated, and the radius of a circle with the same area was determined. Each vent opening is a square shape, 130 inches (3.3 meters) per side. Therefore, the area of the opening is:

$$3.3 \text{ m} \times 3.3 \text{ m} = 10.9 \text{ m}^2$$

A circle with the same area would have a diameter of:

$$2 \times \text{sqrt} (10.9 \text{ m} / \pi) = 3.73 \text{ m}$$

Exit Velocity. Like low exit temperatures, low exit velocities also lead to poor dispersion characteristics and higher impact concentrations. In order to estimate the exit velocity from the vents, the minimum allowable volumetric flow rate of 260,000 ft^3/min (122.7 m^3/s) was used. The low flow rate, which corresponds to a low exit velocity, is a conservative modeling selection. This flow rate is divided in half as the flow is directed to each of the two open vents.

The air flow rate through any single vent is 61.4 m^3/s. If the vent emitted vertically upward, the exit velocity may be estimated by dividing the flow rate by the area of the vent opening, which is 10.9 m^2. In this case, the exit velocity is:

$$61.4\ m^3/s \div 10.9\ m^2 = 5.63\ m/s$$

However, the vents are currently oriented at a 45° angle from the vertical. The exit velocity required by the model is, in fact, the *vertical* exit velocity. The vertical component of the exit velocity from the angled vent is:

$$\sin(45°) \times 5.63\ m/s = 3.98\ m/s$$

In summary, the vents were modeled with the source parameters listed in Table A-1. All values in this table are in metric units because these are the units accepted by AERMOD.

Table A-1. Modeled Source Parameters

Source ID	UTM Easting (X) (m)	UTM Northing (Y) (m)	Base Elevation (m)	Release Height (m)	Exit Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)
V1	613688	3582305	1039.3	10.11 / 13.16 / 16.21 / 19.25 / 22.30 / 25.35 [a]	287.6	3.98 / 5.63 [b]	3.73
V2	613689	3582298	1039.3	10.11 / 13.16 / 16.21 / 19.25 / 22.30 / 25.35 [a]	287.6	3.98 / 5.63 [b]	3.73
V3	613641	3582286	1039.3	10.11 / 13.16 / 16.21 / 19.25 / 22.30 / 25.35 [a]	287.6	3.98 / 5.63 [b]	3.73

[a] Six different possible release heights (33.2 ft, 43.2 ft, 53.2 ft, 63.2 ft, 73.2 ft & 83.2 ft) were included in the analysis.

[b] An exit velocity of 3.98 m/s indicates that the vent is oriented at a 45° angle from the vertical whereas an exit velocity of 5.63 m/s indicates that the vent is oriented vertically upward. Both configurations were included in the analysis.

The locations of all sources (as well as buildings and receptors) were modeled in Zone 13 NAD 83 UTM coordinates.

Model Selection and Control Parameters (AERMOD)

The most recent version of the AMS/EPA Regulatory Air Model (AERMOD Version 09292) developed by the EPA Support Center for Regulatory Air Modeling (SCRAM) was used for this analysis. All regulatory default options were selected. The regulatory default options require:

- Use the elevated terrain algorithms requiring input of terrain height data;
- Use stack-tip downwash (except for building downwash cases);
- Use the calms processing routines; and
- Use the missing data processing routines.

Other important model selections include:

- Each receptor was given a flagpole elevation of 1.5 meters above the ground.
- The model was set to estimate concentrations over an annual averaging period.

- A separate model run was generated for each year of meteorological data.
- Building downwash parameters were included in the model.
- Receptor elevations and hill heights were included in the model.
- A source-group was created for each vent, so that the impact concentrations due to each vent could be evaluated individually.
- The profile base elevation was set to 1038 meters above sea level, which is the elevation of the on-site surface meteorological station.
-

All modeling file are provided electronically on the attached DVD.

Land Use (AERSURFACE)

Several parameters are used to describe the character of the modeled domain, including surface roughness length, albedo and Bowen ratio. These parameters are incorporated into the surface meteorological data set created by AERMET.

AERSURFACE version 08009 was run to estimate which land use parameters best describe the area around the WIPP site. Land Use Land Cover data was obtained from the file U.S. Geological Survey (USGS) website http://edcftp.cr.usgs.gov/pub/data/landcover/states/. The most important input parameter selections for AERSURFACE were:

- The study radius for surface roughness was set a 1 km, which is the default distance recommended by EPA.
- The area around the WIPP site was not divided into sectors, and was evaluated on an annual basis (rather than by season or month). The area within 1 kilometer of the WIPP site is relatively homogeneous with regard to land use, and these parameters are not expected to vary much with seasons.

All AERSURFACE modeling files are included on attached DVD.

Receptor Grid and Terrain Processing (AERMAP)

Discrete cartesian coordinates were placed on top of the WIPP site, in the surrounding areas, along the property boundary, and at the two nearest residences. The model estimates impact concentrations for each individual receptor. All receptors were given a flagpole elevation of 1.5 meters above the ground.

The receptor grids, illustrated in Figures A-3 and A-4, used in the model were designed as follows:

- On the Property Protection Area, receptors were evenly spaced every 10 meters, making a very fine grid of receptors;
- In the area beyond the Property Protection Area but inside the Exclusive Use Area, receptors were evenly spaced every 25 meters;
- In the area beyond the Exclusive Use Area but inside the Off Limits Area (which includes part of the Antelope Ridge Allotment), receptors were evenly spaced every 50 meters;

- In the area beyond the Off Limits Area but inside the WIPP Property Boundary (which includes part of the Antelope Ridge Allotment and all of the Livingston Ridge Allotment), receptors were evenly spaced every 100 meters
- Receptors were also evenly spaced every 100 meters along the WIPP Property Boundary and an additional 100 meters beyond the boundary
- Discrete receptors were also placed at the locations of the two nearest residents, referenced here as Mills Ranch and Smith Ranch.

The model output files provide impact concentrations at each receptor in specific order. In order to evaluate impacts at specific locations, the list of receptors was broken into groups so that specific areas could be evaluated individually. Specifically,

- Receptors 1 – 1385: Property Protection Area;
- Receptors 886-888, 927-929, 968-970, 1009-1011: Training Building;
- Receptors 1386 – 3206: Exclusive Use Area;
- Receptors 3207 – 5022: Off Limits Area (Antelope Ridge);
- Receptors 5023 – 8843: Inside WIPP Property Boundary (Antelope Ridge & Livingston Ridge);
- Receptors 8844 – 9368: Along WIPP Property Boundary and 100 meters beyond;
- Receptor 9369: Mills Ranch
- Receptor 9370: Smith Ranch

Receptor elevations and hill heights were obtained by running AERMAP Version 09040 in conjunction with digital elevation model (DEM) data. 10-meter resolution DEM data was obtained from http://download.geocomm.com for the following New Mexico quad maps:

- BOOTLEG RIDGE
- LOS MEDANOS
- REMUDA BASIN
- THE DIVIDE
- LIVINGSTON RIDGE
- TOWER HILL SOUTH

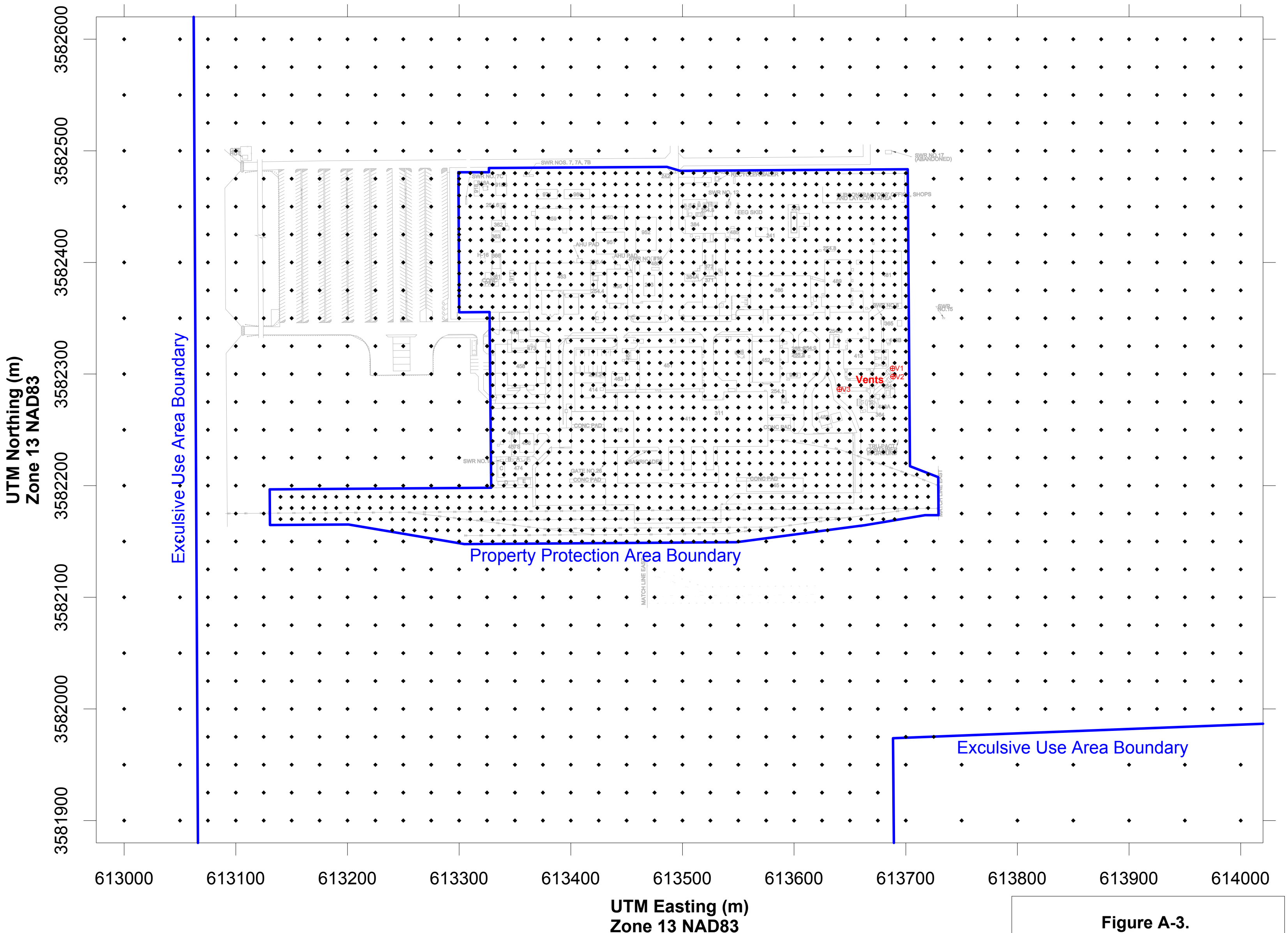

Figure A-3.
Fine Grid of Modeled Receptors

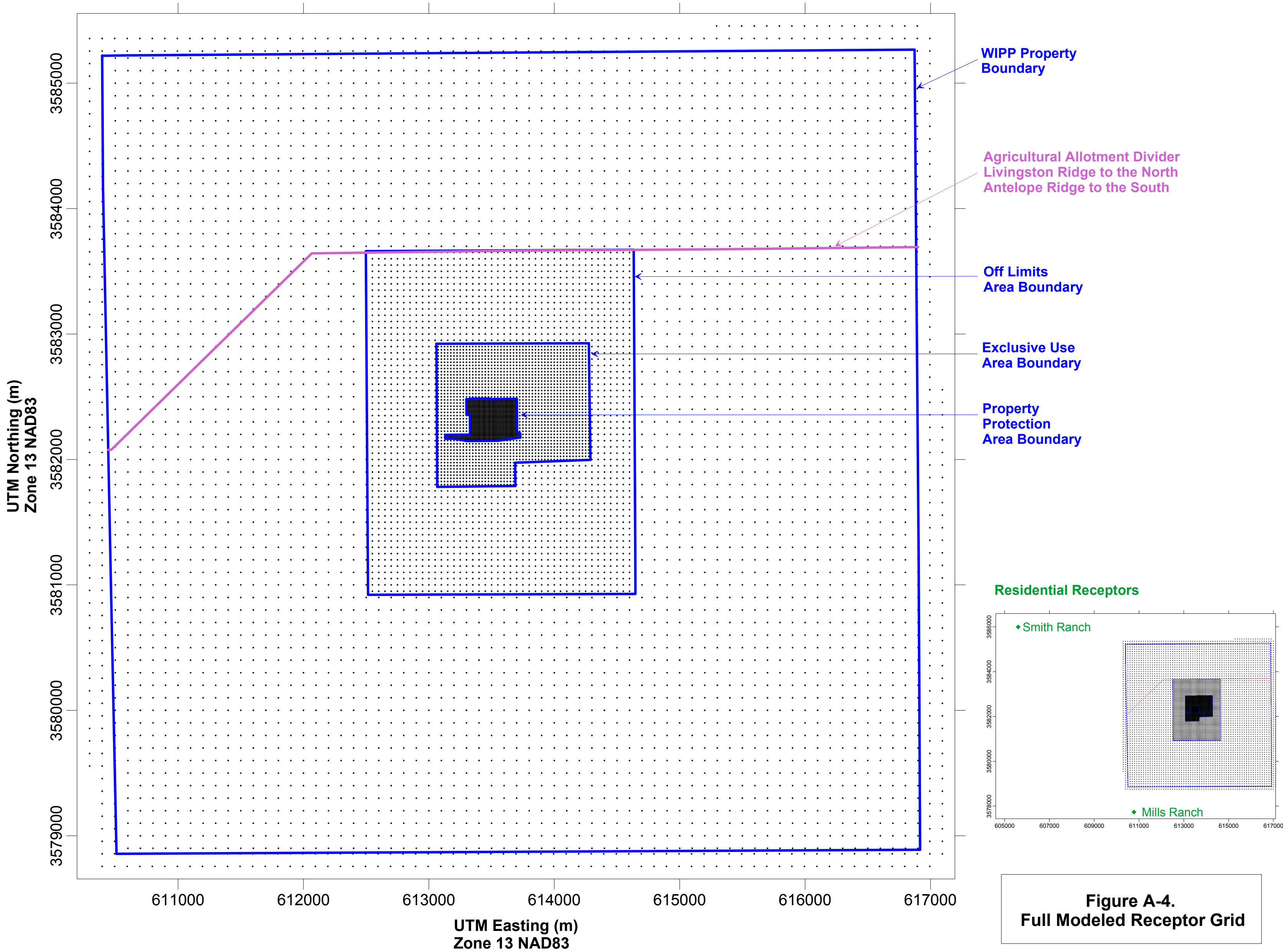

Figure A-4. Full Modeled Receptor Grid

Building Downwash

In addition to downwash effects due to the vent itself (stack tip downwash); the path of the plume may also be affected by nearby structures, leading to building downwash effects. Direction-specific building downwash parameters were generated for all sources in the model using the EPA Building Parameter Input Program PRIME (BPIPPRM dated 04274). Figure A-3 is a plot plan illustrating both the emission points and buildings included in the dispersion modeling. Building corners were assigned UTM coordinates to identify building shapes and locations. Building heights were also input into the PRIME downwash program. This information, along with emission point coordinates and heights, was used by BPIPPRM to generate downwash inputs to AERMOD.

AERMOD considers direction-specific downwash using the PRIME algorithm as determined by the BPIPPRM program. All BPIPPRM input and output files are provided electronically on the attached DVD. Table A-2 shows the modeled building heights for each structure included in the model.

Table A-2. Heights of Downwash Structures Included in the Dispersion Modeling

Building ID	Height (ft)	Building ID	Height (ft)	Building ID	Height (ft)
918B	14.0	MET	8.5	482	12.5
971	12.0	486	17.5	413	19.5
986	12.0	489	17.5	245	18.5
459	19.0	481	18.0	311	129.1
950	14.5	475	12.0	411_W	46.3
952	14.5	458	15.3	411_E	62.9
951	14.5	456	15.6	953	14.5
455	14.0	412	46.3	246	18.5
453	17.5	451	39.2		
384	18.5	452	30.8		

Met Processing (AERMET)

- The Surface File (with file extension .SFC), which contains boundary layer scaling parameters (such as surface friction velocity, mixing height, and Monin-Obukhov length) and reference-height winds and temperature, and
- The Profile File (with file extension .PFL), which contains one or more levels of winds, temperature and the standard deviation of the fluctuating components of the wind.

Although some parameters are measured directly (i.e. wind speed), others must be estimated (i.e. friction velocity). The AERMET preprocessor program version 06341 was used to generate the SFC and PFL files. Five years of meteorological data (2004 – 2008) were processed for this analysis using:

- Surface data parameters from the WIPP on-site monitor,
- Surface data from the National Climactic Data Center (NCDC) for station 93033 at the Carlsbad Municipal Airport in Integrated Surface Hourly variable length ascii format DS-3505 (formerly TD-3505). This meteorological monitor is located about 30 miles west/southwest of the WIPP site in an area with similar topography and meteorology.

- Upper air data from NCDC for station 02023 in Midland, Texas (the nearest upper air met station to the site) in FSL format.

Meteorological parameters recorded at the WIPP on-site monitor included wind speed, wind direction, temperature, relative humidity, precipitation, and station pressure. These values are recorded every 15 minutes and many of them are recorded at 3 separate tower heights above the ground (which help to generate a robust profile of wind speeds and temperatures). In general, the WIPP on-site surface data was of excellent quality and contained only a small fraction of missing or invalid data. Surface data from the Carlsbad monitor was used as a backup to fill in missing parameters required by AERMOD, as well as filling in missing hours of data. The processed meteorological data file capture 95% of all hours of the 5-year period. EPA recommends using a met set with at least 90% data capture.

Important model selections in the AERMET preprocessor include:

- The time stamp on each hour of met data was converted to local standard time (in this case, Mountain Standard Time). Although the data from the on-site monitor is already in local time, both the NCDC surface and upper air data sets are in Greenwich Mean Time. The time stamp on the surface data from the station in Carlsbad, NM was adjusted by 7 hours, and the time stamp on the upper air data from the station in Midland, TX was adjusted by 6 hours.
- On-site measurements of temperature, wind speed, and wind direction were included at all 3 tower heights (2 m, 10 m, & 50 m above the ground).
- The threshold wind speed, which is a value under which winds are considered to be calm, was set to 0.3 m/s for wind speeds recorded by the on-site monitor.

All AERMET modeling files are included on the attached DVD.

Postprocessing and Modeled Impact Concentrations

For each modeled receptor, AERMOD estimated an annual impact concentration (for each of the 5 years of meteorological data) from each of the 3 vents individually. Each impact concentration is based on a pollutant input concentration of 10,000 µg/m^3 per vent from the mine. A series of postprocessing steps were required to use the modeled impact concentrations to estimate ADFs for each receptor. The steps listed below illustrate this procedure for receptor 886 (613630, 3582360) in the modeled scenario with the vents in their current configuration (vents release at a 45° angle and at a height of 33.2 feet above the ground). This particular receptor is inside the Training Building.

1. For the vent configuration described above, the AERMOD output files show the predicted annual impact concentrations for each vent for each year:

Table A-3. AERMOD Estimated Annual Impact Concentrations Using the Current Vent Configuration for Receptor 886

Vent	Annual Impact Concentration (µg/m^3)				
	2004	2005	2006	2007	2008
V1	40.13	39.50	35.83	41.04	37.89
V2	46.53	40.64	39.81	44.52	44.06
V3	17.20	13.59	13.82	12.06	18.51

2. It was assumed that over an entire year, the emissions from one vent are about equal to the emission from another vent. Therefore, the annual impact concentration from one vent may be added to the impact concentration from another vent at the same receptor. For each operating scenario (described in earlier in this attachment), total impact concentrations were estimated.

Table A-4. Estimated Impact Concentrations Using the Current Vent Configuration for Each Operating Scenario at Receptor 886

Operating Scenario	Total Impact Concentration per Operating Scenario (μg/m^3)					
	2004	2005	2006	2007	2008	Annual Maximum Over 5-Year Period
Scenario 1 (V1+V2)	86.67	80.14	75.64	85.56	81.95	**86.67**
Scenario 2 (V1+V3)	57.34	53.10	49.65	53.11	56.40	**57.34**
Scenario 3 (V2+V3)	63.74	54.23	53.63	56.59	62.57	**63.74**

3. Of the three operating scenarios, Scenario 1 produced the highest estimated impact concentration of 86.67 μg/m3. The next step is to use Equation A-1 to estimate the ADF.

$$\text{Air Dispersion Factor} = \frac{86.67\ (\mu g/m^3)}{10{,}000\ (\mu g/m^3)} = 8.67E\text{-}3(\mu g/m^3)$$

4. Although Scenario 1 (which assumed that both of the older vents operate at the same time continuously over a 1-year period) produced the highest estimated impact concentration, it is a very unlikely operating scenario for WIPP. Most of the time, one of the older vents will operate in conjunction with the newer vent V3, which is better represented by Scenarios 2 or 3. Therefore a Mixed Scenario that allows for the vents to operate under Scenario 1 for 20% of the year and the maximum of Scenarios 2 and 3 for the other 80% of the year. The Mixed Scenario is a weighted average of the other two scenarios. For example, in 2004, the weighted average impact concentration for the mixed scenario would be:

$$(20\% \times \underbrace{86.67\ \mu g/m^3}_{\text{from Scenario 1}}) + (80\% \times \underbrace{63.74\ \mu g/m^3}_{\text{maximum of Scenario 2 \& 3}}) = 68.33\ \mu g/m^3$$

5. The Mixed Scenario impacts for this receptor are presented in Table A-5 below.

Table A-5. Estimated Impact Concentrations Using the Current Vent Configuration for the Mixed Scenario at Receptor 886

Operating Scenario	Total Impact Concentration per Operating Scenario (µg/m³)					
	2004	2005	2006	2007	2008	Annual Maximum Over 5-Year Period
Mixed Scenario (20% Scenario 1 + 80% maximum of Scenarios 2 and 3)	68.33	59.41	58.03	62.38	66.45	**68.33**

This procedure was followed for every receptor and every vent configuration scenario. A series of Excel spreadsheets that calculated all of these postprocessed values are included on the attached DVD.

The maximum predicted ADFs at a variety of receptor locations, operating scenarios, and vent configurations are provided in Tables 3a – 3d in the report.

Electronic Files

The attached DVD contains the modeling input and output data files from

- AERMET
- AERMAP
- AERSURFACE, and
- AERMOD.

Also included are the building downwash data and the series of spreadsheets that include the postprocessing of modeled impacts into maximum ADF values for each sensitivity run.

References

EPA, 1997 *Addendum to ISC3User's Guide, The PRIME Plume Rise and Building Downwash Model*. Schulman, L.L., D.G. Strimaitis, and J.S. Scire, 1997. Prepared for the Electric Power Research Institute, Palo Alto, CA., Earth Tech Document A287. A-99-05, II-A-12)

EPA, 2004 *USER'S GUIDE FOR THE AMS/EPA REGULATORY MODEL –AERMOD*. EPA Publication No. EPA-454/B-03-001. Environmental Protection Agency, Research Triangle Park, NC., September 2004, and Addendum 2006

EPA, 2004 *USER'S GUIDE FOR THE AERMOD METEOROLOGICAL PREPROCESSOR (AERMET)*. EPA Publication No. EPA-454/B-03-002.

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Environmental Protection Agency, Research Triangle Park, NC., January 2008

FR, 2005 Federal Register: Part III Environmental Protection Agency *Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule.* Federal Register 40 CFR Part 51. November 9, 2005

Attachment B - Risk Calculations

Cancer risks and non-cancer hazard quotients, and subsequently alternative risk-based limits, were calculated for the following four above-ground receptor populations identified in the original RCRA Part B permit:

- A resident downwind at the WIPP Land Withdrawal Area (LWA) boundary.
- A rancher within the Antelope Ridge Grazing Lease, within the WIPP LWA boundary.
- A rancher within the Livingston Ridge Grazing Lease, within the WIPP LWA.
- A non-waste surface worker at WIPP.

Three additional scenarios were also evaluated:

- a "trainee" at the Training Building in the PPA, assuming that an individual would attend training courses in the on-site training building on average 1 day every other week, based on documented use of the training facility.,
- A resident at the Mills Ranch.
- A resident at the Smith Ranch.

"Forward" risk calculations were used to calculate potential risks based on 1) current permit levels, and 2) current chemical concentrations at the E-300 Drift monitoring station. The E-300 Drift monitoring station is the station used to demonstrate compliance with the permit limits. Air concentrations, presented in parts per billion volume (ppbv), were converted to units of ug/m^3 using equation 1:

Equation 1:

$$COC = E300 * \left(\frac{MW}{24.45} \right)$$

Where: COC = Concentration of Concern (ug/m^3)
E300 = Concentration at the E-300 Monitoring Station (ppbv)
MW = Molecular Weight (g/mol)

Prior to exiting the mine, airflow from the E-300 Drift monitoring location is combined with two other two airflow pathways (Northern experimental area and Waste Shaft) at a point downwind of the monitoring station, and the combined airflow exiting the mine is directed to the exhaust shaft. The VOC concentration in the exhaust shaft is calculated per equation 2:

Equation 2:

$$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust-typ}} \right)$$

Where: ECS_{act} = Actual Exhaust Shaft Concentration (ug/m^3)
V_{panel} = Mine Ventilation Rate from Panel Area (130,000 ft^3/min)
$V_{exhaust-typ}$ = Typical Mine Ventilation Exhaust Rate (425,000 ft^3/min)

Dispersion modeling was performed to derive the Air Dispersion Factors (ADFs) used to predict the dilution of VOC concentrations from the exhaust shaft to the receptor locations. The dispersion modeling approach is described in *Appendix A*. The receptor point concentrations were calculated using equation 3:

Equation 3:

$$R_{con} = ECS_{act} * ADF$$

Where: R_{con} = Receptor concentration (ug/m^3)
ADF = Air dispersion factor, unitless

Standard risk assessment equations were used to calculate cancer risks (equation 4) and non-cancer hazard quotients (equation 5) for each chemical.

Equation 4:

$$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

Equation 5:

$$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

Where: URF = Unit Risk Factor for VOC (m3/ug$^{)-1}$
EF = Exposure Frequency (hours/year)
ED = Exposure Duration (years)
AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
RfC = Reference concentration (mg/m^3)

The relative contribution of each chemical to the overall risk from the emissions was then calculated using equation 6.

Equation 6:

$$Percent\ Risk = \frac{Risk_{ind}}{Risk_{cum}} * 100$$

Where: Percent Risk = Relative risk contribution of the individual chemical (percent)
$Risk_{ind}$ = Risk for the individual chemical (unitless)
$Risk_{cum}$ = Cumulative risk for all chemicals combined (unitless)

Alternative risk-based air limits were established by setting allowable cumulative risk levels (all chemicals combined) for the four above ground receptor populations identified In the RCRA Part B permit and for the trainee scenario, as identified above, and then back-calculating allowable air concentrations corresponding to those risk levels. For the on-site worker and trainee scenarios, acceptable cumulative cancer risk (all chemicals combined) was set at 1 x 10^{-5}, for the resident and rancher scenarios, acceptable cancer risk was set at 1 x 10^{-6}. The percent risk values calculated in equation 6 were used in combination with the allowable cumulative risk levels to allocate target risk levels for each individual chemical, per equation 7.

Equation 7:

$$Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$$

Unlike the carcinogens, alternative limits were not calculated for non-cancer effects. The calculated hazard indices for all non-carcinogens at current air concentrations were well below a hazard index of 1.0, indicating that these chemicals would not pose a potential non-cancer hazard.

Target air concentrations for each carcinogenic chemical were calculated at the receptor point using equation 8, at the exhaust shaft using equation 9, and at the E-300 Drift monitoring station location using equations 10 (concentration in ug/m^3) and 11 (concentration in ppbv).

Equation 8:

$$R_{con} = \frac{Risk * AT_c}{URF * EF * ED}$$

Equation 9:

$$ECS_{act} = \frac{R_{con}}{ADF}$$

Equation 10:

$$COC = ECS_{act} * \left(\frac{V_{exhaust-typ}}{V_{panel}} \right)$$

Equation 11:

$$E300 = COC * \left(\frac{24.45}{MW} \right)$$

Calculation worksheets are presented in Tables B-1 through B-9.

Table B-1
Calculation of Risks and Allowable Air Concentrations
Non-Waste Surface Worker Scenario - PPA
Current Permit Approach
Waste Isolation Pilot Plant (WIPP)

"Forward" Risk Calculations (i.e., Risks) Based on E-300 Monitoring Station

equation 1: $$COC = E300 * \left(\frac{MW}{24.45} \right)$$

equation 2: $$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust-typ}} \right)$$

equation 3: $$R_{con} = ECS_{act} * ADF$$

equation 4: $$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

equation 5: $$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

equation 6: $$Percent\ Risk = \frac{Chemical\ Risk}{Total\ Risk} * 100$$

E-300 = Concentration at the air monitoring point (ppbv)
MW = Molecular Weight of the VOC (g/mole)
COC = Concentration of concern at E-300 Monitoring Station (ug/m^3)
V_{panel} = Mine ventilation panel rate (130,000 ft^3/min)
$V_{exhaust-typ}$ = typical mine ventilation exhaust rate (425,000 ft^3/min)
ECS_{act} = Actual exhaust shaft concentration for VOC (ug/m^3)
ADF = Air dispersion factor, unitless
Rcon = Receptor concentration (ug/m^3)

AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
URF = Unit risk factor for VOC (m^3/ug)$^{-1}$
RfC = Reference concentration (mg/m^3)
EF = Exposure frequency (hours/year)
ED = Exposure duration, years (10 years)
$Risk_{ind}$ = per chemical cancer risk (unitless)
$Risk_{cum}$ = cumulative cancer risks for all chemicals combined (unitless)

Risks and Hazards Based on Current E-300 Limits, Toxicity Values from the Permit, Original ADF

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient* (unitless)	Percent of Total Risk
Carbon Tetrachloride	165	153.84	1038	130,000	425,000	317.56	1.23E-02	3.91	613200		1.5E-05		1920	10	1.83E-06		19
Chlorobenzene	220	112.56	1013	130,000	425,000	309.80	1.23E-02	3.81		87600		2.0E-02	1920	10		4.18E-02	
Chloroform	180	119.39	879	130,000	425,000	268.85	1.23E-02	3.31	613200		2.3E-05		1920	10	2.38E-06		24
1,1-Dichloroethene	100	96.95	397	130,000	425,000	121.29	1.23E-02	1.49	613200		5.0E-05		1920	10	2.34E-06		24
1,2-Dichloroethane	45	98.97	182	130,000	425,000	55.72	1.23E-02	0.69	613200		2.6E-05		1920	10	5.58E-07		6
Methylene Chloride	1930	84.94	6705	130,000	425,000	2050.90	1.23E-02	25.23	613200		4.7E-07		1920	10	3.71E-07		4
1,1,2,2-Tetrachloroethane	50	167.86	343	130,000	425,000	105.00	1.23E-02	1.29	613200		5.8E-05		1920	10	2.35E-06		24
Toluene	190	92.13	716	130,000	425,000	218.99	1.23E-02	2.69		87600		4.0E-01	1920	10		1.48E-03	
1,1,1-Trichloroethane	590	133.42	3220	130,000	425,000	984.80	1.23E-02	12.11		87600		7.0E-01	1920	10		3.79E-03	
														Cumulative	**9.8E-06**	**4.7E-02**	100

* Consistent with the approach used in the permit, non-cancer hazard quotients were only calculated for chemicals with no available URF values.

Risks and Hazards Based on Current Measured Concentrations at E-300 Drift Monitoring Station, Current Toxicity Values, new ADF*

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient (unitless)	Percent of Total Risk
Carbon Tetrachloride	108.73	153.84	684	130,000	425,000	209.26	1.14E-02	2.39	613200	87600	6.0E-06	1.00E-01	1920	10	4.48E-07	0.005229	78
Chlorobenzene	0	112.56	0	130,000	425,000	0	1.14E-02	0	613200	87600		5.0E-02	1920	10		0	
Chloroform	10.46	119.39	51	130,000	425,000	15.62	1.14E-02	0.18	613200	87600	2.3E-05	9.8E-02	1920	10	1.28E-07	3,98E-04	22
1,1-Dichloroethene**	0	96.95	0	130,000	425,000	0	1.14E-02	0	613200	87600		2.0E-01	1920	10		0	
1,2-Dichloroethane	0	98.97	0	130,000	425,000	0	1.14E-02	0	613200	87600	2.6E-05	2.4E+00	1920	10	0	0	0
Methylene Chloride	1.99	84.94	7	130,000	425,000	2.11	1.14E-02	0.024	613200	87600	4.7E-07	1.0E+00	1920	10	3.55E-10	5.28E-06	0.06
1,1,2,2-Tetrachloroethane	0	167.86	0	130,000	425,000	0	1.14E-02	0	613200	87600	5.8E-05		1920	10	0		0
Toluene	0.01	92.13	0.038	130,000	425,000	0.012	1.14E-02	0.00013	613200	87600		5.0E+00	1920	10		5.76E-09	
1,1,1-Trichloroethane	17.56	133.42	96	130,000	425,000	29.31	1.14E-02	0.33	613200	87600		5.0E+00	1920	10		1.46E-05	
														Cumulative	**5.8E-07**	**4.2E-04**	100

* ADF was calculated at the point of maximum impact in the PPA, assuming 45 degree vent angle, no additional stack height, and vent usage of 20% vents 1 & 2, 80% highest impact of vents 1 & 3 or vents 2 & 3
** USEPA has withdrawn the URF for 1,1-DCE; inhalation evaluated based on non-cancer effects.

Table B-1
Calculation of Risks and Allowable Air Concentrations
Non-Waste Surface Worker Scenario - PPA
Current Permit Approach
Waste Isolation Pilot Plant (WIPP)

"Reverse" Risk Calculations (i.e., Allowable Air Concentrations at E-300 Monitoring Station) Based on Target Risk Levels

equation 7: $Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$

equation 8: $R_{con} = \dfrac{Risk * AT_r}{URF * EF * ED}$

equation 9: $ECS_{act} = \dfrac{R_{con}}{ADF}$

equation 10: $COC = ECS_{act} * \left(\dfrac{V_{exhaust-typ}}{V_{panel}}\right)$

equation 11: $E300 = COC * \left(\dfrac{24.45}{MW}\right)$

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based on Original Permit Assumptions

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-05	1.87E-06	613200		1.5E-05		1920	10	3.98	1.23E-02	323.18	130,000	425,000	1057	153.84	167.9	165
Chlorobenzene				87600		2.0E-02	1920	10		1.23E-02		130,000	425,000		112.56	*	220
Chloroform	1.0E-05	2.42E-06	613200		2.3E-05		1920	10	3.37	1.23E-02	273.61	130,000	425,000	894	119.39	183	180
1,1-Dichloroethene	1.0E-05	2.38E-06	613200		5.0E-05		1920	10	1.52	1.23E-02	123.43	130,000	425,000	404	96.95	102	100
1,2-Dichloroethane	1.0E-05	5.68E-07	613200		2.6E-05		1920	10	0.70	1.23E-02	56.70	130,000	425,000	185	98.97	46	45
Methylene Chloride	1.0E-05	3.78E-07	613200		4.7E-07		1920	10	25.67	1.23E-02	2087.18	130,000	425,000	6823	84.94	1964	1930
1,1,2,2-Tetrachloroethane	1.0E-05	2.39E-06	613200		5.8E-05		1920	10	1.31	1.23E-02	106.86	130,000	425,000	349	167.86	51	50
Toluene				87600		4.0E-01	1920	10		1.23E-02		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane				87600		7.0E-01	1920	10		1.23E-02		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.
** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker set at 1E-5, for residents and ranch workers set at 1E-6

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based Re-apportionment of Risk to Reflect Current Conditions, New Toxicity Values, New ADF

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-05	7.77E-06	613200	87600	6.0E-06	1.00E-01	1920	10	41.36	1.14E-02	3628.04	130,000	425,000	11861	153.84	1885	165
Chlorobenzene			613200	87600		5.0E-02	1920	10		1.14E-02		130,000	425,000		112.56	*	220
Chloroform	1.0E-05	2.22E-06	613200	87600	2.3E-05	9.8E-02	1920	10	3.09	1.14E-02	270.86	130,000	425,000	886	119.39	181	180
1,1-Dichloroethene			613200	87600		2.0E-01	1920	10		1.14E-02		130,000	425,000		96.95	*	100
1,2-Dichloroethane	1.0E-05	0	613200	87600	2.6E-05	2.4E+00	1920	10	0	1.14E-02	0	130,000	425,000	0	98.97	0	45
Methylene Chloride***	1.0E-05	6.15E-09	613200	87600	4.7E-07	1.0E+00	1920	10	0.42	1.14E-02	36.66	130,000	425,000	120	84.94	35	1930
1,1,2,2-Tetrachloroethane	1.0E-05	0	613200	87600	5.8E-05		1920	10	0	1.14E-02	0	130,000	425,000	0	167.86	0	50
Toluene			613200	87600		5.0E+00	1920	10		1.14E-02		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane			613200	87600		5.0E+00	1920	10		1.14E-02		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.
** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker and trainee set at 1E-5, for residents and ranch workers set at 1E-6
*** Methylene chloride target risk is set at a very low value, based on current emision rates <1% of total risk. As an example, if target risk was arbitrarily set as 1%, E-300 COC would be 561 ppbv.

Table B-2
Calculation of Risks and Allowable Air Concentrations
Off-Site Resident Scenario
Current Permit Approach
Waste Isolation Pilot Plant (WIPP)

"Forward" Risk Calculations (i.e., Risks) Based on E-300 Monitoring Station

equation 1:
$$COC = E300 * \left(\frac{MW}{24.45}\right)$$

equation 2:
$$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust-typ}}\right)$$

equation 3:
$$R_{con} = ECS_{act} * ADF$$

equation 4:
$$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

equation 5:
$$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

equation 6:
$$Percent\ Risk = \frac{Chemical\ Risk}{Total\ Risk} * 100$$

E-300 = Concentration at the air monitoring point (ppbv)
MW = Molecular Weight of the VOC (g/mole)
COC = Concentration of concern at E-300 Monitoring Station (ug/m^3)
V_{panel} = Mine ventilation panel rate (130,000 ft^3/min)
$V_{exhaust-typ}$ = typical mine ventilation exhaust rate, (425,000 ft^3/min)
ECS_{act} = Actual exhaust shaft concentration for VOC (ug/m^3)
ADF = Air dispersion factor, unitless
Rcon = Receptor concentration (ug/m^3)

AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
URF = Unit risk factor for VOC (m^3/ug)$^{-1}$
RfC = Reference concentration (mg/m^3)
EF = Exposure frequency (hours/year)
ED = Exposure duration, years (35 years)
$Risk_{ind}$ = per chemical cancer risk (unitless)
$Risk_{cum}$ = cumulative cancer risks for all chemicals combined (unitless)

Risks and Hazards Based on Current E-300 Limits, Toxicity Values from the Permit, Original ADF

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient* (unitless)	Percent of Total Risk
Carbon Tetrachloride	165	153.84	1038	130,000	425,000	317.56	1.20E-04	0.038	613200		1.5E-05		8760	35	2.86E-07		19
Chlorobenzene	220	112.56	1013	130,000	425,000	309.80	1.20E-04	0.037		306600		2.0E-02	8760	35		1.86E-03	
Chloroform	180	119.39	879	130,000	425,000	268.85	1.20E-04	0.032	613200		2.3E-05		8760	35	3.71E-07		24
1,1-Dichloroethene	100	96.95	397	130,000	425,000	121.29	1.20E-04	0.015	613200		5.0E-05		8760	35	3.64E-07		24
1,2-Dichloroethane	45	98.97	182	130,000	425,000	55.72	1.20E-04	0.0067	613200		2.6E-05		8760	35	8.69E-08		6
Methylene Chloride	1930	84.94	6705	130,000	425,000	2050.90	1.20E-04	0.25	613200		4.7E-07		8760	35	5.78E-08		4
1,1,2,2-Tetrachloroethane	50	167.86	343	130,000	425,000	105.00	1.20E-04	0.013	613200		5.8E-05		8760	35	3.65E-07		24
Toluene	190	92.13	716	130,000	425,000	218.99	1.20E-04	0.026		306600		4.0E-01	8760	35		6.57E-05	
1,1,1-Trichloroethane	590	133.42	3220	130,000	425,000	984.80	1.20E-04	0.12		306600		7.0E-01	8760	35		1.69E-04	
														Cumulative	**1.5E-06**	**2.1E-03**	100

* Consistent with the approach used in the permit, non-cancer hazard quotients were only calculated for chemicals with no available URF values.

Risks and Hazards Based on Current Measured Concentrations at E-300 Drift Monitoring Station, Current Toxicity Values, new ADF*

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient (unitless)	Percent of Total Risk
Carbon Tetrachloride	108.73	153.84	684	130,000	425,000	209.26	8.78E-05	0.018	613200	306600	6.0E-06	1.00E-01	8760	35	5.51E-08	0.000184	78
Chlorobenzene	0	112.56	0	130,000	425,000	0	8.78E-05	0	613200	306600		5.0E-02	8760	35		0	
Chloroform	10.46	119.39	51	130,000	425,000	15.62	8.78E-05	0.0014	613200	306600	2.3E-05	9.8E-02	8760	35	1.58E-08	1.40E-05	22
1,1-Dichloroethene**	0	96.95	0	130,000	425,000	0	8.78E-05	0	613200	306600		2.0E-01	8760	35		0	
1,2-Dichloroethane	0	98.97	0	130,000	425,000	0	8.78E-05	0	613200	306600	2.6E-05	2.4E+00	8760	35	0	0	0
Methylene Chloride	1.99	84.94	7	130,000	425,000	2.11	8.78E-05	0.00019	613200	306600	4.7E-07	1.0E+00	8760	35	4.36E-11	1.86E-07	0.06
1,1,2,2-Tetrachloroethane	0	167.86	0	130,000	425,000	0	8.78E-05	0	613200	306600	5.8E-05		8760	35	0		0
Toluene	0.01	92.13	0.038	130,000	425,000	0.012	8.78E-05	0.0000010	613200	306600		5.0E+00	8760	35		2.02E-10	
1,1,1-Trichloroethane	17.56	133.42	96	130,000	425,000	29.31	8.78E-05	0.0026	613200	306600		5.0E+00	8760	35		5.15E-07	
														Cumulative	**7.1E-08**	**1.5E-05**	100

* ADF was calculated at the point of maximum impact off-property, assuming 45 degree vent angle, no additional stack height, and vent usage of 20% vents 1 & 2, 80% highest impact of vents 1 & 3 or vents 2 & 3
** USEPA has withdrawn the URF for 1,1-DCE; inhalation evaluated based on non-cancer effects.

Table B-2
Calculation of Risks and Allowable Air Concentrations
Off-Site Resident Scenario
Current Permit Approach
Waste Isolation Pilot Plant (WIPP)

"Reverse" Risk Calculations (i.e., Allowable Air Concentrations at E-300 Monitoring Station) Based on Target Risk Levels

equation 7: $Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$

equation 8: $R_{con} = \frac{Risk * AT_c}{URF * EF * ED}$

equation 9: $ECS_{act} = \frac{R_{con}}{ADF}$

equation 10: $COC = ECS_{act} * \left(\frac{V_{exhaust-typ}}{V_{panel}} \right)$

equation 11: $E300 = COC * \left(\frac{24.45}{MW} \right)$

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based on Original Permit Assumptions

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	1.87E-07	613200		1.5E-05		8760	35	0.025	1.20E-04	207.44	130,000	425,000	678	153.84	108	165
Chlorobenzene				306600		2.0E-02	8760	35		1.20E-04		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.42E-07	613200		2.3E-05		8760	35	0.021	1.20E-04	175.62	130,000	425,000	574	119.39	118	180
1,1-Dichloroethene	1.0E-06	2.38E-07	613200		5.0E-05		8760	35	0.010	1.20E-04	79.23	130,000	425,000	259	96.95	65	100
1,2-Dichloroethane	1.0E-06	5.68E-08	613200		2.6E-05		8760	35	0.0044	1.20E-04	36.40	130,000	425,000	119	98.97	29	45
Methylene Chloride	1.0E-06	3.78E-08	613200		4.7E-07		8760	35	0.16	1.20E-04	1339.71	130,000	425,000	4380	84.94	1261	1930
1,1,2,2-Tetrachloroethane	1.0E-06	2.39E-07	613200		5.8E-05		8760	35	0.0082	1.20E-04	68.59	130,000	425,000	224	167.86	33	50
Toluene				306600		4.0E-01	8760	35		1.20E-04		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane				306600		7.0E-01	8760	35		1.20E-04		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.
** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker set at 1E-5, for residents and ranch workers set at 1E-6

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based Re-apportionment of Risk to Reflect Current Conditions, New Toxicity Values, New ADF

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	7.77E-07	613200	306600	6.0E-06	1.00E-01	8760	35	0.26	8.78E-05	2949.93	130,000	425,000	9644	153.84	1533	165
Chlorobenzene			613200	306600		5.0E-02	8760	35		8.78E-05		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.22E-07	613200	306600	2.3E-05	9.8E-02	8760	35	0.019	8.78E-05	220.24	130,000	425,000	720	119.39	147	180
1,1-Dichloroethene			613200	306600		2.0E-01	8760	35		8.78E-05		130,000	425,000		96.95	*	100
1,2-Dichloroethane	1.0E-06	0	613200	306600	2.6E-05	2.4E+00	8760	35	0	8.78E-05	0	130,000	425,000	0	98.97	0	45
Methylene Chloride***	1.0E-06	6.15E-10	613200	87600	4.7E-07	1.0E+00	8760	35	0.0026	8.78E-05	29.81	130,000	425,000	97	84.94	28	1930
1,1,2,2-Tetrachloroethane	1.0E-06	0	613200	306600	5.8E-05		8760	35	0	8.78E-05	0	130,000	425,000	0	167.86	0	50
Toluene			613200	306600		5.0E+00	8760	35		8.78E-05		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane			613200	306600		5.0E+00	8760	35		8.78E-05		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.
** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker and trainee set at 1E-5, for residents and ranch workers set at 1E-6
*** Methylene chloride target risk is set at a very low value, based on current emision rates <1% of total risk. As an example, if target risk was arbitrarily set as 1%, E-300 COC would be 456 ppbv.

Table B-3
Calculation of Risks and Allowable Air Concentrations
Antelope Ridge Ranch Worker Scenario
Current Permit Approach
Waste Isolation Pilot Plant (WIPP)

"Forward" Risk Calculations (i.e., Risks) Based on E-300 Monitoring Station

equation 1:
$$COC = E300 * \left(\frac{MW}{24.45} \right)$$

equation 2:
$$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust-typ}} \right)$$

equation 3:
$$R_{con} = ECS_{act} * ADF$$

equation 4:
$$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

equation 5:
$$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

equation 6:
$$Percent\ Risk = \frac{Chemical\ Risk}{Total\ Risk} * 100$$

E-300 = Concentration at the air monitoring point (ppbv)
MW = Molecular Weight of the VOC (g/mole)
COC = Concentration of concern at E-300 Monitoring Station (ug/m^3)
V_{panel} = Mine ventilation panel rate (130,000 ft^3/min)
$V_{exhaust-typ}$ = typical mine ventilation exhaust rate, (425,000 ft^3/min)
ECS_{act} = Actual exhaust shaft concentration for VOC (ug/m^3)
ADF = Air dispersion factor, unitless
Rcon = Receptor concentration (ug/m^3)

AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
URF = Unit risk factor for VOC (m^3/ug)$^{-1}$
RfC = Reference concentration (mg/m^3)
EF = Exposure frequency (hours/year)
ED = Exposure duration, years (35 years)
$Risk_{ind}$ = per chemical cancer risk (unitless)
$Risk_{cum}$ = cumulative cancer risks for all chemicals combined (unitless)

Risks and Hazards Based on Current E-300 Limits, Toxicity Values from the Permit, Original ADF

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient* (unitless)	Percent of Total Risk
Carbon Tetrachloride	165	153.84	1038	130,000	425,000	317.56	6.70E-05	0.021	613200		1.5E-05		2080	35	3.79E-08		19
Chlorobenzene	220	112.56	1013	130,000	425,000	309.80	6.70E-05	0.021		306600		2.0E-02	2080	35		2.46E-04	
Chloroform	180	119.39	879	130,000	425,000	268.85	6.70E-05	0.018	613200		2.3E-05		2080	35	4.92E-08		24
1,1-Dichloroethene	100	96.95	397	130,000	425,000	121.29	6.70E-05	0.0081	613200		5.0E-05		2080	35	4.82E-08		24
1,2-Dichloroethane	45	98.97	182	130,000	425,000	55.72	6.70E-05	0.0037	613200		2.6E-05		2080	35	1.15E-08		6
Methylene Chloride	1930	84.94	6705	130,000	425,000	2050.90	6.70E-05	0.14	613200		4.7E-07		2080	35	7.67E-09		4
1,1,2,2-Tetrachloroethane	50	167.86	343	130,000	425,000	105.00	6.70E-05	0.0070	613200		5.8E-05		2080	35	4.84E-08		24
Toluene	190	92.13	716	130,000	425,000	218.99	6.70E-05	0.015		306600		4.0E-01	2080	35		8.71E-06	
1,1,1-Trichloroethane	590	133.42	3220	130,000	425,000	984.80	6.70E-05	0.066		306600		7.0E-01	2080	35		2.24E-05	
														Cumulative	**2.0E-07**	**2.8E-04**	100

* Consistent with the approach used in the permit, non-cancer hazard quotients were only calculated for chemicals with no available URF values.

Risks and Hazards Based on Current Measured Concentrations at E-300 Drift Monitoring Station, Current Toxicity Values, new ADF*

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient (unitless)	Percent of Total Risk
Carbon Tetrachloride	108.73	153.84	684	130,000	425,000	209.26	6.72E-04	0.14	613200	306600	6.0E-06	1.00E-01	2080	35	1E-07	0.000334	78
Chlorobenzene	0	112.56	0	130,000	425,000	0	6.72E-04	0	613200	306600		5.0E-02	2080	35		0	
Chloroform	10.46	119.39	51	130,000	425,000	15.62	6.72E-04	0.010	613200	306600	2.3E-05	9.8E-02	2080	35	2.87E-08	2.54E-05	22
1,1-Dichloroethene**	0	96.95	0	130,000	425,000	0	6.72E-04	0	613200	306600		2.0E-01	2080	35		0	
1,2-Dichloroethane	0	98.97	0	130,000	425,000	0	6.72E-04	0	613200	306600	2.6E-05	2.4E+00	2080	35	0	0	0
Methylene Chloride	1.99	84.94	7	130,000	425,000	2.11	6.72E-04	0.0014	613200	306600	4.7E-07	1.0E+00	2080	35	7.93E-11	3.37E-07	0.06
1,1,2,2-Tetrachloroethane	0	167.86	0	130,000	425,000	0	6.72E-04	0	613200	306600	5.8E-05		2080	35	0		0
Toluene	0.01	92.13	0.038	130,000	425,000	0.012	6.72E-04	0.0000077	613200	306600		5.0E+00	2080	35		3.68E-10	
1,1,1-Trichloroethane	17.56	133.42	96	130,000	425,000	29.31	6.72E-04	0.0197	613200	306600		5.0E+00	2080	35		9.35E-07	
														Cumulative	1.3E-07	**2.7E-05**	100

* ADF was calculated at the point of maximum impact in the Antelope Ridge Alottment, assuming 45 degree vent angle, no additional stack height, and vent usage of 20% vents 1 & 2, 80% highest impact of vents 1 & 3 or vents 2 & 3
** USEPA has withdrawn the URF for 1,1-DCE; inhalation evaluated based on non-cancer effects.

Table B-3
Calculation of Risks and Allowable Air Concentrations
Antelope Ridge Ranch Worker Scenario
Current Permit Approach
Waste Isolation Pilot Plant (WIPP)

"Reverse" Risk Calculations (i.e., Allowable Air Concentrations at E-300 Monitoring Station) Based on Target Risk Levels

equation 7: $$Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$$

equation 8: $$R_{con} = \frac{Risk * AT_c}{URF * EF * ED}$$

equation 9: $$ECS_{act} = \frac{R_{con}}{ADF}$$

equation 10: $$COC = ECS_{act} * \left(\frac{V_{exhaust-typ}}{V_{panel}}\right)$$

equation 11: $$E300 = COC * \left(\frac{24.45}{MW}\right)$$

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based on Original Permit Assumptions

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)
Carbon Tetrachloride	1.0E-06	1.87E-07	613200		1.5E-05		2080	35	0.10	6.70E-05	1564.74	130,000	425,000	5116	153.84	813
Chlorobenzene				306600		2.0E-02	2080	35		6.70E-05		130,000	425,000		112.56	*
Chloroform	1.0E-06	2.42E-07	613200		2.3E-05		2080	35	0.089	6.70E-05	1324.74	130,000	425,000	4331	119.39	887
1,1-Dichloroethene	1.0E-06	2.38E-07	613200		5.0E-05		2080	35	0.040	6.70E-05	597.64	130,000	425,000	1954	96.95	493
1,2-Dichloroethane	1.0E-06	5.68E-08	613200		2.6E-05		2080	35	0.018	6.70E-05	274.54	130,000	425,000	898	98.97	222
Methylene Chloride	1.0E-06	3.78E-08	613200		4.7E-07		2080	35	0.68	6.70E-05	10105.54	130,000	425,000	33037	84.94	9510
1,1,2,2-Tetrachloroethane	1.0E-06	2.39E-07	613200		5.8E-05		2080	35	0.035	6.70E-05	517.38	130,000	425,000	1691	167.86	246
Toluene				306600		4.0E-01	2080	35		6.70E-05		130,000	425,000		92.13	*
1,1,1-Trichloroethane				306600		7.0E-01	2080	35		6.70E-05		130,000	425,000		133.42	*

Current Limits (ppbv)
165
220
180
100
45
1930
50
190
590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker set at 1E-5, for residents and ranch workers set at 1E-6

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based Re-apportionment of Risk to Reflect Current Conditions, New Toxicity Values, New ADF

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)
Carbon Tetrachloride	1.0E-06	7.77E-07	613200	306600	6.0E-06	1.00E-01	2080	35	1.09	6.72E-04	1623.22	130,000	425,000	5307	153.84	843
Chlorobenzene			613200	306600		5.0E-02	2080	35		6.72E-04		130,000	425,000		112.56	*
Chloroform	1.0E-06	2.22E-07	613200	306600	2.3E-05	9.8E-02	2080	35	0.081	6.72E-04	121.19	130,000	425,000	396	119.39	81
1,1-Dichloroethene			613200	306600		2.0E-01	2080	35		6.72E-04		130,000	425,000		96.95	*
1,2-Dichloroethane	1.0E-06	0	613200	306600	2.6E-05	2.4E+00	2080	35	0	6.72E-04	0	130,000	425,000	0	98.97	0
Methylene Chloride***	1.0E-06	6.15E-10	613200	87600	4.7E-07	1.0E+00	2080	35	0.011	6.72E-04	16.40	130,000	425,000	54	84.94	15
1,1,2,2-Tetrachloroethane	1.0E-06	0	613200	306600	5.8E-05		2080	35	0	6.72E-04	0	130,000	425,000	0	167.86	0
Toluene			613200	306600		5.0E+00	2080	35		6.72E-04		130,000	425,000		92.13	*
1,1,1-Trichloroethane			613200	306600		5.0E+00	2080	35		6.72E-04		130,000	425,000		133.42	*

Current Limits (ppbv)
165
220
180
100
45
1930
50
190
590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker and trainee set at 1E-5, for residents and ranch workers set at 1E-6

*** Methylene chloride target risk is set at a very low value, based on current emision rates <1% of total risk. As an example, if target risk was arbitrarily set as 1%, E-300 COC would be 251 ppbv.

Table B-4
Calculation of Risks and Allowable Air Concentrations
Livingston Ridge Ranch Worker Scenario
Current Permit Approach
Waste Isolation Pilot Plant (WIPP)

"Forward" Risk Calculations (i.e., Risks) Based on E-300 Monitoring Station

equation 1: $$COC = E300 * \left(\frac{MW}{24.45}\right)$$

equation 2: $$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust-typ}}\right)$$

equation 3: $$R_{con} = ECS_{act} * ADF$$

equation 4: $$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

equation 5: $$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

equation 6: $$Percent\ Risk = \frac{Chemical\ Risk}{Total\ Risk} * 100$$

E-300 = Concentration at the air monitoring point (ppbv)
MW = Molecular Weight of the VOC (g/mole)
COC = Concentration of concern at E-300 Monitoring Station (ug/m^3)
V_{panel} = Mine ventilation panel rate (130,000 ft^3/min)
$V_{exhaust-typ}$ = typical mine ventilation exhaust rate, (425,000 ft^3/min)
ECS_{act} = Actual exhaust shaft concentration for VOC (ug/m^3)
ADF = Air dispersion factor, unitless
Rcon = Receptor concentration (ug/m^3)

AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
URF = Unit risk factor for VOC (m^3/ug)$^{-1}$
RfC = Reference concentration (mg/m^3)
EF = Exposure frequency (hours/year)
ED = Exposure duration, years (35 years)
$Risk_{ind}$ = per chemical cancer risk (unitless)
$Risk_{cum}$ = cumulative cancer risks for all chemicals combined (unitless)

Risks and Hazards Based on Current E-300 Limits, Toxicity Values from the Permit, Original ADF

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient* (unitless)	Percent of Total Risk
Carbon Tetrachloride	165	153.84	1038	130,000	425,000	317.56	9.80E-05	0.031	613200		1.5E-05		2080	35	5.54E-08		19
Chlorobenzene	220	112.56	1013	130,000	425,000	309.80	9.80E-05	0.030		306600		2.0E-02	2080	35		3.60E-04	
Chloroform	180	119.39	879	130,000	425,000	268.85	9.80E-05	0.026	613200		2.3E-05		2080	35	7.19E-08		24
1,1-Dichloroethene	100	96.95	397	130,000	425,000	121.29	9.80E-05	0.012	613200		5.0E-05		2080	35	7.06E-08		24
1,2-Dichloroethane	45	98.97	182	130,000	425,000	55.72	9.80E-05	0.0055	613200		2.6E-05		2080	35	1.69E-08		6
Methylene Chloride	1930	84.94	6705	130,000	425,000	2050.90	9.80E-05	0.20	613200		4.7E-07		2080	35	1.12E-08		4
1,1,2,2-Tetrachloroethane	50	167.86	343	130,000	425,000	105.00	9.80E-05	0.010	613200		5.8E-05		2080	35	7.09E-08		24
Toluene	190	92.13	716	130,000	425,000	218.99	9.80E-05	0.021		306600		4.0E-01	2080	35		1.27E-05	
1,1,1-Trichloroethane	590	133.42	3220	130,000	425,000	984.80	9.80E-05	0.10		306600		7.0E-01	2080	35		3.27E-05	
														Cumulative	**3.0E-07**	**4.1E-04**	100

* Consistent with the approach used in the permit, non-cancer hazard quotients were only calculated for chemicals with no available URF values.

Risks and Hazards Based on Current Measured Concentrations at E-300 Drift Monitoring Station, Current Toxicity Values, new ADF*

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient (unitless)	Percent of Total Risk
Carbon Tetrachloride	108.73	153.84	684	130,000	425,000	209.26	1.76E-04	0.037	613200	306600	6.0E-06	1.00E-01	2080	35	2.62E-08	8.75E-05	78
Chlorobenzene	0	112.56	0	130,000	425,000	0	1.76E-04	0	613200	306600		5.0E-02	2080	35		0	
Chloroform	10.46	119.39	51	130,000	425,000	15.62	1.76E-04	0.0027	613200	306600	2.3E-05	9.8E-02	2080	35	7.51E-09	6.66E-06	22
1,1-Dichloroethene**	0	96.95	0	130,000	425,000	0	1.76E-04	0	613200	306600		2.0E-01	2080	35		0	
1,2-Dichloroethane	0	98.97	0	130,000	425,000	0	1.76E-04	0	613200	306600	2.6E-05	2.4E+00	2080	35	0	0	0
Methylene Chloride	1.99	84.94	7	130,000	425,000	2.11	1.76E-04	0.00037	613200	306600	4.7E-07	1.0E+00	2080	35	2.08E-11	8.84E-08	0.06
1,1,2,2-Tetrachloroethane	0	167.86	0	130,000	425,000	0	1.76E-04	0	613200	306600	5.8E-05		2080	35	0		0
Toluene	0.01	92.13	0.038	130,000	425,000	0.012	1.76E-04	0.0000020	613200	306600		5.0E+00	2080	35		9.63E-11	
1,1,1-Trichloroethane	17.56	133.42	96	130,000	425,000	29.31	1.76E-04	0.0052	613200	306600		5.0E+00	2080	35		2.45E-07	
														Cumulative	**3.4E-08**	**7.0E-06**	100

* ADF was calculated at the point of maximum impact in the Livingstone Ridge Alottment, assuming 45 degree vent angle, no additional stack height, and vent usage of 20% vents 1 & 2, 80% highest impact of vents 1 & 3 or vents 2 & 3
** USEPA has withdrawn the URF for 1,1-DCE; inhalation evaluated based on non-cancer effects.

Table B-4
Calculation of Risks and Allowable Air Concentrations
Livingston Ridge Ranch Worker Scenario
Current Permit Approach
Waste Isolation Pilot Plant (WIPP)

"Reverse" Risk Calculations (i.e., Allowable Air Concentrations at E-300 Monitoring Station) Based on Target Risk Levels

equation 7:

$$Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$$

equation 8:

$$R_{con} = \frac{Risk * AT_c}{URF * EF * ED}$$

equation 9:

$$ECS_{act} = \frac{R_{con}}{ADF}$$

equation 10:

$$COC = ECS_{act} * \left(\frac{V_{exhaust-typ}}{V_{panel}} \right)$$

equation 11:

$$E300 = COC * \left(\frac{24.45}{MW} \right)$$

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based on Original Permit Assumptions

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	1.87E-07	613200		1.5E-05		2080	35	0.10	9.80E-05	1069.77	130,000	425,000	3497	153.84	556	165
Chlorobenzene				306600		2.0E-02	2080	35		9.80E-05		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.42E-07	613200		2.3E-05		2080	35	0.089	9.80E-05	905.69	130,000	425,000	2961	119.39	606	180
1,1-Dichloroethene	1.0E-06	2.38E-07	613200		5.0E-05		2080	35	0.040	9.80E-05	408.59	130,000	425,000	1336	96.95	337	100
1,2-Dichloroethane	1.0E-06	5.68E-08	613200		2.6E-05		2080	35	0.018	9.80E-05	187.70	130,000	425,000	614	98.97	152	45
Methylene Chloride	1.0E-06	3.78E-08	613200		4.7E-07		2080	35	0.68	9.80E-05	6908.89	130,000	425,000	22587	84.94	6502	1930
1,1,2,2-Tetrachloroethane	1.0E-06	2.39E-07	613200		5.8E-05		2080	35	0.035	9.80E-05	353.72	130,000	425,000	1156	167.86	168	50
Toluene				306600		4.0E-01	2080	35		9.80E-05		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane				306600		7.0E-01	2080	35		9.80E-05		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker set at 1E-5, for residents and ranch workers set at 1E-6

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based Re-apportionment of Risk to Reflect Current Conditions, New Toxicity Values, New ADF

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	7.77E-07	613200	306600	6.0E-06	1.00E-01	2080	35	1.09	1.76E-04	6197.75	130,000	425,000	20262	153.84	3220	165
Chlorobenzene			613200	306600		5.0E-02	2080	35		1.76E-04		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.22E-07	613200	306600	2.3E-05	9.8E-02	2080	35	0.081	1.76E-04	462.72	130,000	425,000	1513	119.39	310	180
1,1-Dichloroethene			613200	306600		2.0E-01	2080	35		1.76E-04		130,000	425,000		96.95	*	100
1,2-Dichloroethane	1.0E-06	0	613200	306600	2.6E-05	2.4E+00	2080	35	0	1.76E-04	0	130,000	425,000	0	98.97	0	45
Methylene Chloride***	1.0E-06	6.15E-10	613200	87600	4.7E-07	1.0E+00	2080	35	0.011	1.76E-04	62.63	130,000	425,000	205	84.94	59	1930
1,1,2,2-Tetrachloroethane	1.0E-06	0	613200	306600	5.8E-05		2080	35	0	1.76E-04	0	130,000	425,000	0	167.86	0	50
Toluene			613200	306600		5.0E+00	2080	35		1.76E-04		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane			613200	306600		5.0E+00	2080	35		1.76E-04		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker and trainee set at 1E-5, for residents and ranch workers set at 1E-6

*** Methylene chloride target risk is set at a very low value, based on current emision rates <1% of total risk. As an example, if target risk was arbitrarily set as 1%, E-300 COC would be 958 ppbv.

Table B-5
Calculation of Risks and Allowable Air Concentrations
Trainee Scenario - PPA
"Best Case" Approach
Waste Isolation Pilot Plant (WIPP)

"Forward" Risk Calculations (i.e., Risks) Based on E-300 Monitoring Station

equation 1: $$COC = E300 * \left(\frac{MW}{24.45}\right)$$

equation 2: $$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust-typ}}\right)$$

equation 3: $$R_{con} = ECS_{act} * ADF$$

equation 4: $$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

equation 5: $$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

equation 6: $$Percent\ Risk = \frac{Chemical\ Risk}{Total\ Risk} * 100$$

E-300 = Concentration at the air monitoring point (ppbv)
MW = Molecular Weight of the VOC (g/mole)
COC = Concentration of concern at E-300 Monitoring Station (ug/m^3)
V_{panel} = Mine ventilation panel rate (130,000 ft^3/min)
$V_{exhaust-typ}$ = typical mine ventilation exhaust rate (425,000 ft^3/min)
ECS_{act} = Actual exhaust shaft concentration for VOC (ug/m^3)
ADF = Air dispersion factor, unitless
Rcon = Receptor concentration (ug/m^3)

AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
URF = Unit risk factor for VOC (m^3/ug)$^{-1}$
RfC = Reference concentration (mg/m^3)
EF = Exposure frequency (hours/year)
ED = Exposure duration, years (10 years)
$Risk_{ind}$ = per chemical cancer risk (unitless)
$Risk_{cum}$ = cumulative cancer risks for all chemicals combined (unitless)

Risks and Hazards Based on Current Measured Concentrations at E-300 Drift Monitoring Station, Current Toxicity Values, new ADF*

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient (unitless)	Percent of Total Risk
Carbon Tetrachloride	108.73	153.84	684	130,000	425,000	209	8.69E-05	0.018	613200	87600	6.0E-06	1.00E-01	192	10	3.42E-10	3.99E-06	78
Chlorobenzene	0	112.56	0	130,000	425,000	0	8.69E-05	0	613200	87600		5.0E-02	192	10		0	
Chloroform	10.46	119.39	51	130,000	425,000	16	8.69E-05	0.0014	613200	87600	2.3E-05	9.8E-02	192	10	9.78E-11	3.04E-07	22
1,1-Dichloroethene**	0	96.95	0	130,000	425,000	0	8.69E-05	0	613200	87600		2.0E-01	192	10		0	
1,2-Dichloroethane	0	98.97	0	130,000	425,000	0	8.69E-05	0	613200	87600	2.6E-05	2.4E+00	192	10	0	0	0
Methylene Chloride	1.99	84.94	7	130,000	425,000	2.1	8.69E-05	0.00018	613200	87600	4.7E-07	1.0E+00	192	10	2.70E-13	4.03E-09	0.06
1,1,2,2-Tetrachloroethane	0	167.86	0	130,000	425,000	0	8.69E-05	0	613200	87600	5.8E-05		192	10	0		0
Toluene	0.01	92.13	0.038	130,000	425,000	0.012	8.69E-05	0.0000010	613200	87600		5.0E+00	192	10		4.39E-12	
1,1,1-Trichloroethane	17.56	133.42	96	130,000	425,000	29	8.69E-05	0.00	613200	87600		5.0E+00	192	10		1.12E-08	
														Cumulative	**4.4E-10**	**3.2E-07**	100

* ADF was calculated at the point of maximum impact in the PPA, assuming vertical vent orientation, 50 ft additional stack height, and vent usage of 20% vents 1 & 2, 80% highest impact of vents 1 & 3 or vents 2 & 3
** USEPA has withdrawn the URF for 1,1-DCE; inhalation evaluated based on non-cancer effects.

"Reverse" Risk Calculations (i.e., Allowable Air Concentrations at E-300 Monitoring Station) Based on Target Risk Levels

equation 7: $$Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$$

equation 8: $$R_{con} = \frac{Risk * AT_c}{URF * EF * ED}$$

equation 9: $$ECS_{act} = \frac{R_{con}}{ADF}$$

equation 10: $$COC = ECS_{act} * \left(\frac{V_{exhaust-typ}}{V_{panel}}\right)$$

equation 11: $$E300 = COC * \left(\frac{24.45}{MW}\right)$$

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based Re-apportionment of Risk to Reflect Current Conditions, New Toxicity Values, New ADF

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-05	7.77E-06	613200	87600	6.0E-06	1.00E-01	192	10	414	8.69E-05	4759451	130,000	425,000	15559744	153.84	2472931	165
Chlorobenzene			613200	87600		5.0E-02	192	10		8.69E-05		130,000	425,000		112.56	*	220
Chloroform	1.0E-05	2.22E-06	613200	87600	2.3E-05	9.8E-02	192	10	31	8.69E-05	355335	130,000	425,000	1161672	119.39	237900	180
1,1-Dichloroethene			613200	87600		2.0E-01	192	10		8.69E-05		130,000	425,000		96.95	*	100
1,2-Dichloroethane	1.0E-05	0	613200	87600	2.6E-05	2.4E+00	192	10	0	8.69E-05	0	130,000	425,000	0	98.97	0	45
Methylene Chloride	1.0E-05	6.15E-09	613200	87600	4.7E-07	1.0E+00	192	10	4.2	8.69E-05	48095	130,000	425,000	157235	84.94	45260	1930
1,1,2,2-Tetrachloroethane	1.0E-05	0	613200	87600	5.8E-05		192	10	0	8.69E-05	0	130,000	425,000	0	167.86	0	50
Toluene			613200	87600		5.0E+00	192	10		8.69E-05		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane			613200	87600		5.0E+00	192	10		8.69E-05		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.
** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker and trainee set at 1E-5, for residents and ranch workers set at 1E-6

Table B-6
Calculation of Risks and Allowable Air Concentrations
Off-Site Resident Scenario - Mills Ranch
"Best Case" Approach
Waste Isolation Pilot Plant (WIPP)

"Forward" Risk Calculations (i.e., Risks) Based on E-300 Monitoring Station

equation 1:
$$COC = E300 * \left(\frac{MW}{24.45}\right)$$

equation 2:
$$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust\text{-}typ}}\right)$$

equation 3:
$$R_{con} = ECS_{act} * ADF$$

equation 4:
$$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

equation 5:
$$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

equation 6:
$$Percent\ Risk = \frac{Chemical\ Risk}{Total\ Risk} * 100$$

E-300 = Concentration at the air monitoring point (ppbv)
MW = Molecular Weight of the VOC (g/mole)
COC = Concentration of concern at E-300 Monitoring Station (ug/m^3)
V_{panel} = Mine ventilation panel rate (130,000 ft^3/min)
$V_{exhaust\text{-}typ}$ = typical mine ventilation exhaust rate, (425,000 ft^3/min)
ECS_{act} = Actual exhaust shaft concentration for VOC (ug/m^3)
ADF = Air dispersion factor, unitless
Rcon = Receptor concentration (ug/m^3)

AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
URF = Unit risk factor for VOC (m^3/ug)$^{-1}$
RfC = Reference concentration (mg/m^3)
EF = Exposure frequency (hours/year)
ED = Exposure duration, years (35 years)
$Risk_{ind}$ = per chemical cancer risk (unitless)
$Risk_{cum}$ = cumulative cancer risks for all chemicals combined (unitless)

Risks and Hazards Based on Current E-300 Limits, Toxicity Values from the Permit, Original ADF

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust\text{-}typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient* (unitless)	Percent of Total Risk
Carbon Tetrachloride	165	153.84	1038	130,000	425,000	317.56	1.20E-04	0.038	613200		1.5E-05		8760	35	2.86E-07		19
Chlorobenzene	220	112.56	1013	130,000	425,000	309.80	1.20E-04	0.037		306600		2.0E-02	8760	35		1.86E-03	
Chloroform	180	119.39	879	130,000	425,000	268.85	1.20E-04	0.032	613200		2.3E-05		8760	35	3.71E-07		24
1,1-Dichloroethene	100	96.95	397	130,000	425,000	121.29	1.20E-04	0.015	613200		5.0E-05		8760	35	3.64E-07		24
1,2-Dichloroethane	45	98.97	182	130,000	425,000	55.72	1.20E-04	0.0067	613200		2.6E-05		8760	35	8.69E-08		6
Methylene Chloride	1930	84.94	6705	130,000	425,000	2050.90	1.20E-04	0.25	613200		4.7E-07		8760	35	5.78E-08		4
1,1,2,2-Tetrachloroethane	50	167.86	343	130,000	425,000	105.00	1.20E-04	0.013	613200		5.8E-05		8760	35	3.65E-07		24
Toluene	190	92.13	716	130,000	425,000	218.99	1.20E-04	0.026		306600		4.0E-01	8760	35		6.57E-05	
1,1,1-Trichloroethane	590	133.42	3220	130,000	425,000	984.80	1.20E-04	0.12		306600		7.0E-01	8760	35		1.69E-04	
														Cumulative	**1.5E-06**	**2.1E-03**	100

* Consistent with the approach used in the permit, non-cancer hazard quotients were only calculated for chemicals with no available URF values.

Risks and Hazards Based on Current Measured Concentrations at E-300 Drift Monitoring Station, Current Toxicity Values, new ADF*

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust\text{-}typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient (unitless)	Percent of Total Risk
Carbon Tetrachloride	108.73	153.84	684	130,000	425,000	209.26	6.47E-06	0.0014	613200	306600	6.0E-06	1.00E-01	8760	35	4.06E-09	1.35E-05	78
Chlorobenzene	0	112.56	0	130,000	425,000	0	6.47E-06	0	613200	306600		5.0E-02	8760	35		0	
Chloroform	10.46	119.39	51	130,000	425,000	15.62	6.47E-06	0.00010	613200	306600	2.3E-05	9.8E-02	8760	35	1.16E-09	1.03E-06	22
1,1-Dichloroethene**	0	96.95	0	130,000	425,000	0	6.47E-06	0	613200	306600		2.0E-01	8760	35		0	
1,2-Dichloroethane	0	98.97	0	130,000	425,000	0	6.47E-06	0	613200	306600	2.6E-05	2.4E+00	8760	35	0	0	0
Methylene Chloride	1.99	84.94	7	130,000	425,000	2.11	6.47E-06	0.000014	613200	306600	4.7E-07	1.0E+00	8760	35	3.22E-12	1.37E-08	0.06
1,1,2,2-Tetrachloroethane	0	167.86	0	130,000	425,000	0	6.47E-06	0	613200	306600	5.8E-05		8760	35	0		0
Toluene	0.01	92.13	0.038	130,000	425,000	0.012	6.47E-06	0.000000075	613200	306600		5.0E+00	8760	35		1.49E-11	
1,1,1-Trichloroethane	17.56	133.42	96	130,000	425,000	29.31	6.47E-06	0.00019	613200	306600		5.0E+00	8760	35		3.79E-08	
														Cumulative	**5.2E-09**	**1.1E-06**	100

* ADF was calculated at the point of maximum impact off-property, assuming vertical vent orientation, 50 ft additional stack height, and vent usage of 20% vents 1 & 2, 80% highest impact of vents 1 & 3 or vents 2 & 3

** USEPA has withdrawn the URF for 1,1-DCE; inhalation evaluated based on non-cancer effects.

Table B-6
Calculation of Risks and Allowable Air Concentrations
Off-Site Resident Scenario - Mills Ranch
"Best Case" Approach
Waste Isolation Pilot Plant (WIPP)

"Reverse" Risk Calculations (i.e., Allowable Air Concentrations at E-300 Monitoring Station) Based on Target Risk Levels

equation 7: $Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$

equation 8: $R_{con} = \dfrac{Risk * AT_c}{URF * EF * ED}$

equation 9: $ECS_{act} = \dfrac{R_{con}}{ADF}$

equation 10: $COC = ECS_{act} * \left(\dfrac{V_{exhaust-typ}}{V_{panel}} \right)$

equation 11: $E300 = COC * \left(\dfrac{24.45}{MW} \right)$

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based on Original Permit Assumptions

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	1.87E-07	613200		1.5E-05		8760	35	0.025	1.20E-04	207.44	130,000	425,000	678	153.84	108	165
Chlorobenzene				306600		2.0E-02	8760	35		1.20E-04		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.42E-07	613200		2.3E-05		8760	35	0.021	1.20E-04	175.62	130,000	425,000	574	119.39	118	180
1,1-Dichloroethene	1.0E-06	2.38E-07	613200		5.0E-05		8760	35	0.010	1.20E-04	79.23	130,000	425,000	259	96.95	65	100
1,2-Dichloroethane	1.0E-06	5.68E-08	613200		2.6E-05		8760	35	0.0044	1.20E-04	36.40	130,000	425,000	119	98.97	29	45
Methylene Chloride	1.0E-06	3.78E-08	613200		4.7E-07		8760	35	0.16	1.20E-04	1339.71	130,000	425,000	4380	84.94	1261	1930
1,1,2,2-Tetrachloroethane	1.0E-06	2.39E-07	613200		5.8E-05		8760	35	0.0082	1.20E-04	68.59	130,000	425,000	224	167.86	33	50
Toluene				306600		4.0E-01	8760	35		1.20E-04		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane				306600		7.0E-01	8760	35		1.20E-04		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker set at 1E-5, for residents and ranch workers set at 1E-6

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based Re-apportionment of Risk to Reflect Current Conditions, New Toxicity Values, New ADF

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	7.77E-07	613200	306600	6.0E-06	1.00E-01	8760	35	0.26	6.47E-06	40031.46	130,000	425,000	130872	153.84	20800	165
Chlorobenzene			613200	306600		5.0E-02	8760	35		6.47E-06		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.22E-07	613200	306600	2.3E-05	9.8E-02	8760	35	0.019	6.47E-06	2988.70	130,000	425,000	9771	119.39	2001	180
1,1-Dichloroethene			613200	306600		2.0E-01	8760	35		6.47E-06		130,000	425,000		96.95	*	100
1,2-Dichloroethane	1.0E-06	0	613200	306600	2.6E-05	2.4E+00	8760	35	0	6.47E-06	0	130,000	425,000	0	98.97	0	45
Methylene Chloride***	1.0E-06	6.15E-10	613200	87600	4.7E-07	1.0E+00	8760	35	0.0026	6.47E-06	404.53	130,000	425,000	1322	84.94	381	1930
1,1,2,2-Tetrachloroethane	1.0E-06	0	613200	306600	5.8E-05		8760	35	0	6.47E-06	0	130,000	425,000	0	167.86	0	50
Toluene			613200	306600		5.0E+00	8760	35		6.47E-06		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane			613200	306600		5.0E+00	8760	35		6.47E-06		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker and trainee set at 1E-5, for residents and ranch workers set at 1E-6

Table B-7
Calculation of Risks and Allowable Air Concentrations
Off-Site Resident Scenario - Smith Ranch
"Best Case" Approach
Waste Isolation Pilot Plant (WIPP)

"Forward" Risk Calculations (i.e., Risks) Based on E-300 Monitoring Station

equation 1:
$$COC = E300 * \left(\frac{MW}{24.45}\right)$$

equation 2:
$$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust-typ}}\right)$$

equation 3:
$$R_{con} = ECS_{act} * ADF$$

equation 4:
$$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

equation 5:
$$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

equation 6:
$$Percent\ Risk = \frac{Chemical\ Risk}{Total\ Risk} * 100$$

E-300 = Concentration at the air monitoring point (ppbv)
MW = Molecular Weight of the VOC (g/mole)
COC = Concentration of concern at E-300 Monitoring Station (ug/m^3)
V_{panel} = Mine ventilation panel rate (130,000 ft^3/min)
$V_{exhaust-typ}$ = typical mine ventilation exhaust rate, (425,000 ft^3/min)
ECS_{act} = Actual exhaust shaft concentration for VOC (ug/m^3)
ADF = Air dispersion factor, unitless
Rcon = Receptor concentration (ug/m^3)

AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
URF = Unit risk factor for VOC (m^3/ug)$^{-1}$
RfC = Reference concentration (mg/m^3)
EF = Exposure frequency (hours/year)
ED = Exposure duration, years (35 years)
$Risk_{ind}$ = per chemical cancer risk (unitless)
$Risk_{cum}$ = cumulative cancer risks for all chemicals combined (unitless)

Risks and Hazards Based on Current E-300 Limits, Toxicity Values from the Permit, Original ADF

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient* (unitless)	Percent of Total Risk
Carbon Tetrachloride	165	153.84	1038	130,000	425,000	317.56	1.20E-04	0.038	613200		1.5E-05		8760	35	2.86E-07		19
Chlorobenzene	220	112.56	1013	130,000	425,000	309.80	1.20E-04	0.037		306600		2.0E-02	8760	35		1.86E-03	
Chloroform	180	119.39	879	130,000	425,000	268.85	1.20E-04	0.032	613200		2.3E-05		8760	35	3.71E-07		24
1,1-Dichloroethene	100	96.95	397	130,000	425,000	121.29	1.20E-04	0.015	613200		5.0E-05		8760	35	3.64E-07		24
1,2-Dichloroethane	45	98.97	182	130,000	425,000	55.72	1.20E-04	0.0067	613200		2.6E-05		8760	35	8.69E-08		6
Methylene Chloride	1930	84.94	6705	130,000	425,000	2050.90	1.20E-04	0.25	613200		4.7E-07		8760	35	5.78E-08		4
1,1,2,2-Tetrachloroethane	50	167.86	343	130,000	425,000	105.00	1.20E-04	0.013	613200		5.8E-05		8760	35	3.65E-07		24
Toluene	190	92.13	716	130,000	425,000	218.99	1.20E-04	0.026		306600		4.0E-01	8760	35		6.57E-05	
1,1,1-Trichloroethane	590	133.42	3220	130,000	425,000	984.80	1.20E-04	0.12		306600		7.0E-01	8760	35		1.69E-04	
														Cumulative	**1.5E-06**	**2.1E-03**	100

* Consistent with the approach used in the permit, non-cancer hazard quotients were only calculated for chemicals with no available URF values.

Risks and Hazards Based on Current Measured Concentrations at E-300 Drift Monitoring Station, Current Toxicity Values, new ADF*

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient (unitless)	Percent of Total Risk
Carbon Tetrachloride	108.73	153.84	684	130,000	425,000	209.26	8.89E-06	0.0019	613200	306600	6.0E-06	1.00E-01	8760	35	5.58E-09	1.86E-05	78
Chlorobenzene	0	112.56	0	130,000	425,000	0	8.89E-06	0	613200	306600		5.0E-02	8760	35		0	
Chloroform	10.46	119.39	51	130,000	425,000	15.62	8.89E-06	0.00014	613200	306600	2.3E-05	9.8E-02	8760	35	1.60E-09	1.42E-06	22
1,1-Dichloroethene**	0	96.95	0	130,000	425,000	0	8.89E-06	0	613200	306600		2.0E-01	8760	35		0	
1,2-Dichloroethane	0	98.97	0	130,000	425,000	0	8.89E-06	0	613200	306600	2.6E-05	2.4E+00	8760	35	0	0	0
Methylene Chloride	1.99	84.94	7	130,000	425,000	2.11	8.89E-06	0.000019	613200	306600	4.7E-07	1.0E+00	8760	35	4.42E-12	1.88E-08	0.06
1,1,2,2-Tetrachloroethane	0	167.86	0	130,000	425,000	0	8.89E-06	0	613200	306600	5.8E-05		8760	35	0		0
Toluene	0.01	92.13	0.038	130,000	425,000	0.012	8.89E-06	0.00000010	613200	306600		5.0E+00	8760	35		2.05E-11	
1,1,1-Trichloroethane	17.56	133.42	96	130,000	425,000	29.31	8.89E-06	0.00026	613200	306600		5.0E+00	8760	35		5.21E-08	
														Cumulative	**7.2E-09**	**1.5E-06**	100

* ADF was calculated at the point of maximum impact off-property, assuming vertical vent orientation, 50 ft additional stack height, and vent usage of 20% vents 1 & 2, 40% vents 1 & 3, 80% highest impact of vents 1 & 3 or vents 2 & 3
** USEPA has withdrawn the URF for 1,1-DCE; inhalation evaluated based on non-cancer effects.

Table B-7
Calculation of Risks and Allowable Air Concentrations
Off-Site Resident Scenario - Smith Ranch
"Best Case" Approach
Waste Isolation Pilot Plant (WIPP)

"Reverse" Risk Calculations (i.e., Allowable Air Concentrations at E-300 Monitoring Station) Based on Target Risk Levels

equation 7: $$Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$$

equation 8: $$R_{con} = \frac{Risk * AT_c}{URF * EF * ED}$$

equation 9: $$ECS_{act} = \frac{R_{con}}{ADF}$$

equation 10: $$COC = ECS_{act} * \left(\frac{V_{exhaust-typ}}{V_{panel}}\right)$$

equation 11: $$E300 = COC * \left(\frac{24.45}{MW}\right)$$

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based on Original Permit Assumptions

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	1.87E-07	613200		1.5E-05		8760	35	0.025	1.20E-04	207.44	130,000	425,000	678	153.84	108	165
Chlorobenzene				306600		2.0E-02	8760	35		1.20E-04		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.42E-07	613200		2.3E-05		8760	35	0.021	1.20E-04	175.62	130,000	425,000	574	119.39	118	180
1,1-Dichloroethene	1.0E-06	2.38E-07	613200		5.0E-05		8760	35	0.010	1.20E-04	79.23	130,000	425,000	259	96.95	65	100
1,2-Dichloroethane	1.0E-06	5.68E-08	613200		2.6E-05		8760	35	0.0044	1.20E-04	36.40	130,000	425,000	119	98.97	29	45
Methylene Chloride	1.0E-06	3.78E-08	613200		4.7E-07		8760	35	0.16	1.20E-04	1339.71	130,000	425,000	4380	84.94	1261	1930
1,1,2,2-Tetrachloroethane	1.0E-06	2.39E-07	613200		5.8E-05		8760	35	0.0082	1.20E-04	68.59	130,000	425,000	224	167.86	33	50
Toluene				306600		4.0E-01	8760	35		1.20E-04		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane				306600		7.0E-01	8760	35		1.20E-04		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker set at 1E-5, for residents and ranch workers set at 1E-6

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based Re-apportionment of Risk to Reflect Current Conditions, New Toxicity Values, New ADF

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	7.77E-07	613200	306600	6.0E-06	1.00E-01	8760	35	0.26	8.89E-06	29134.26	130,000	425,000	95247	153.84	15138	165
Chlorobenzene			613200	306600		5.0E-02	8760	35		8.89E-06		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.22E-07	613200	306600	2.3E-05	9.8E-02	8760	35	0.019	8.89E-06	2175.13	130,000	425,000	7111	119.39	1456	180
1,1-Dichloroethene			613200	306600		2.0E-01	8760	35		8.89E-06		130,000	425,000		96.95	*	100
1,2-Dichloroethane	1.0E-06	0	613200	306600	2.6E-05	2.4E+00	8760	35	0	8.89E-06	0	130,000	425,000	0	98.97	0	45
Methylene Chloride***	1.0E-06	6.15E-10	613200	87600	4.7E-07	1.0E+00	8760	35	0.0026	8.89E-06	294.41	130,000	425,000	962	84.94	277	1930
1,1,2,2-Tetrachloroethane	1.0E-06	0	613200	306600	5.8E-05		8760	35	0	8.89E-06	0	130,000	425,000	0	167.86	0	50
Toluene			613200	306600		5.0E+00	8760	35		8.89E-06		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane			613200	306600		5.0E+00	8760	35		8.89E-06		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker and trainee set at 1E-5, for residents and ranch workers set at 1E-6

Table B-8
Calculation of Risks and Allowable Air Concentrations
Antelope Ridge Ranch Worker Scenario
"Best Case" Approach
Waste Isolation Pilot Plant (WIPP)

"Forward" Risk Calculations (i.e., Risks) Based on E-300 Monitoring Station

equation 1: $$COC = E300 * \left(\frac{MW}{24.45}\right)$$

equation 2: $$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust-typ}}\right)$$

equation 3: $$R_{con} = ECS_{act} * ADF$$

equation 4: $$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

equation 5: $$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

equation 6: $$Percent\ Risk = \frac{Chemical\ Risk}{Total\ Risk} * 100$$

E-300 = Concentration at the air monitoring point (ppbv)
MW = Molecular Weight of the VOC (g/mole)
COC = Concentration of concern at E-300 Monitoring Station (ug/m^3)
V_{panel} = Mine ventilation panel rate (130,000 ft^3/min)
$V_{exhaust-typ}$ = typical mine ventilation exhaust rate, (425,000 ft^3/min)
ECS_{act} = Actual exhaust shaft concentration for VOC (ug/m^3)
ADF = Air dispersion factor, unitless
Rcon = Receptor concentration (ug/m^3)

AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
URF = Unit risk factor for VOC (m^3/ug)$^{-1}$
RfC = Reference concentration (mg/m^3)
EF = Exposure frequency (hours/year)
ED = Exposure duration, years (35 years)
$Risk_{ind}$ = per chemical cancer risk (unitless)
$Risk_{cum}$ = cumulative cancer risks for all chemicals combined (unitless)

Risks and Hazards Based on Current E-300 Limits, Toxicity Values from the Permit, Original ADF

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient* (unitless)	Percent of Total Risk
Carbon Tetrachloride	165	153.84	1038	130,000	425,000	317.56	6.70E-05	0.021	613200		1.5E-05		2080	35	3.79E-08		19
Chlorobenzene	220	112.56	1013	130,000	425,000	309.80	6.70E-05	0.021		306600		2.0E-02	2080	35		2.46E-04	
Chloroform	180	119.39	879	130,000	425,000	268.85	6.70E-05	0.018	613200		2.3E-05		2080	35	4.92E-08		24
1,1-Dichloroethene	100	96.95	397	130,000	425,000	121.29	6.70E-05	0.0081	613200		5.0E-05		2080	35	4.82E-08		24
1,2-Dichloroethane	45	98.97	182	130,000	425,000	55.72	6.70E-05	0.0037	613200		2.6E-05		2080	35	1.15E-08		6
Methylene Chloride	1930	84.94	6705	130,000	425,000	2050.90	6.70E-05	0.14	613200		4.7E-07		2080	35	7.67E-09		4
1,1,2,2-Tetrachloroethane	50	167.86	343	130,000	425,000	105.00	6.70E-05	0.0070	613200		5.8E-05		2080	35	4.84E-08		24
Toluene	190	92.13	716	130,000	425,000	218.99	6.70E-05	0.015		306600		4.0E-01	2080	35		8.71E-06	
1,1,1-Trichloroethane	590	133.42	3220	130,000	425,000	984.80	6.70E-05	0.066		306600		7.0E-01	2080	35		2.24E-05	
														Cumulative	**2.0E-07**	**2.8E-04**	100

* Consistent with the approach used in the permit, non-cancer hazard quotients were only calculated for chemicals with no available URF values.

Risks and Hazards Based on Current Measured Concentrations at E-300 Drift Monitoring Station, Current Toxicity Values, new ADF*

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient (unitless)	Percent of Total Risk
Carbon Tetrachloride	108.73	153.84	684	130,000	425,000	209.26	2.94E-04	0.062	613200	306600	6.0E-06	1.00E-01	2080	35	4.38E-08	0.000146	78
Chlorobenzene	0	112.56	0	130,000	425,000	0	2.94E-04	0	613200	306600		5.0E-02	2080	35		0	
Chloroform	10.46	119.39	51	130,000	425,000	15.62	2.94E-04	0.0046	613200	306600	2.3E-05	9.8E-02	2080	35	1.25E-08	1.11E-05	22
1,1-Dichloroethene**	0	96.95	0	130,000	425,000	0	2.94E-04	0	613200	306600		2.0E-01	2080	35		0	
1,2-Dichloroethane	0	98.97	0	130,000	425,000	0	2.94E-04	0	613200	306600	2.6E-05	2.4E+00	2080	35	0	0	0
Methylene Chloride	1.99	84.94	7	130,000	425,000	2.11	2.94E-04	0.00062	613200	306600	4.7E-07	1.0E+00	2080	35	3.47E-11	1.48E-07	0.06
1,1,2,2-Tetrachloroethane	0	167.86	0	130,000	425,000	0	2.94E-04	0	613200	306600	5.8E-05		2080	35	0		0
Toluene	0.01	92.13	0.038	130,000	425,000	0.012	2.94E-04	0.0000034	613200	306600		5.0E+00	2080	35		1.61E-10	
1,1,1-Trichloroethane	17.56	133.42	96	130,000	425,000	29.31	2.94E-04	0.0086	613200	306600		5.0E+00	2080	35		4.09E-07	
														Cumulative	**5.6E-08**	**1.2E-05**	100

* ADF was calculated at the point of maximum impact in the Antelope Ridge Alottment, assuming vertical vent orientation, 50 ft additional stack height, and vent usage of 20% vents 1 & 2, 80% highest impact of vents 1 & 3 or vents 2 & 3
** USEPA has withdrawn the URF for 1,1-DCE; inhalation evaluated based on non-cancer effects.

Table B-8
Calculation of Risks and Allowable Air Concentrations
Antelope Ridge Ranch Worker Scenario
"Best Case" Approach
Waste Isolation Pilot Plant (WIPP)

"Reverse" Risk Calculations (i.e., Allowable Air Concentrations at E-300 Monitoring Station) Based on Target Risk Levels

equation 7: $$Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$$

equation 8: $$R_{con} = \frac{Risk * AT_c}{URF * EF * ED}$$

equation 9: $$ECS_{act} = \frac{R_{con}}{ADF}$$

equation 10: $$COC = ECS_{act} * \left(\frac{V_{exhaust-typ}}{V_{panel}} \right)$$

equation 11: $$E300 = COC * \left(\frac{24.45}{MW} \right)$$

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based on Original Permit Assumptions

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	1.87E-07	613200		1.5E-05		2080	35	0.10	6.70E-05	1564.74	130,000	425,000	5116	153.84	813	165
Chlorobenzene				306600		2.0E-02	2080	35		6.70E-05		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.42E-07	613200		2.3E-05		2080	35	0.089	6.70E-05	1324.74	130,000	425,000	4331	119.39	887	180
1,1-Dichloroethene	1.0E-06	2.38E-07	613200		5.0E-05		2080	35	0.040	6.70E-05	597.64	130,000	425,000	1954	96.95	493	100
1,2-Dichloroethane	1.0E-06	5.68E-08	613200		2.6E-05		2080	35	0.018	6.70E-05	274.54	130,000	425,000	898	98.97	222	45
Methylene Chloride	1.0E-06	3.78E-08	613200		4.7E-07		2080	35	0.68	6.70E-05	10105.54	130,000	425,000	33037	84.94	9510	1930
1,1,2,2-Tetrachloroethane	1.0E-06	2.39E-07	613200		5.8E-05		2080	35	0.035	6.70E-05	517.38	130,000	425,000	1691	167.86	246	50
Toluene				306600		4.0E-01	2080	35		6.70E-05		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane				306600		7.0E-01	2080	35		6.70E-05		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker set at 1E-5, for residents and ranch workers set at 1E-6

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based Re-apportionment of Risk to Reflect Current Conditions, New Toxicity Values, New ADF

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	7.77E-07	613200	306600	6.0E-06	1.00E-01	2080	35	1.09	2.94E-04	3710.22	130,000	425,000	12130	153.84	1928	165
Chlorobenzene			613200	306600		5.0E-02	2080	35		2.94E-04		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.22E-07	613200	306600	2.3E-05	9.8E-02	2080	35	0.081	2.94E-04	277.00	130,000	425,000	906	119.39	185	180
1,1-Dichloroethene			613200	306600		2.0E-01	2080	35		2.94E-04		130,000	425,000		96.95	*	100
1,2-Dichloroethane	1.0E-06	0	613200	306600	2.6E-05	2.4E+00	2080	35	0	2.94E-04	0	130,000	425,000	0	98.97	0	45
Methylene Chloride***	1.0E-06	6.15E-10	613200	87600	4.7E-07	1.0E+00	2080	35	0.011	2.94E-04	37.49	130,000	425,000	123	84.94	35	1930
1,1,2,2-Tetrachloroethane	1.0E-06	0	613200	306600	5.8E-05		2080	35	0	2.94E-04	0	130,000	425,000	0	167.86	0	50
Toluene			613200	306600		5.0E+00	2080	35		2.94E-04		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane			613200	306600		5.0E+00	2080	35		2.94E-04		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker and trainee set at 1E-5, for residents and ranch workers set at 1E-6

Table B-9
Calculation of Risks and Allowable Air Concentrations
Livingston Ridge Ranch Worker Scenario
"Best Case" Approach
Waste Isolation Pilot Plant (WIPP)

"Forward" Risk Calculations (i.e., Risks) Based on E-300 Monitoring Station

equation 1:
$$COC = E300 * \left(\frac{MW}{24.45}\right)$$

equation 2:
$$ECS_{act} = COC * \left(\frac{V_{panel}}{V_{exhaust-typ}}\right)$$

equation 3:
$$R_{con} = ECS_{act} * ADF$$

equation 4:
$$Cancer\ Risk = \frac{R_{con} * URF * EF * ED}{AT_c}$$

equation 5:
$$Hazard\ Quotient = \frac{R_{con} * EF * ED}{AT_{nc} * RfC * 1000}$$

equation 6:
$$Percent\ Risk = \frac{Chemical\ Risk}{Total\ Risk} * 100$$

E-300 = Concentration at the air monitoring point (ppbv)
MW = Molecular Weight of the VOC (g/mole)
COC = Concentration of concern at E-300 Monitoring Station (ug/m^3)
V_{panel} = Mine ventilation panel rate (130,000 ft^3/min)
$V_{exhaust-typ}$ = typical mine ventilation exhaust rate, (425,000 ft^3/min)
ECS_{act} = Actual exhaust shaft concentration for VOC (ug/m^3)
ADF = Air dispersion factor, unitless
Rcon = Receptor concentration (ug/m^3)

AT_c = Averaging time for carcinogens in hours (70 years total)
AT_{nc} = Averaging time for non-carcinogens in hours (based on Exposure Duration)
URF = Unit risk factor for VOC (m^3/ug)$^{-1}$
RfC = Reference concentration (mg/m^3)
EF = Exposure frequency (hours/year)
ED = Exposure duration, years (35 years)
$Risk_{ind}$ = per chemical cancer risk (unitless)
$Risk_{cum}$ = cumulative cancer risks for all chemicals combined (unitless)

Risks and Hazards Based on Current E-300 Limits, Toxicity Values from the Permit, Original ADF

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient* (unitless)	Percent of Total Risk
Carbon Tetrachloride	165	153.84	1038	130,000	425,000	317.56	9.80E-05	0.031	613200		1.5E-05		2080	35	5.54E-08		19
Chlorobenzene	220	112.56	1013	130,000	425,000	309.80	9.80E-05	0.030		306600		2.0E-02	2080	35		3.60E-04	
Chloroform	180	119.39	879	130,000	425,000	268.85	9.80E-05	0.026	613200		2.3E-05		2080	35	7.19E-08		24
1,1-Dichloroethene	100	96.95	397	130,000	425,000	121.29	9.80E-05	0.012	613200		5.0E-05		2080	35	7.06E-08		24
1,2-Dichloroethane	45	98.97	182	130,000	425,000	55.72	9.80E-05	0.0055	613200		2.6E-05		2080	35	1.69E-08		6
Methylene Chloride	1930	84.94	6705	130,000	425,000	2050.90	9.80E-05	0.20	613200		4.7E-07		2080	35	1.12E-08		4
1,1,2,2-Tetrachloroethane	50	167.86	343	130,000	425,000	105.00	9.80E-05	0.010	613200		5.8E-05		2080	35	7.09E-08		24
Toluene	190	92.13	716	130,000	425,000	218.99	9.80E-05	0.021		306600		4.0E-01	2080	35		1.27E-05	
1,1,1-Trichloroethane	590	133.42	3220	130,000	425,000	984.80	9.80E-05	0.10		306600		7.0E-01	2080	35		3.27E-05	
														Cumulative	**3.0E-07**	**4.1E-04**	100

* Consistent with the approach used in the permit, non-cancer hazard quotients were only calculated for chemicals with no available URF values.

Risks and Hazards Based on Current Measured Concentrations at E-300 Drift Monitoring Station, Current Toxicity Values, new ADF*

Chemical	E-300 (ppbv)	MW (g/mole)	COC (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	ECS_{act} (ug/m^3)	ADF (unitless)	Rcon (ug/m^3)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Cancer Risk (unitless)	Hazard Quotient (unitless)	Percent of Total Risk
Carbon Tetrachloride	108.73	153.84	684	130,000	425,000	209.26	9.66E-05	0.020	613200	306600	6.0E-06	1.00E-01	2080	35	1.44E-08	4.8E-05	78
Chlorobenzene	0	112.56	0	130,000	425,000	0	9.66E-05	0	613200	306600		5.0E-02	2080	35		0	
Chloroform	10.46	119.39	51	130,000	425,000	15.62	9.66E-05	0.0015	613200	306600	2.3E-05	9.8E-02	2080	35	4.12E-09	3.66E-06	22
1,1-Dichloroethene**	0	96.95	0	130,000	425,000	0	9.66E-05	0	613200	306600		2.0E-01	2080	35		0	
1,2-Dichloroethane	0	98.97	0	130,000	425,000	0	9.66E-05	0	613200	306600	2.6E-05	2.4E+00	2080	35	0	0	0
Methylene Chloride	1.99	84.94	7	130,000	425,000	2.11	9.66E-05	0.00020	613200	306600	4.7E-07	1.0E+00	2080	35	1.14E-11	4.85E-08	0.06
1,1,2,2-Tetrachloroethane	0	167.86	0	130,000	425,000	0	9.66E-05	0	613200	306600	5.8E-05		2080	35	0		0
Toluene	0.01	92.13	0.038	130,000	425,000	0.012	9.66E-05	0.0000011	613200	306600		5.0E+00	2080	35		5.29E-11	
1,1,1-Trichloroethane	17.56	133.42	96	130,000	425,000	29.31	9.66E-05	0.0028	613200	306600		5.0E+00	2080	35		1.34E-07	
														Cumulative	**1.9E-08**	**3.8E-06**	100

* ADF was calculated at the point of maximum impact in the Livingstone Ridge Alottment, assuming vertical vent orientation, 50 ft additional stack height, and vent usage of 20% vents 1 & 2, 80% highest impact of vents 1 & 3 or vents 2 & 3
** USEPA has withdrawn the URF for 1,1-DCE; inhalation evaluated based on non-cancer effects.

Table B-9
Calculation of Risks and Allowable Air Concentrations
Livingston Ridge Ranch Worker Scenario
"Best Case" Approach
Waste Isolation Pilot Plant (WIPP)

"Reverse" Risk Calculations (i.e., Allowable Air Concentrations at E-300 Monitoring Station) Based on Target Risk Levels

equation 7:

$$Risk_{ind} = Risk_{cum} * 0.01 * Percent\ Risk$$

equation 8:

$$R_{con} = \frac{Risk * AT_c}{URF * EF * ED}$$

equation 9:

$$ECS_{act} = \frac{R_{con}}{ADF}$$

equation 10:

$$COC = ECS_{act} * \left(\frac{V_{exhaust-typ}}{V_{panel}} \right)$$

equation 11:

$$E300 = COC * \left(\frac{24.45}{MW} \right)$$

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based on Original Permit Assumptions

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	1.87E-07	613200		1.5E-05		2080	35	0.10	9.80E-05	1069.77	130,000	425,000	3497	153.84	556	165
Chlorobenzene				306600		2.0E-02	2080	35		9.80E-05		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.42E-07	613200		2.3E-05		2080	35	0.089	9.80E-05	905.69	130,000	425,000	2961	119.39	606	180
1,1-Dichloroethene	1.0E-06	2.38E-07	613200		5.0E-05		2080	35	0.040	9.80E-05	408.59	130,000	425,000	1336	96.95	337	100
1,2-Dichloroethane	1.0E-06	5.68E-08	613200		2.6E-05		2080	35	0.018	9.80E-05	187.70	130,000	425,000	614	98.97	152	45
Methylene Chloride	1.0E-06	3.78E-08	613200		4.7E-07		2080	35	0.68	9.80E-05	6908.89	130,000	425,000	22587	84.94	6502	1930
1,1,2,2-Tetrachloroethane	1.0E-06	2.39E-07	613200		5.8E-05		2080	35	0.035	9.80E-05	353.72	130,000	425,000	1156	167.86	168	50
Toluene				306600		4.0E-01	2080	35		9.80E-05		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane				306600		7.0E-01	2080	35		9.80E-05		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker set at 1E-5, for residents and ranch workers set at 1E-6

Back-Calculated Concentration of Concern (COC) at E-300 Drift Monitoring Station, Based Re-apportionment of Risk to Reflect Current Conditions, New Toxicity Values, New ADF

Chemical	$Risk_{cum}$ (unitless)**	$Risk_{ind}$ (unitless)	ATc (hours)	ATnc (hours)	URF (m^3/ug)	RfC (mg/m^3)	EF (hrs/year)	ED (years)	Rcon (ug/m^3)	ADF (unitless)	ECS_{act} (ug/m^3)	V_{panel} (ft^3/min)	$V_{exhaust-typ}$ (ft^3/min)	COC (ug/m^3)	MW (g/mole)	E-300 COC (ppbv)	Current Limits (ppbv)
Carbon Tetrachloride	1.0E-06	7.77E-07	613200	306600	6.0E-06	1.00E-01	2080	35	1.09	9.66E-05	11291.96	130,000	425,000	36916	153.84	5867	165
Chlorobenzene			613200	306600		5.0E-02	2080	35		9.66E-05		130,000	425,000		112.56	*	220
Chloroform	1.0E-06	2.22E-07	613200	306600	2.3E-05	9.8E-02	2080	35	0.081	9.66E-05	843.04	130,000	425,000	2756	119.39	564	180
1,1-Dichloroethene			613200	306600		2.0E-01	2080	35		9.66E-05		130,000	425,000		96.95	*	100
1,2-Dichloroethane	1.0E-06	0	613200	306600	2.6E-05	2.4E+00	2080	35	0	9.66E-05	0	130,000	425,000	0	98.97	0	45
Methylene Chloride***	1.0E-06	6.15E-10	613200	87600	4.7E-07	1.0E+00	2080	35	0.011	9.66E-05	114.11	130,000	425,000	373	84.94	107	1930
1,1,2,2-Tetrachloroethane	1.0E-06	0	613200	306600	5.8E-05		2080	35	0	9.66E-05	0	130,000	425,000	0	167.86	0	50
Toluene			613200	306600		5.0E+00	2080	35		9.66E-05		130,000	425,000		92.13	*	190
1,1,1-Trichloroethane			613200	306600		5.0E+00	2080	35		9.66E-05		130,000	425,000		133.42	*	590

* E-300 COC not calculated for non-carcinogens because these chemicals do not contribute significant hazard. A health-based limit would be orders of magnitude higher than measured concentrations.

** Cumulative Target Risk for all chemicals ($Risk_{cum}$) for surface worker and trainee set at 1E-5, for residents and ranch workers set at 1E-6