There is Nothing Here for You: Passive Institutional Controls and Preemptive Resource Exploitation - 16197

Robert Watson*, John Callicoat*, and Andy L. Ward, PhD.**
*AECOM, Professional Solutions
**U.S. Department of Energy, Carlsbad Field Office, Carlsbad NM 88220

ABSTRACT

The Department of Energy (DOE) Carlsbad Field Office (CBFO) is required by Title 40 CFR Part 191.14(c) and Title 40 CFR Part 194.43 to develop a Passive Institutional Controls (PICs) program to prevent the likelihood for future human intrusion into the Waste Isolation Pilot Plant (WIPP). The purpose of this paper is to explore how the exploitation of resources under nuclear waste repositories as a part of PICs could reduce the risk of future human intrusion. The WIPP, located in the northern Permian Basin near Carlsbad, New Mexico, is a geologic repository for the permanent isolation of defense-related transuranic waste.

In 1995, a series of geophysical surveys by the New Mexico Bureau of Mines and Mineral Resources estimated the total hydrocarbon reserves underneath the WIPP, which included a 16-sectionarea plus a one mile buffer. Since that time the Delaware Basin well database has been maintained to closely monitor hydrocarbon extraction activities. The database was used in compiling relevant oil and gas extraction data retrieved from The New Mexico Oil Conservation Division. The volume of hydrocarbons extracted from 1995 to the present suggests that if current extraction growth trends continue (as historic market and production data indicate they will), all known crude oil reserves under the WIPP, obtainable through current extraction technology, will be depleted within approximately 10 years, i.e., by 2026. This is well before the anticipated WIPP closure and start of the Active Institutional Controls (AICs) program called for in 40 CFR Part 194.41(b). In addition, gas resources, although more difficult to forecast, are not expected to last beyond 2137.

Title 40 CFR 194.33 states, “Inadvertent and intermittent intrusion by drilling for resources . . . is the most severe human intrusion scenario.” This human intrusion scenario is the feature, event, and process (FEP) that performance assessment (PA) has identified as having the most significant impact on radionuclide releases during the 10,000 year regulatory period for the WIPP. Title 40 CFR 194.43 requires a PICs program which contains “. . . [records] in the international archives that would likely be consulted by individuals in search of unexploited resources.” Due to political, social, and economic motivators for resource exploration and exploitation, the potential future absence of hydrocarbon resources under the WIPP is important in deterring possible human intrusion. To minimize the risk of future human

intrusion, it may be necessary to consider actively removing as many of the exploitable hydrocarbon resources under and around a nuclear waste repository as is practicable before the end of the period of AICs (i.e., 100 years after closure of the repository).

Additionally, communicating the absence of hydrocarbon resources under a nuclear repository should take a prominent role in any PICs program. Due to its high-cost nature, exploratory drilling of any kind currently involves cost/benefit analysis. If in the future the economic realities of resource exploration remain similar to today, and future oil companies know the resources for a particular area have already been heavily exploited, hypothetically, they would become less motivated to drill in that area. They would instead opt to explore an area with better prospects. It is important then that the remaining hydrocarbon reserves be clearly stated and prominently displayed. In essence we should communicate the message, loud and clear, "There is nothing here for you."

INTRODUCTION

The Waste Isolation Pilot Plant (WIPP), located in the northern Permian Basin near Carlsbad, New Mexico, is a geologic repository for the permanent isolation of defense-related transuranic waste. The Department of Energy (DOE) Carlsbad Field Office (CBFO) is required by Title 40 Code of Federal Regulations (CFR) Part 191.14(c) [1] and Title 40 CFR Part 194.43[2] to develop a passive institutional controls (PICs) program, which includes detailed information about the disposal system that may reduce the likelihood for future human intrusion into the WIPP. This regulation is summarized as follows:

> "Any compliance application shall include detailed descriptions of the measures that will be employed to preserve knowledge about the location, design, and contents of the disposal system . . . [and] other passive institutional controls practicable to indicate the dangers of the waste and its location."

Based on the containment requirements in 40 CFR 191.13[1], the disposal system is subject to a performance assessment (PA) which, among other things, predicts the likelihood and severity of future human intrusion into the WIPP for 10,000 years. Title 40 CFR 194.33[2] states, "Inadvertent and intermittent intrusion by drilling for resources . . . is the most severe human intrusion scenario." This human intrusion scenario is the feature, event, and process (FEP) that PA has identified as having the most significant impact on radionuclide releases during the 10,000 year regulatory period for the WIPP. Title 40 CFR 194.43[2] requires a PICs program which contains ". . . [records] in the international archives that would likely be consulted by individuals in search of unexploited resources." Due to political, social, and economic motivators for resource exploration and exploitation, the potential future absence of hydrocarbon resources under the WIPP will be important in deterring possible future human intrusion.

Because exploratory drilling into a geologic repository is considered to be the worst human intrusion scenario, it seems logical that a record of the type and extent of resources available under and around a waste repository be a prominent part of any PICs program. Furthermore, to minimize the risk of future human intrusion with or without successful PICs, agencies planning and operating nuclear repositories should actively extract, to the extent practicable, all of the known valuable resources around and under their facilities.

DESCRIPTION

Methods

During the WIPP planning process and due to the underground nature of the repository, the possibility of resource extraction on and around the WIPP site was a major concern. In 1995, a series of geophysical surveys by the New Mexico Bureau of Mines and Mineral Resources (NMBMMR) [3] estimated the total hydrocarbon reserves underneath the WIPP (see Fig. 1), which includes the 16-section land withdrawal area plus a one mile buffer (see Fig. 2). Since that time, the Delaware Basin well database [4] has been maintained to closely monitor hydrocarbon extraction activities. Other resource extraction activities, e.g., potash mining, are also monitored, but because exploratory drilling is the only future human intrusion scenario considered in PA, the scope of this research was limited to hydrocarbons.

Oil and gas extraction volumes from 1995 - present were obtained from data available in an online database maintained by the State of New Mexico Oil Conservation Division (NMOCD) [5] and compiled in the Delaware Basin well database. The data were analyzed as follows:

1. The total extraction volume in barrels (BBLS) for oil and billions of cubic feet (BCF) for gas for each year across all wells in the 16-section land withdrawal area plus the one -mile buffer was calculated.
2. Using those totals, the average percent increase/decrease in yearly extraction from year- to-year was calculated.
3. Using the average year-to-year production increase/decrease, extraction totals were forecast into the future.
4. Extraction numbers were forecast using the current average growth rate, a zero growth rate, and an inverse of the current average growth rate. The inverse was chosen as a hypothetical “what if” if the trend were reversed.
5. With the total hydrocarbon resource volumes derived from the NMBMMR geophysical surveys as the ceiling, extraction totals were summed into the future until the ceiling was reached.

6. The year the ceiling was reached for each of the three forecasts was noted.

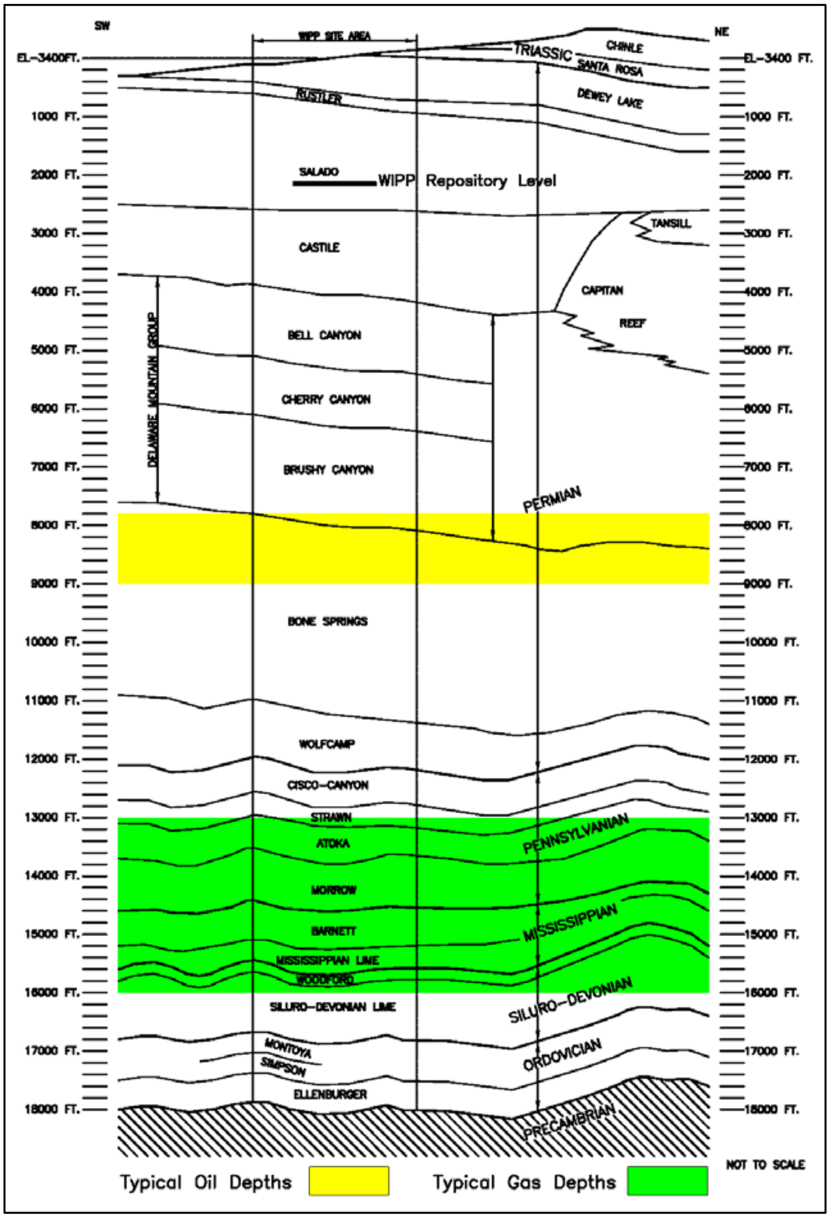

Fig. 1. Stratigraphic Map of Hydrocarbon Resources near the WIPP

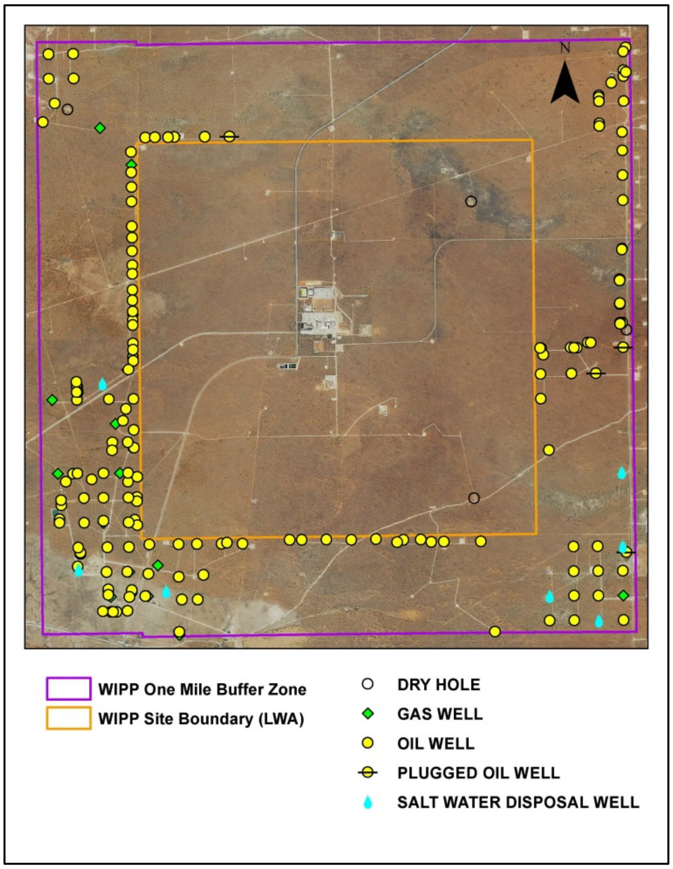

Fig. 2. 16 Section Land Withdrawal Area Plus One Mile Buffer

Results

Based on 1995 geophysical surveys, the NMBMMR estimated there were approximately 33 million barrels of crude oil underneath the 16-section area of the WIPP and the onemile buffer, extractable through the following methods: primary - hydrocarbons recovered by way of natural drivers i.e. pressure differential between the bottom and top of the well; secondary- mechanically pumping the hydrocarbons out of the well; and tertiary - advanced oil recovery techniques such as water-flooding.. Additionally, they estimated approximately 354 billion cubic feet of gas under the same area. At the time, while there were some extraction activities already taking place near the repository site, the “oil boom” was not yet in full swing. Using the NMBMMR volumes as a ceiling, the years at which all of those resources will be depleted under various circumstances are shown in Figures 3 and 4, and Tables I and II.

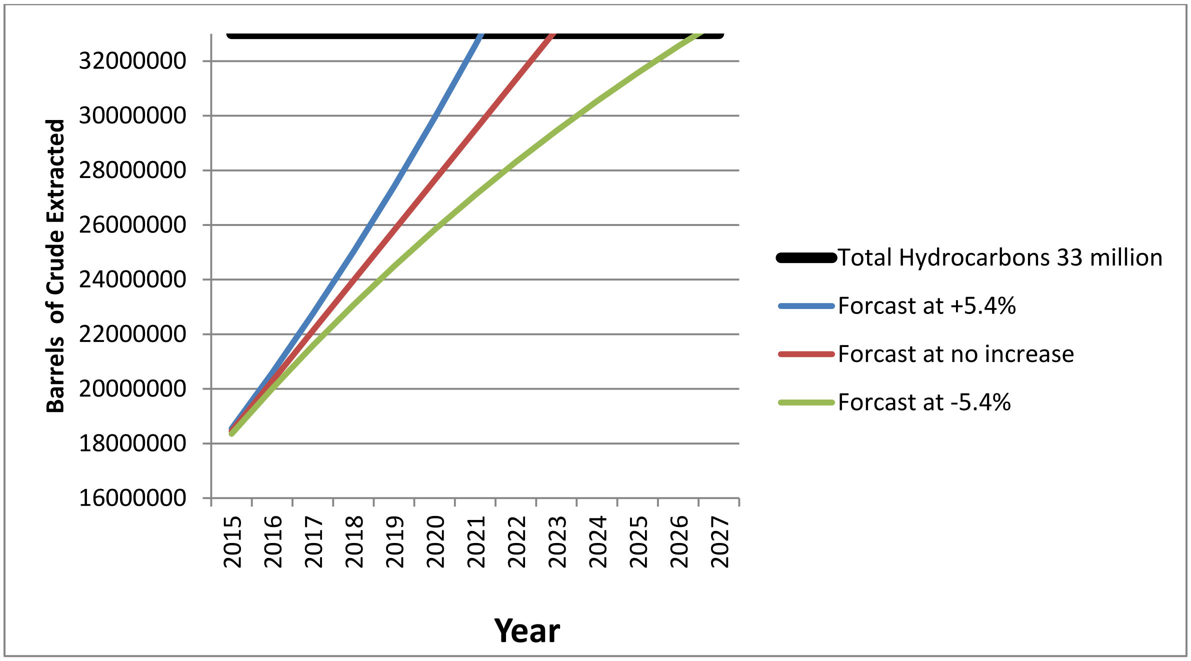

Figure 3. Oil Extraction Forecast

Table I. Oil Extraction Forecast

Oil Wells	
Average Yearly Increase	**Year of Complete Extraction**
Current Average (5.4%)	2021
Zero Growth (0%)	2022
Inverse Growth (-5.4%)	2026

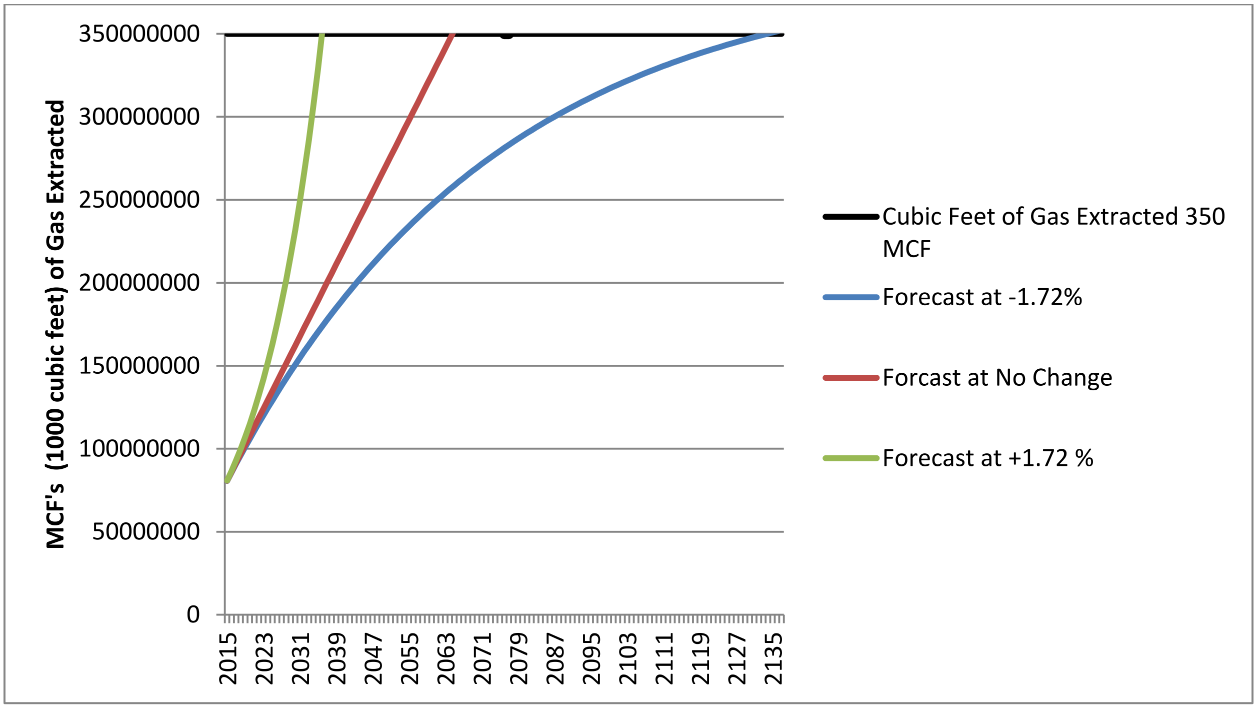

Figure 4. Gas Extraction Forecast

Table II. Gas Extraction Forecast

Gas Wells	
Average Yearly Increase	**Year of Complete Extraction**
Current Average (-1.72%)	2137
Zero Growth (0%)	2065
Inverse Growth (1.72%)	2036

DISCUSSION

The volume of hydrocarbons extracted from 1995 to the present suggests that if current extraction growth trends continue as historic market and production data from 1946 to 2015 indicate they will (see Fig. 5), all known oil reserves under the WIPP obtainable through current extraction technologies will be depleted in approximately 10 years, i.e., by 2026. Gas is more difficult to predict. While trends show gas lasting until 2137 if the current status quo is maintained, there are several scenarios which could alter this trend dramatically.

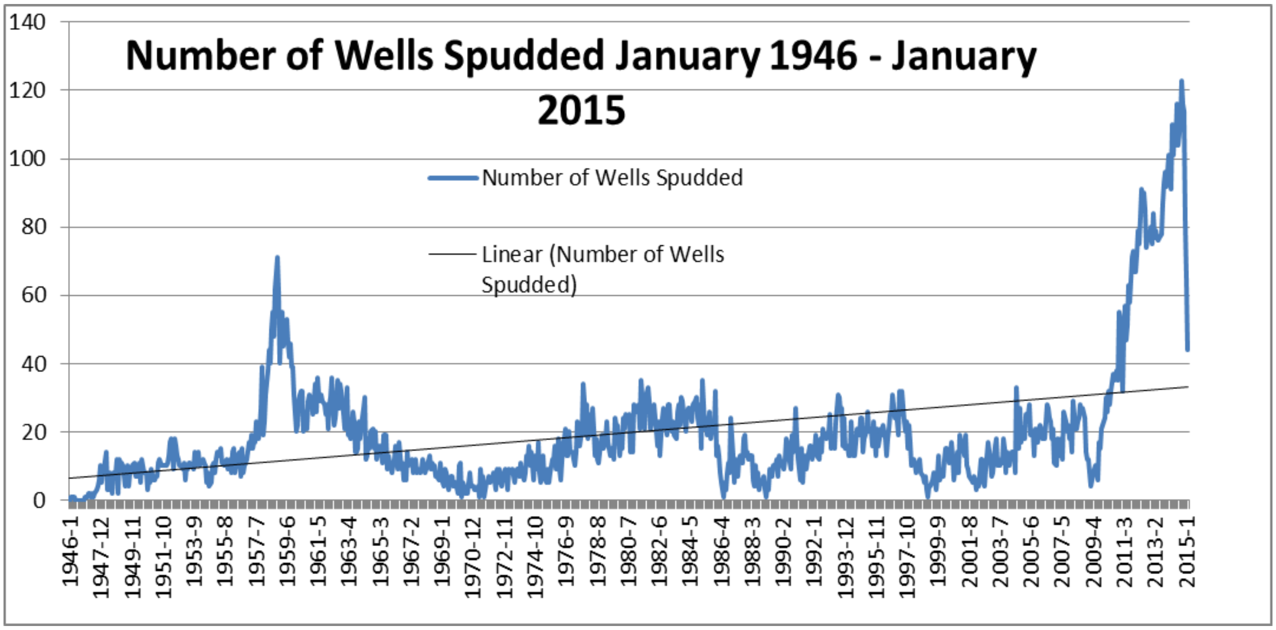

Fig. 5. Number of Wells Spudded in the Land Withdrawal Area Plus One -Mile Buffer from January 1946 – January 2015

At present, when the oil wells begin to dry up and reach the end of their production life, well operators will face a choice. They can convert their oil wells to gas, which would in many cases include costly re-working. Or alternatively, well operators could plug the well and move on, leaving the gas in the ground in favor of pursuing more profitable crude oil elsewhere. There will likely be a mix of these patterns as oil becomes depleted. Therefore, gas resources remain somewhat of a wild card. It is likely, due to the much higher value of crude oil, most operators will plug their wells and move on. Consequently, the gas resources under the WIPP, to some extent, will remain untapped. In the context of PICs, this is fine. Historically, crude oil has been the primary draw for exploratory drilling. The absence of crude oil resources is what PICs should focus on, as it will likely have the greatest impact to future operator's decisions on whether to perform exploratory drilling.

In the future scenario where PICs are functioning successfully, communicating the absence of resources under and around a nuclear waste repository should be a priority in the PICs program. It would be the repositories second line of defense, right behind the issue of possible radioactive release. The Memorandum "Effects of The Collapse of Civilization on the Probability of Exploratory Drilling" [6] states, "Depletion of a resource in an area generally will result in an end to exploratory drilling for that resource at that location." Because inadvertent and intermittent intrusion by drilling for resources is the most likely human intrusion scenario, it is the responsibility of PICs managers to do everything in their power to discourage this type of intrusion. Due to its high-cost nature, exploratory drilling of any kind currently involves cost/benefit analysis. If in the future the economic realities of resource exploration remain similar to today, and future oil companies know the resources for a particular area have already been heavily exploited, hypothetically, they would have much less motivation to drill in that area. They would instead opt to explore an area with better prospects. It is important then, that the remaining hydrocarbon reserves be clearly stated and prominently displayed. In essence we should communicate the message, loud and clear, "there is nothing here for you."

If oil becomes so valuable or scarce that extraction companies no longer care about the risks of drilling through a nuclear repository, the "inadvertent" part of the equation is removed and there is no PICs program that could exist to prevent an intrusion. The intrusion would be reckless and purposeful. We have no control over future attitudes about oil, nuclear repositories and risk. We do, however, have control over quantities of hydrocarbons existing around our repositories, and taking an active role in limiting those resources is a form of risk management.

In the scenario where oil is still a high-value commodity and PICs have failed, the heavy preemptive exploitation of the hydrocarbon resources around the repository will act as the only line of defense. Unless drillers improbably drill a well right above the repository as the first location for future exploration, they will repeatedly come up empty handed while exploring the area. That evidence will tell them the oil has been removed, or was never present; especially if they discover the hundreds of existing plugged wells. The landscape will tell its own story. Again, "there is nothing here for you."

CONCLUSION

PICs will fail at some point in the future. This is a foregone conclusion. While PICs are still functioning, we can give them extra strength in reducing the likelihood of future intrusions into the WIPP repository through preemptive resource exploitation. When PICs fail, the remains of plugged wells and the absence of hydrocarbon resources around the repository will stand as possibly the only defense WIPP will have against inadvertent human intrusion. The WIPP, by allowing heavy resource extraction around its borders has already implicitly employed this strategy. The crude oil will be gone many years before PICs even begins. This strategy has the potential to be even more effective at future repositories where it may be actively employed as a condition of the repositories existence.

By regulatory necessity, drilling around the WIPP is limited to an area outside of the Land Withdrawal Area (LWA). While there are wells that kick out horizontally into the LWA, erecting a drilling rig directly over the LWA is not permitted. Therefore, there is some uncertainty as to whether all hydrocarbons can be removed. This is an artifact of building the repository without a regulatory mandate to remove all hydrocarbon resources first.

If a repository site were to have a mandate to first remove all hydrocarbon resources before building, they could, hypothetically, remove with a relatively high level of certainty, all of the available hydrocarbon resources at the source site itself. This would have several benefits. The first and most obvious would be to reduce the probability of inadvertent future human intrusion. Another possible benefit would be economic. The money obtained from extracting the hydrocarbon resources could act as a potential source of funding for the repository itself.

REFERENCES

1. U.S. Environmental Protection Agency (EPA). 1993. "40 CFR Part 191: Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes; Final Rule." *Federal Register*, vol. 58 (December 20, 1993): 66398–416.

2. U.S. Environmental Protection Agency (EPA). 1998. "40 CFR Part 194: Criteria for the Certification and Recertification of the Waste Isolation Pilot Plant's Compliance with the Disposal Regulations: Certification Decision; Final Rule." *Federal Register*, vol. 63 (May 18, 1998): 27353–406.

3. New Mexico Bureau of Mines and Mineral Resources (NMBMMR). 1995. *Evaluation of Mineral Resources at the Waste Isolation Pilot Plant*. Final Report, Vols. I-IV.

4. Delaware Basin Well Tracking Application

5. New Mexico Oil Conservation Division, http://www.emnrd.state.nm.us/OCD

6. Guzowski R.V., 1990. *Effects of the Collapse of Civilization on the Probability of Exploratory Drilling.*