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To: John Keiling, Program Manager, Permits Management Program, New Mexico Environment Department
From: Robert H. Gilkeson, Registered Geologist, RCRA Groundwater Specialist
Subject: Comment on the New Mexico Environment Department Notice of Disapproval issued to Sandia National Laboratories Albuquerque Facility on November 20, 2006 concerning the Corrective Measures Implementation Work Plan for the Mixed Waste Landfill.
Copies: Ines Triay, EM Division, Department of Energy Headquarters
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<u>Introduction</u>. On November 20, 2006 the New Mexico Environment Department (NMED) issued a Notice of Disapproval to the Department of Energy and Sandia National Laboratories (DOE/SNL) concerning a number of deficiencies in the Mixed Waste Landfill (MWL) Corrective Measures Implementation Work Plan (CMIP) (submitted to NMED in November 2005), and NMED concerns for new soil gas sampling at the MWL to identify releases of contamination from the hazardous and radioactive waste that are buried in unlined trenches and pits. The issuance of the NOD over one year after DOE/SNL submitted the CMIP is evidence of the poor performance of NMED to conduct business to protect the environment on a professional schedule. There is a pressing need for Governor Richardson to form a “blue-ribbon” panel to investigate the poor performance of the NMED, an executive agency guided by the Governor.

My comment on the NMED NOD is focused on the following NMED concerns:

- <u>The need for new soil gas measurements</u>.
  The DOE/SNL response does not meet the concerns of NMED for new soil gas measurements across the 2.6 acre MWL to identify new releases from discrete pits and trenches. An additional problem is the overall failure to characterize the contamination in soil gas beneath the discrete pits and trenches at the MWL at any time in the past, and the failure to have the ongoing monitoring of soil gas that is required by the Resource Conservation and Recovery Act (RCRA) and the DOE Orders.
- <u>The need for long-term monitoring of soil gas for early detection of contamination released from the MWL</u>. The DOE/SNL response does not provide for the early detection of contamination released from the MWL because the proposed monitoring wells are too few and are installed at locations outside the boundary of the MWL. Early detection of contamination requires a large network of monitoring wells that are located within the MWL.

A large network of monitoring wells is required because the MWL is not a landfill that meets regulatory requirements for disposal of the hazardous waste or radioactive waste that are buried in the MWL. The MWL is best considered a waste dump that is intended for permanent burial of a dangerous mixture of commingled radioactive and hazardous waste that RCRA and DOE Orders do not presently allow disposal of in unlined pits and trenches, or even commingled disposal in engineered landfills. The fact that the MWL does not have the engineered features that are required in landfills (*i.e.,* liners, leak detection and leachate collection) requires the installation of a large network of monitoring wells located beneath the pits and trenches for early detection of the release of contamination for as long as the wastes are a danger. In fact, the wastes are a danger for a period of greater than the next 100,000 years and the National Academy of Sciences recognizes that "institutional controls" cannot be guaranteed for a period beyond 100 years. The unsound decision to leave the dangerous waste permanently buried at a shallow depth in the MWL dumpsite in a major urban center above the sole source aquifer requires careful and continuous monitoring of releases of contamination to the unsaturated strata beneath the unlined pits and trenches. This requirement is expensive and cannot be compromised.

- <u>The need for additional groundwater monitoring wells at locations within the MWL</u>. The NMED NOD instructed DOE/SNL to propose the location of new groundwater monitoring wells at locations within the MWL where past studies identified "hot spots" of contamination. The nonresponsive reply by DOE/SNL is that wells cannot be located within the MWL because of the damage that would be done to the earth cover that is planned to be installed over the dumpsite. In fact, the additional monitoring wells should have been installed more than ten years ago as part of the RCRA characterization. The single-minded plan of DOE/SNL to drape a thin earth cover over the MWL and then claim that critically important wells cannot be installed because they will damage the integrity of the "dirt blanket" is unconscionable.

A NOD from NMED to DOE/SNL dated March 23, 2007 requires the replacement of monitoring well BW1 at the MWL because of multiple factors. Indeed, the many factors cited in the March 23 NOD also require the replacement of <u>six</u> of the seven monitoring wells installed at the MWL. The March 23, 2007 NOD is evidence that the groundwater beneath the MWL was never properly monitored over the past 15 years, and the claim in DOE/SNL reports that "contamination is not present" is only lip service and not based on valid data.

- <u>The need to monitor tritium levels in soil gas in the unsaturated zone beneath the pits and trenches of the MWL and to set trigger parameters for tritium and other contaminants at levels that provide early detection of contamination</u>. The scheme of DOE/SNL to shirk from the responsibility to monitor tritium levels in the unsaturated zone is unacceptable and prevents the early detection of the release of this highly mobile contaminant from the pits and trenches. Similarly, DOE/SNL set the action levels for tritium and other contaminants at levels that are too high for early detection of contamination and when the presence of contamination triggers the need for corrective action.

- The need to abandon the failed fate and transport model. The DOE/SNL fate and transport model is not based on physical data collected from the unsaturated zone beneath the pits and trenches of the MWL. In fact, the great lateral and vertical heterogeneity in the geologic materials beneath the MWL is an obstacle to gathering the required data to model the travel of contamination through the vadose zone to the groundwater. The fate and transport model predicted that trace metals such as nickel and chrome would never reach the regional aquifer but these contaminants are now present at high levels in the groundwater. The nickel contamination has been present at high levels for more than the past ten years and the claim that the nickel is from corrosion of the stainless steel well screens is unproven. The obvious need to replace corroded well screens was not done. In addition, the measurement of nickel isotopes in the contaminated groundwater would provide important information on the source of the nickel but the isotopic studies were not done. Instead of installing monitoring well that produce reliable and representative water samples, trust is placed in an unreliable fate and transport model that contamination from the Sandia MWL waste dump cannot reach the precious groundwater.

The limitations of fate and transport models is described in a paper by noted hydrologist Shlomo P. Neuman:

National Academies Press - "*Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites (2000), Appendix G – "Mathematical Models Used for Site Closure Decisions"* by Shlomo P. Neuman and Benjamin Ross –

> *"The tendency has been to rely on models at the expense of detailed site investigations, site monitoring, and field experimentation. In fact, models have often been used to "demonstrate" that additional site or experimental data would be of little value for a project. The reasons for this state of affairs are easily identified as regulatory and budgetary pressures."*

> *"It is often tempting to "demonstrate" by means of a model that a given waste disposal or remedial option is safe, or that additional site data would be of little value, by basing the model on assumptions, parameters and inputs that favor a predetermined outcome."*

- **The NMED NOD Requires Additional Characterization of the Vadose Zone Beneath the Sandia MWL.**

The NMED Notice of Disapproval (NOD) on November 20, 2006 had the following concerns for new soil-gas monitoring at the Sandia Mixed Waste Landfill (MWL):

> *"As the Permittees are aware, most site characterization data for the MWL (other than groundwater data) dates before the mid 1990's. Because the rupturing of containers and the leaking of their contents could have occurred since the mid 1990's, the NMED requires more current soil-gas data to help resolve this issue."*

The proposal by Sandia/DOE to take new soil gas measurements at only six locations at the MWL is nonresponsive to the NMED concern that rupturing of containers and the leaking of their contents could have occurred. The rupturing of containers could have occurred in any of the disposal pits and trenches and is more likely to have occurred because of the compaction activities with heavy equipment in the past year that were part of installing the subgrade across the entire surface of the 2.6-acre MWL. The fact that NMED approved the installation of the subgrade in the face of issuing a NOD for the CMIP is another example of the poor performance of NMED. The Sandia/DOE proposal is also nonresponsive to the NOD because none of the six proposed locations for new soil gas measurements are located above or below the disposal pits and trenches.

Active Soil Gas Survey. The six locations proposed by Sandia/DOE for measurement of soil gas are circled in red on Figure 1. The proposed locations are where high levels of volatile organic contaminants (VOCs) were measured in the 1994 active soil gas survey that was part of the RCRA Facility Investigation. Figure 1 shows the locations of where soil gas measurements were taken at shallow depths with a Geoprobe^{R}. The 1994 survey collected soil gas at depths of only 10 ft and 30 ft below ground surface (bgs). The RCRA Phase 2 Report noted that the soil gas concentrations were markedly higher at the 30 ft depth. The measured concentrations at the 10-ft and 30-ft depth are in Table 1 for the six locations proposed by Sandia/DOE for collecting new soil gas samples. The great increase at the 30-ft depth is evidence that the RCRA Facility Investigation in the 1990's failed to provide the necessary knowledge of the nature and extent of contamination released from the MWL to the unsaturated zone. Therefore, the new proposal by Sandia/DOE to only measure soil gas to a depth of 30 ft bgs is unacceptable.

The levels of total VOCs and tetrachloroethene (PCE) measured at the six locations are listed below in Table 1. The very large increase between the 10-ft and 30-ft depths is evidence that the measurements were insufficient to characterize the highest levels of VOC's in the unsaturated zone beneath the MWL. The reported depth of the trenches is 20 feet compared to a depth of 25 feet for the pits. It is essential for the new soil gas survey to fully characterize contamination in the unsaturated zone beneath the MWL from immediately below the trenches and pits to the top of the regional zone of saturation and to install the network of soil gas monitoring wells that are necessary for the permanent long-term detection of the release of contaminants from the unlined pits and trenches at the MWL.

Passive Soil Gas Survey. A passive soil gas survey in 1993 measured the flux of certain VOC's released to the atmosphere across the land surface at the MWL. The measurement locations are displayed on Figure 2. Note the close spacing of measurements in the southern half of the classified area compared to the sparse number of measurements taken in the northern half of the classified area and across the unclassified area. Figure 3 compares the locations of the passive soil gas measurements to the locations of the trenches to illustrate the failure of the passive soil gas survey to characterize the VOC contamination emanating from the trenches. A comparison of Figure 2 to Figure 3 shows that markedly higher levels of VOC's were measured over the pits for the few measurements that were located above the pits.

The Sandia MWL does not meet NMED or RCRA regulations for a landfill. The critical need for a large network of monitoring wells in the vadose zone and in the groundwater below the MWL is because the engineered features required in landfills are not present below the pits and trenches of the MWL dumpsite. There are no liners and no engineered features for leak detection or leachate collection. Other reasons that the extensive network of monitoring wells are required is that the Sandia MWL is located above a sole source aquifer within New Mexico's largest population center and the pits and trenches contain an inventory of radioactive, hazardous and mixed wastes that regulations do not allow codisposal of because the mixture of wastes increases the probability of release from the pits and trenches with passage of time. The wastes disposed of in the Sandia MWL are a danger for longer than the next hundred thousand years. The early detection of contamination released from the MWL is a requirement of RCRA and of DOE Orders.

Required activities to characterize and monitor the unsaturated zone below the Sandia MWL. The failure of Sandia/DOE to characterize contamination in the unsaturated zone below the MWL in the activities performed for the RCRA Facility Investigation must be addressed in the new sampling plan. The profile of contamination in the unsaturated zone must be characterized over the 2.6-acre MWL for the total thickness from below the trenches and pits to the water table of the regional zone of saturation. This characterization shall include
1). the measurement of constituents in soil gas samples that are collected from probe holes with the Geoprobe^R or other sampling system that are located across the MWL,
2). the installation of a network of angle wells beneath the pits and trenches at the MWL for the early detection of the release of contamination as soil gas or moisture, and
3). the installation of new vertical monitoring wells for the combined purpose of long-term monitoring of soil gas contamination in the unsaturated zone and contamination in groundwater at the water table in the alluvial fan sediments, and deeper in the productive aquifer strata known as the "Ancestral Rio Grade Strata". The geologic setting beneath the MWL is displayed on Figure 6. The installation of combination wells for the collection of both soil gas and water samples is the most cost-effective strategy to address the failure of Sandia/DOE to meet the requirements of RCRA, DOE Orders, and the NMED Consent Order for installing the necessary monitoring at the MWL.

New Soil Gas Survey With the Geoprobe^R. The first activity at the Sandia MWL is the use of a Geoprobe^R or similar equipment to collect soil gas samples across the MWL at appropriate locations and depths to characterize soil gas contamination from the pits and trenches. The collected samples should be analyzed for a suite of VOC's, tritium and methane. The results from the survey will be studied to determine the need for measurements at additional locations and at deeper depth.

In the classified section of the MWL, the Geoprobe^R soil gas measurements shall be taken around the perimeter of the MWL at the locations where the measurements were taken in the 1993 survey (locations are displayed on Figure 1) with samples collected at depths of 10 ft, 30 ft, and 60 ft. Inside the classified area of the MWL, the Geoprobe^R should be used to collect gas samples at a minimum of 20 of the locations where the passive soil gas measurements were taken as shown on Figure 3.

In the unclassified section of the MWL, the Geoprobe^R soil gas measurements shall be taken around the perimeter of the MWL at the locations where the measurements were taken in the 1993 survey with samples collected at depths of 10 ft, 30 ft, and 60 ft. Inside the unclassified area, the Geoprobe^R shall be used to collect soil gas samples at depths of 10 ft, 30 ft, and 60 ft in the corridors between trenches B, C, and D, to the west of Trench D, to the east and south of Trench E, to the west of Trench G, and immediately surrounding the circular Trench F.

The comparison of Figures 2 and 3 shows the markedly higher contamination that was measured by the few passive samplers that were located directly above the trenches. Therefore, it is essential to probe through the subgrade to a depth of 1 foot into the original soil cover at a minimum of ten locations above each of the six trenches for collection of soil gas samples. Core shall be collected from the probe holes for accurate knowledge of the thickness of the subgrade above the trenches. Additional probe holes shall be placed as needed to accurately map the thickness of the subgrade above the trenches. A detailed map of the thickness of the subgrade above the trenches is important information on the amount of compaction that was caused by the heavy equipment that were used to install and compact the subgrade. Because of the shallow depth of the Geoprobe^R measurements, the probe holes may not be sealed and dilution of the soil gas samples with atmospheric air may occur. Therefore, after collection of the soil gas samples, sorbent cartridges shall be sealed into the probe holes for a period of 14 days before they are retrieved and analyzed for volatile and semivolatile contaminants. A suitable sorbent cartridge is available from Beacon Environmental Services, the company that performed the soil gas survey at the MWL in 1993.

The results from the new active and passive soil gas surveys and the locations of high levels of contamination that were identified in the RCRA facility investigations shall be used to identify the locations for installing a network of monitoring wells within the MWL and in the perimeter surrounding the MWL for early detection of contamination released from the pits and trenches to the unsaturated zone.

<u>Two types of soil gas monitoring wells are required for long-term monitoring.</u>

– <u>Deep Vertical Wells</u>. A network of deep vertical wells shall be installed at appropriate locations within the MWL and immediately at the perimeter of the MWL. The boreholes for the wells shall be drilled with the resonant sonic method that is equipped for the collection of gas samples and water samples in “real time” as part of drilling. The wells shall be constructed to monitor both a vertical profile of soil gas and groundwater quality beneath the “hot spots” that were identified in the RCRA Phase 1 and 2 facility investigations and by the new soil gas surveys described above. The RCRA investigations were not thorough which requires new characterization efforts to improve identification of “hot spots” within the MWL.

The deep vertical wells shall be of a design that allows use of borehole geophysical methods to monitor profiles of soil moisture beginning on a quarterly basis and never on a schedule of less than an annual basis. An appropriate design for the vertical wells is the “inside-out well design” developed by Idaho National Engineering Laboratory. Wells of this design are presently in use for monitoring soil gas and groundwater at the excavated Sandia Chemical Waste Landfill.

The Sandia/DOE position that new wells may damage the earth cover requires a delay in installation of the cover. The NMED NOD requires Sandia/DOE to propose new locations for groundwater monitoring wells at locations within the MWL where elevated levels of contamination were identified in the RCRA Facility Investigation. The elevated levels of contamination include the 271,000 gallons of hexavalent chromium contaminated reactor coolant water that was disposed of into Trench D, the tritium "hot spot" over a large part of the classified area that is displayed on Figure 4, and the VOC 'hot spots" that are the basis for the proposed soil gas sampling locations displayed on Figure 1. There are other hot spots that are not described here in this brief discussion.

The unacceptable proposal of Sandia/DOE to install deep vertical wells for soil gas measurement outside of the boundary of the dirt cover. Sandia/DOE responded to the NMED NOD with a proposal to install three deep vertical multiple-port monitoring wells to a depth of 400 feet below ground surface for the collection of soil gas samples. The proposal consists of three Flexible Liner Underground Technologies (FLUTe™) wells. The proposal is unacceptable because of the need for groundwater monitoring and the "inside out" well design by the Idaho National Engineering will provide for collection of soil gas samples and groundwater samples. In addition, the "inside out" well will also provide for measurement of profiles of *in situ* moisture content with neutron sounds that may be lowered into the wells. Another reason that the Sandia proposal is unacceptable is that the deep vertical wells are at locations outside the MWL beyond the perimeter of the soil cover. The wells are located too far from the discrete trenches and pits for the early detection of vapor phase contamination although Sandia/DOE claim this is the purpose for the wells.

– **Angle wells.** Multiple-port angle wells shall be installed beneath the disposal trenches and pits for characterization of the soil gas contamination that is now present beneath the MWL or may be released in the future. The angle wells shall be of a design for monitoring the soil gas and the profiles of soil moisture over the next 50 years. The "inside out" well design that is described for the vertical wells is also appropriate for the angle wells. The boreholes for the angle wells shall be drilled with the resonant sonic drilling method that is equipped to collect soil gas samples as part of drilling the boreholes. Collection of soil gas samples on an interval of every 20 feet of drilling is important to identify the locations of sampling ports in the installed well.

Figure 3 shows the locations of angle boreholes BH-1 to BH-13 that were drilled at locations around the perimeter of the MWL. The boreholes were drilled at an angle of 30 degrees from vertical with a resonant sonic drill rig. The drilling method accomplished drilling an appropriate distance below the trenches for boreholes BH-1, -2, -4 and -13. Mistakes in borehole locations compromised the data from boreholes BH-3, -5, -6, -7, and -12. Similarly, boreholes BH -8, -9, and -10 were not at optimum locations for characterization of contamination beneath the disposal pits. Nevertheless, the drilling history established the success of the resonant sonic drilling methods for drilling angle holes that are suitable for installing the long term monitoring wells beneath the pits and trenches at the MWL. The knowledge gained from the active and passive soil gas surveys are important information for identifying the location of the new angle wells. A minimum of three angle wells is required below Trenches A. B, D, E, and G, and two wells below Trenches C and F. The minimum number of angle wells beneath the classified area of the MWL is estimated to be eight. It is important to keep in mind that comprehensive monitoring of the unsaturated zone beneath the trenches and pits is essential because the wastes are permanently buried in the MWL dump and the engineered features that are required at hazardous and mixed waste landfills, i.e., liners, leak detection, and leachate collection do not exist.

<u>The Sandia/DOE position that new wells may damage the earth cover requires a delay in installation of the cover</u>. The NMED NOD requires Sandia/DOE to propose new locations for groundwater monitoring wells at locations within the MWL where elevated levels of contamination were identified in the RCRA Facility Investigation. The elevated levels of contamination include the 271,000 gallons of hexavalent chromium contaminated reactor coolant water that was disposed of into Trench D, the tritium "hot spot" over a large part of the classified area that is displayed on Figure 5, and the VOC 'Hot spots" that are the basis for the proposed soil gas sampling locations displayed on Figure 1.

Monitoring well MW4 was installed to investigate contamination at the water table below Trench D. However, Figure 6 shows that the upper screen in well MW4 was installed too deep below the water table for the intended purpose, and therefore, the NMED Consent Order requires that well MW4 be replaced with a new monitoring well. This new multiple-port monitoring well for collection of soil gas samples with a screen installed at the water table should be drilled at an appropriate angle and located along the southwestern side of Trench D in the corridor between Trench D and Trench C.

In addition, there are no monitoring wells installed for monitoring groundwater contamination related to the high levels of tritium that are buried in the pits in the classified area and that have released a flux of tritium across the soil surface as shown by Figure 4. It is important to install "inside out" multiple-port wells at a minimum of four locations in the classified area for measuring accurate profiles of tritium and VOC contamination in the unsaturated zone and for investigation of tritium, VOC and other contamination at the water table of the regional zone of saturation. An important location for one of the wells is at Pit 33 where 822 Curies of Tritium was buried. The second "inside out" well is needed north of the classified area to replace existing monitoring well MW1 where high levels of nickel and chrome are measured in groundwater samples. The third "inside out" well should be located in the southeastern corner of the classified section to investigate contamination from the "acid pit" where chemical wastes were disposed of beginning in 1959. The location for the fourth vertical "inside out" well in the classified area should be based on the findings from the new soil gas surveys.

Furthermore, there is a need to install a minimum of six "inside out" vertical monitoring wells in the unclassified section of the MWL including along the western boundary of the MWL. One well should be installed at the highest level of VOC contamination identified in the RCRA Facility Investigation. The location of the second well should be identified from the new soil gas surveys that are needed across the unclassified area. Two of the wells shall be installed along the western boundary of the MWL to monitor water quality at the water table in the alluvial fan sediments (AF Facies). Two of the monitoring wells shall be installed along the western boundary of the MWL to monitor water quality in the productive aquifer strata – the "Ancestral Rio Grande Strata" that are located beneath the AF Facies. The geologic setting beneath the MWL is displayed on Figure 6. DOE/SNL has never installed the network of monitoring wells at the MWL that are required by RCRA or DOE Orders.

- **The NMED Letter of March 23, 2007 Requires Replacement of the Background Water Quality Well BW1 at the Sandia MWL.**

The NMED issued a letter on March 23, 2007 to DOE/SNL that describes the reasons that require replacement of the background water quality well BW1 at the Sandia MWL as follows:

- Low Water Levels. From the NMED letter of March 23, 2007:

> *"A spreadsheet provided to the NMED shows that the water level in MWL-BW1 (measured in January 2006) is only 2.29 feet above the bottom of the well screen. Because the well at this time cannot deliver sufficient water to properly obtain samples, it is no longer capable of providing representative water samples."*

The ongoing decline in water levels also requires replacement of well MWL-MW3. The Sandia Field Measurement Log on file at NMED shows that the water level in MW-3 (measured in April 2006) is only 2.02 feet above the bottom of the well screen. The field measurement log shows that the water sample was collected from the 5-ft long sump that is installed below the bottom of the screen. The collected water sample had a very high turbidity of 76.2 NTU and EPA requires monitoring wells to produce water that has a turbidity not greater than 5 NTU. It is a disappointment that NMED did not identify that well MW3 is also **"*no longer capable of providing representative water samples."***

- Corrosion of Stainless Steel Screens. From the NMED letter of March 23, 2007:

> *"Because of problems associated with stainless-steel screened wells at the MWL (chromium and nickel detections), the replacement well shall be screened with polyvinyl (PVC) plastic casing."*

The NMED concern for the corrosion of stainless steel well screens also requires replacement of monitoring wells MW1, MW2, and MW3 because these wells also have stainless steel screens. The levels of nickel and chromium measured in water samples from wells MW1 and MW3 exceed the New Mexico Water Quality Standard. The levels of chromium exceed the EPA MCL for drinking water. The NMED Sandia Consent Order has the following requirements for the design and construction of monitoring wells at the Sandia MWL:

> *"The design and construction of groundwater monitoring wells and piezometers shall [emphasis added] comply with the guidelines established in EPA guidance, including, but not limited to: RCRA GROUND-WATER MONITORING: DRAFT TECHNICAL GUIDANCE - U.S. EPA NOVEMBER 1992"* [known as the RCRA Manual for Groundwater Monitoring]

From pages 6-16 to 6-18 of the RCRA Manual:
"Monitoring well casing and screen materials should not chemically alter ground-water samples, especially with respect to the analytes of concern, as a result of their sorbing, desorbing, or leaching analytes. For example, if a metal such as chromium is an analyte of interest, the well casing or screen should not

increase or decrease the amount of chromium in the ground water. Any material leaching from the casing or screen should not be an analyte of interest, or interfere in the analysis of an analyte of interest."

From page 6-30 of the RCRA Manual:
"The presence of corrosion products represents a high potential for the alteration of ground-water sample chemical quality. The surfaces where corrosion occurs also present potential sites for a variety of chemical reactions and adsorption. These surface interactions can cause significant changes in dissolved metal or organic compounds in ground-water samples."

Furthermore, NMED requires replacement of corroded screens at the Los Alamos National Laboratory (LANL). On April 5, 2007 NMED issued a Notice of Disapproval (NOD) to LANL that requires the replacement of stainless steel well screens where LANL claims high nickel and chromium levels in groundwater are because of corrosion of the well screens. From the NOD:

> *"The required actions stem from: speculation by the Permittees that nickel and chromium detections represent leaching of stainless steel well casing in screens #1 and #2, --" [Emphasis Added).*

NMED should adhere to uniform enforcement at both Sandia and LANL. Over the past ten years, NMED accepted the speculation by Sandia that the high chromium and nickel levels measured in MWL wells are due to corrosion of the stainless steel screens. In fact, the NMED action concerning the LANL wells where corrosion may be the cause of high metal levels measured in groundwater now requires NMED to order that monitoring wells MW1, MW2, and MW3 at the Sandia MWL be replaced with new monitoring wells with PVC screens and casing. As discussed above, corrosion is one of the reasons NMED now requires replacement of well BW1 at the MWL.

- Cross-Gradient Location of Wells. From the NMED letter of March 23, 2007:

> *"Although NMED agrees that the current cross-gradient location of well MWL-BW1 allows for the collection of representative background water-quality data, the Permittees shall replace the well at another location east and more directly upgradient of the MWL, consistent with normal practice for the installation of background wells."*

The fact that the recent NMED report (the Moats Evaluation) on the water quality data from the Sandia MWL did not use the water quality data from well BW1 as representative of background is evidence that NMED does not consider well BW1 to have provided representative background water quality data. NMED now requires the correct installation of a background water quality well at a location upgradient of the MWL to monitor water quality at the water table of the fine-grained sediments. Unfortunately, NMED is making a mistake to not enforce the requirement of RCRA for installation of a background water quality well in the productive aquifer strata – the "Ancestral Rio Grande Deposits" (ARG Strata) that underlie the Alluvial Fan Sediments. The RCRA regulations stress the importance of monitoring the aquifer strata that produce large supplies of water to supply wells and the ARG Strata are the sole source aquifer for the region of Albuquerque and Bernalillo County. NMED is remiss to not identify the important requirement to monitor the ARG STRATA at the Sandia MWL.

In addition, wells MW1 and MW2 require replacement because they are located north of the MWL and cross-gradient of the southwest direction of groundwater travel at the water table of the regional zone of saturation. See Figure 7.

- Avoid invasion of screened intervals with drilling fluids and well construction materials. From the NMED letter of March 23, 2007:

> *"The Permittees shall install the well in a manner that avoids the use of drilling fluids or construction materials that have the potential to interfere with the reliability of hydrologic or analytical data obtained from the well."*

Wells BW1, MW2 and MW3 require replacement because they were drilled with the mud-rotary drilling methods that used bentonite clay drilling muds that have the potential to interfere with the reliability of hydrologic or analytical data obtained from the wells. In addition, it is necessary to replace well MW5 because of mistakes in well construction that caused the well screen to be invaded with the bentonite grout backfill materials. The well development records on file at the NMED show that well development was not able to remove the bentonite grout from the screened interval of well MW5.

- NMED Sandia Consent Order Requires Replacement of Wells at the MWL. The NMED letter of March 23, 2007 cites the following requirement from the Sandia Consent Order:

> *"In accordance with Section VII.A of the Order on Consent (April 24, 2004), if a well is any way unusable for its intended purpose, it must be replaced with an equivalent well. Thus the U.S. Department of Energy and Sandia Corporation (the Permittees) shall replace well MWL-BW1."*

The above statement in the NMED Sandia Consent Order also requires replacement of wells MW1, MW2, MW3, MW4 and MW5 at the Sandia MWL. The reasons to replace wells MW1, MW2, and MW3 are described earlier in this presentation.

Well MW4. The need to replace well MW4 was described briefly in an earlier part of this report and is described in greater detail here. Well MW4 requires replacement because the well was installed to monitor contamination at the water table beneath Trench D. The contamination was from 271,000 gallons of reactor coolant water that was disposed of in the trench. The coolant water was contaminated with high levels of hexavalent chromium – the toxic contaminant in the movie ***Erin Brockovich.*** However, Figure 6 shows that the upper screen in well MW4 is located too deep below the water table for its intended purpose. The very low level of nitrate in water produced from the upper screen is also evidence that the well does not produce water at the water table. High nitrate levels are ubiquitous at the water table across Sandia.

An additional reason that well MW4 must be plugged and abandoned is that the low water levels in the upper screen are evidence of leakage from the upper screen to the lower screen and the well is a fast pathway for introducing contamination into the deeper productive aquifer strata that are the sole source aquifer for the region of Albuquerque and Bernalillo County.

Well MW5. The intended purpose for well MW5 was to measure water levels and water quality down-gradient of the MWL to improve knowledge of the direction of groundwater travel. However, Figure 6 shows that the well screen is installed across both the alluvial fan sediments and the deeper productive aquifer strata. The NMED Consent Order requires wells to be installed in only one zone of saturation in terms of aquifer properties as follows:

> *"In constructing a well or piezometer, Respondents shall ensure that the well or piezometer will not serve as a conduit for contaminants to migrate between different zones of saturation."*

An October 30, 2001 position paper of the NMED Hazardous Waste Bureau provides additional caution on cross-cutting screens as follows:

> *"Wells with screened intervals connecting intervals of different head and/or hydraulic conductivity may act as conduits for vertical flow within the screened interval."*

The information on Figure 6 shows that the screen in well MW5 and the lower screen in well MW4 are connecting intervals of different head and hydraulic conductivity.

As explained earlier, another reason that requires replacement of well MW5 is that the well screen is contaminated with bentonite grout materials because of a mistake in the construction of the well. The grout contamination masks the detection of contaminants in the water produced from the well.

Analysis of tritium levels in soil gas samples is important for early detection of contamination. The position of DOE/SNL that tritium analyses in soil gas samples is not a routine analysis and therefore, will not be performed is unreasonable. There are well established methods for analysis of tritium in soil gas samples with a resolution of better than 300 pCi/L and these analytical methods shall be used for routine analysis of tritium levels in the sampling ports in the large network of monitoring wells that are required for long-term monitoring of releases from the pits and trenches. In addition, the value of analysis for helium isotopes in the soil gas samples should be studied. It is possible that analysis of helium isotopes could be a substitute for the analysis of tritium. Instead of doing the routine monitoring of soil gas that is necessary, DOE/SNL proposes to only monitor the emanation of tritium to the atmosphere at locations outside the perimeter of the dirt cover. These measurements are important but they do not replace the need for routine monitoring of tritium levels in the soil gas beneath the discrete trenches and pits at the MWL.

Unreasonable scheme of DOE/SNL to set "trigger levels" for contaminants at high levels. The proposal by DOE/SNL to set the trigger levels for VOC contaminants in soil gas at 20 ppmV is unacceptable because the high trigger levels prevent early detection of contamination and prevent identification of the travel of VOC's through the unsaturated zone to contaminate the groundwater. Accurate measurement with best analytical methods is essential for monitoring the release of VOC contaminants from the unlined trenches and pits for early detection of locations where the contaminants pose a danger to releases to the air pathway and a danger to groundwater. In addition, the trigger levels for contaminants in groundwater should be based on the analytical methods that provide accurate measurements at the lowest levels possible for the monitoring wells and the background wells. The presence of contamination from the MWL is then based on an intercomparison of high quality water quality data from the network of wells that are sampled with low-flow water sampling methods.

Tritium is an important indicator parameter for the early detection of contamination from the MWL in groundwater. Unfortunately, the groundwater samples are presently analyzed with an analytical method that does not measure tritium at levels below approximately 150 pCi/L. However, analytical methods are available from the University of Miami that accurately measure tritium levels in groundwater at levels less than 1 pCi/L. Because tritium is used as an indicator parameter for the presence of contamination in groundwater from the MWL, it is essential to use the University of Miami for analysis of tritium.

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Table 1. Soil Gas Concentrations Measured in 1994 at Locations Where Sandia/DOE Propose to Collect New Soil Gas Samples.

Note: The proposed locations are displayed on Figure 1. The soil gas samples were collected at depths of 10 ft and 30 ft below ground surface.

- Two locations approximately 10 to 20 ft west of western side of Trench A

	Total VOCs (ppb)				Tetrachloroethene (ppb)			
	10 ft	30 ft	change	% change	10 ft	30 ft	change	% change
-	1514	3960	+2446	+162%	1080	1700	+620	+57%
-	1166	4510	+3344	+ 287%	627	1479	+852	+136%

Three locations in north-south corridor between Trenches B and C

	Total VOCs (ppb)				Tetrachloroethene (ppb)			
	10 ft	30 ft	change	% change	10 ft	30 ft	change	% change
-	8020	9500	+1480	+18%	5200	5900	+700	+13%
-	30700	27700	-3000	-10%	1700	2500	+800	+47%
-	2460	4630	+2170	+88%	380	690	+310	+82%

One location outside MWL at southeast corner of classified area

	Total VOCs (ppb)				Tetrachloroethene (ppb)			
	10 ft	30 ft	change	% change	10 ft	30 ft	change	% change
-	477	2400	+1923	+403%	69	260	+191	+277%

Figure 1. Map Showing the Six Locations Proposed by Sandia for the Collection of Soil Gas Samples. The proposed locations are circled in red.

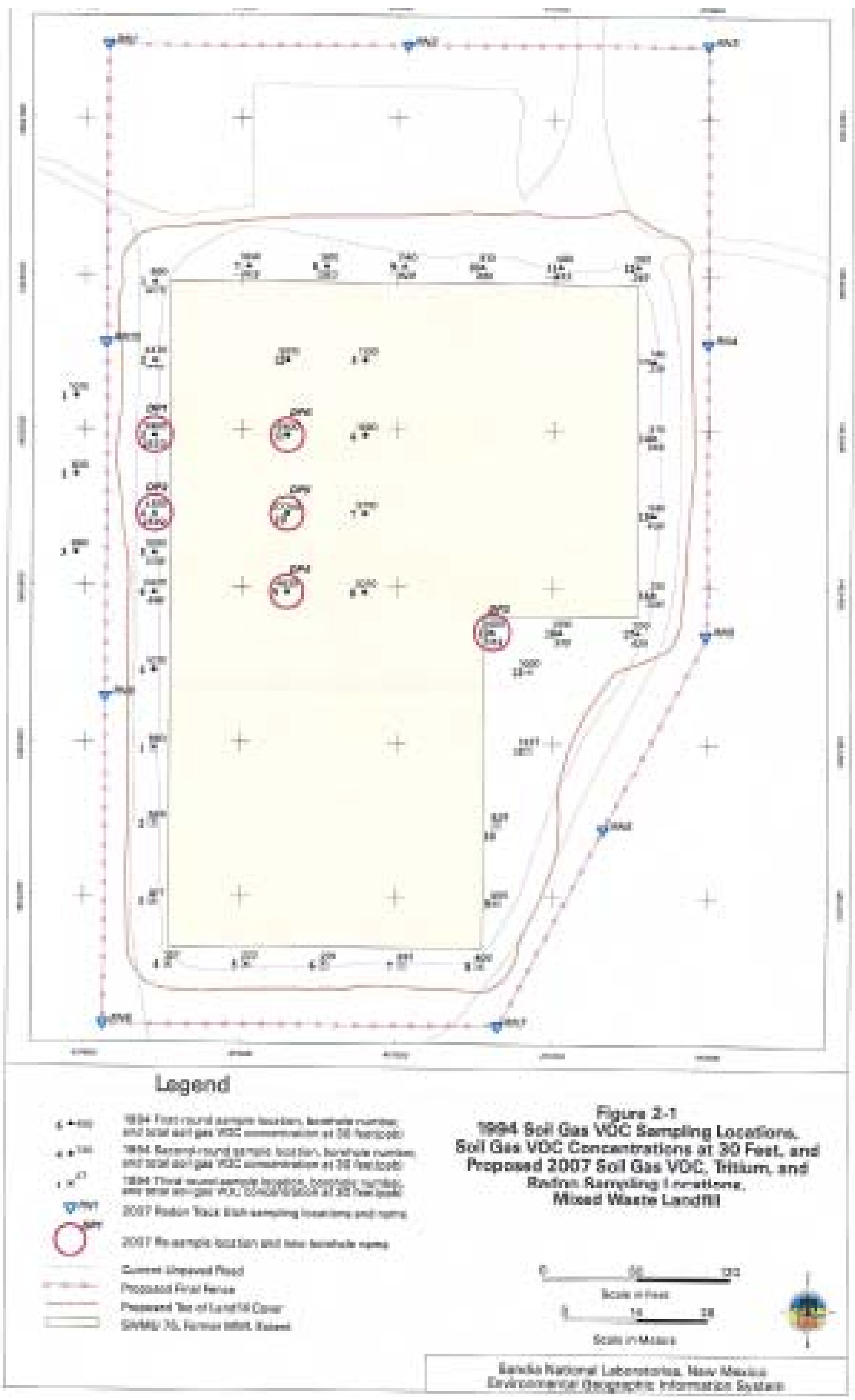


Figure 2. Map Showing the Locations of the Passive Soil Gas Measurements at Land Surface in the 1993 Soil Gas Survey at the Sandia MWL.

The map posts the measured values for the solvent tetrachloroethene (PCE) in nanograms per square meter per minute.

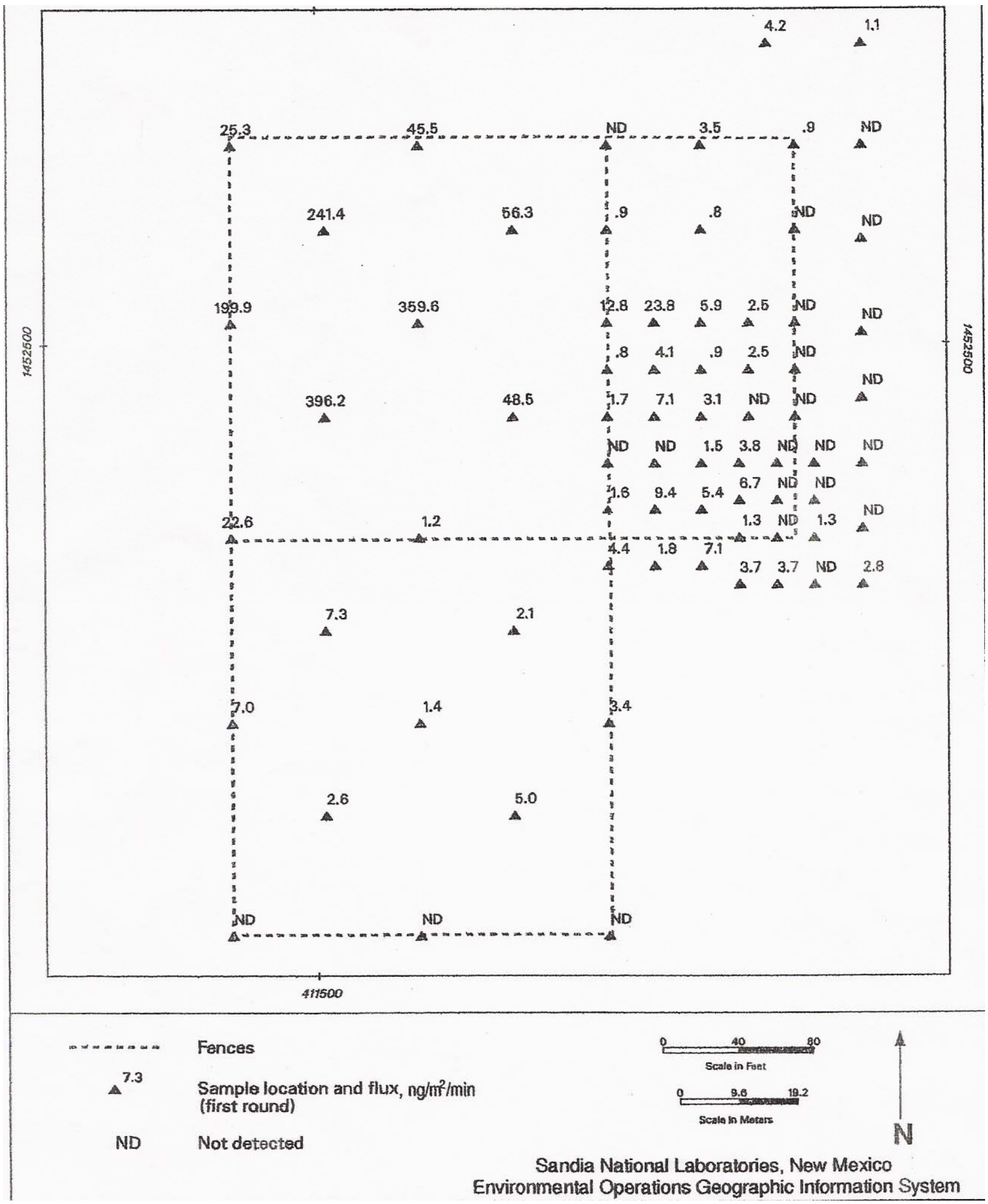


Figure 3. Locations of Soil Gas Measurements and Boreholes Compared to the Locations of Trenches and Pits at the Sandia Mixed Waste Landfill.

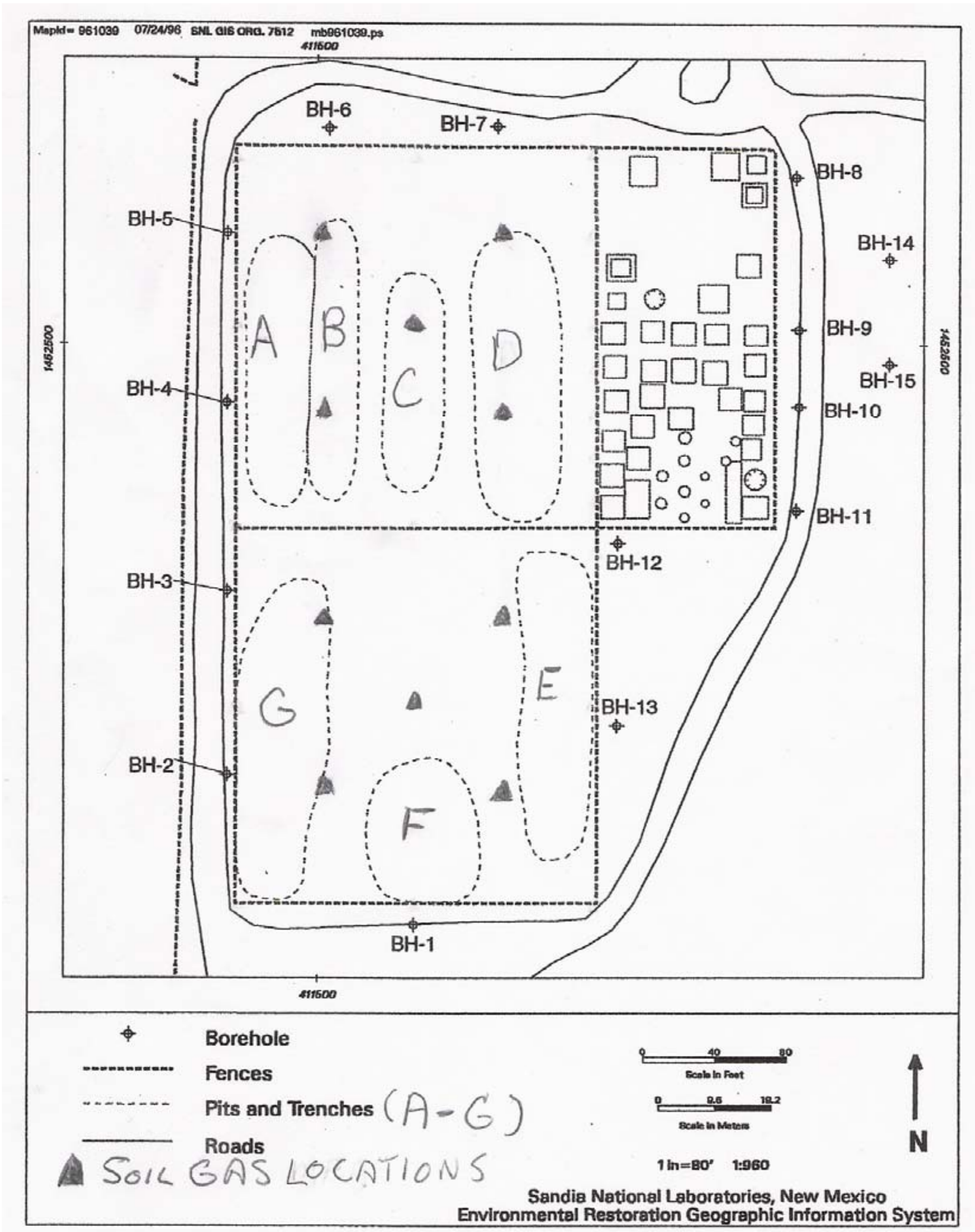


Figure 4. Tritium Contamination Measured in Surface Soils at the Sandia MWL.

The highest tritium contamination is measured immediately south of the disposal pit #33 where 822 Curies of tritium was buried. A monitoring well was never installed at the MWL to monitor the tritium hot spot.

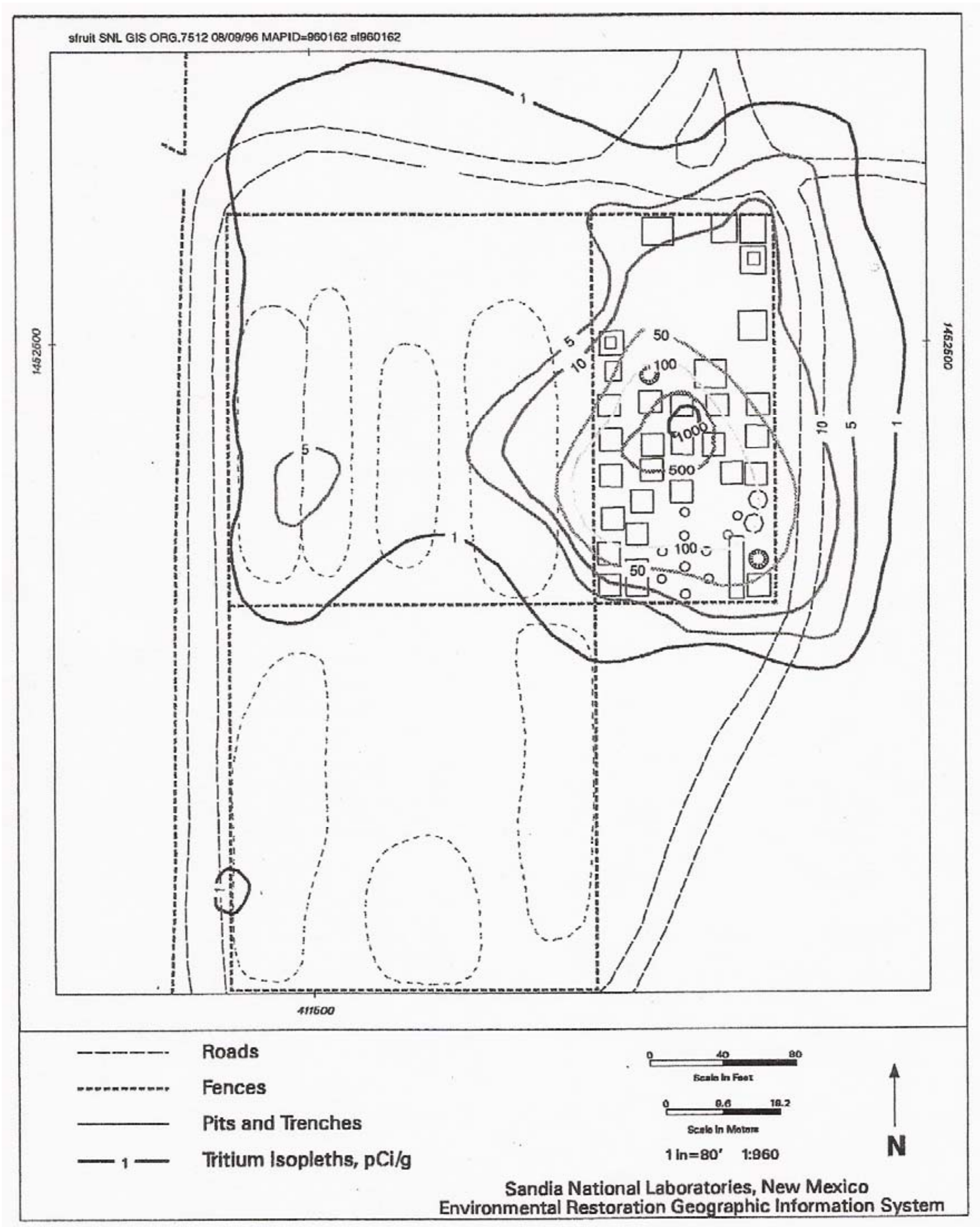


Figure 5. Map of the Sandia Mixed Waste Landfill showing the locations of the six monitoring wells MW1 to MW6 and the background water quality well BW1.

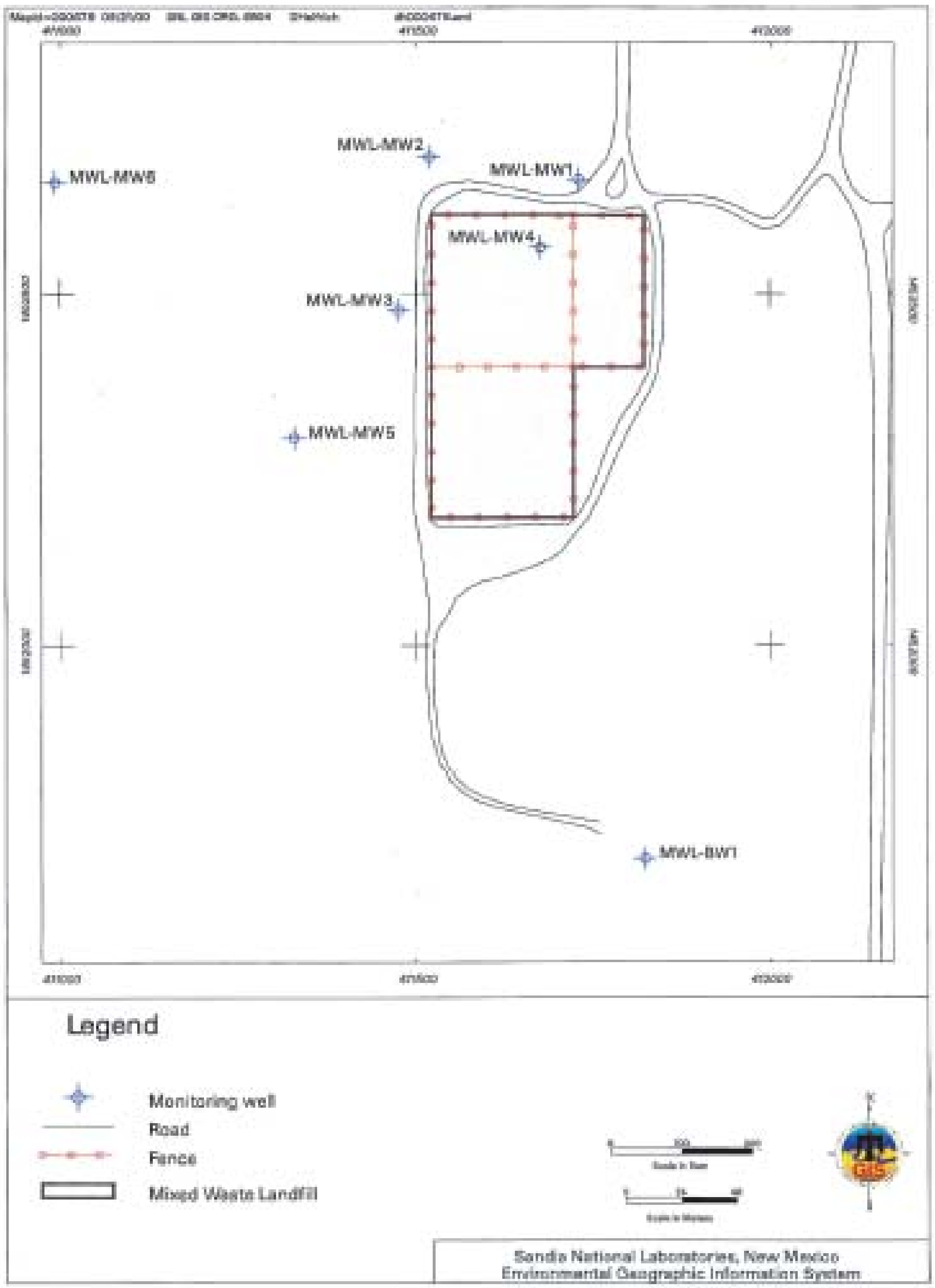
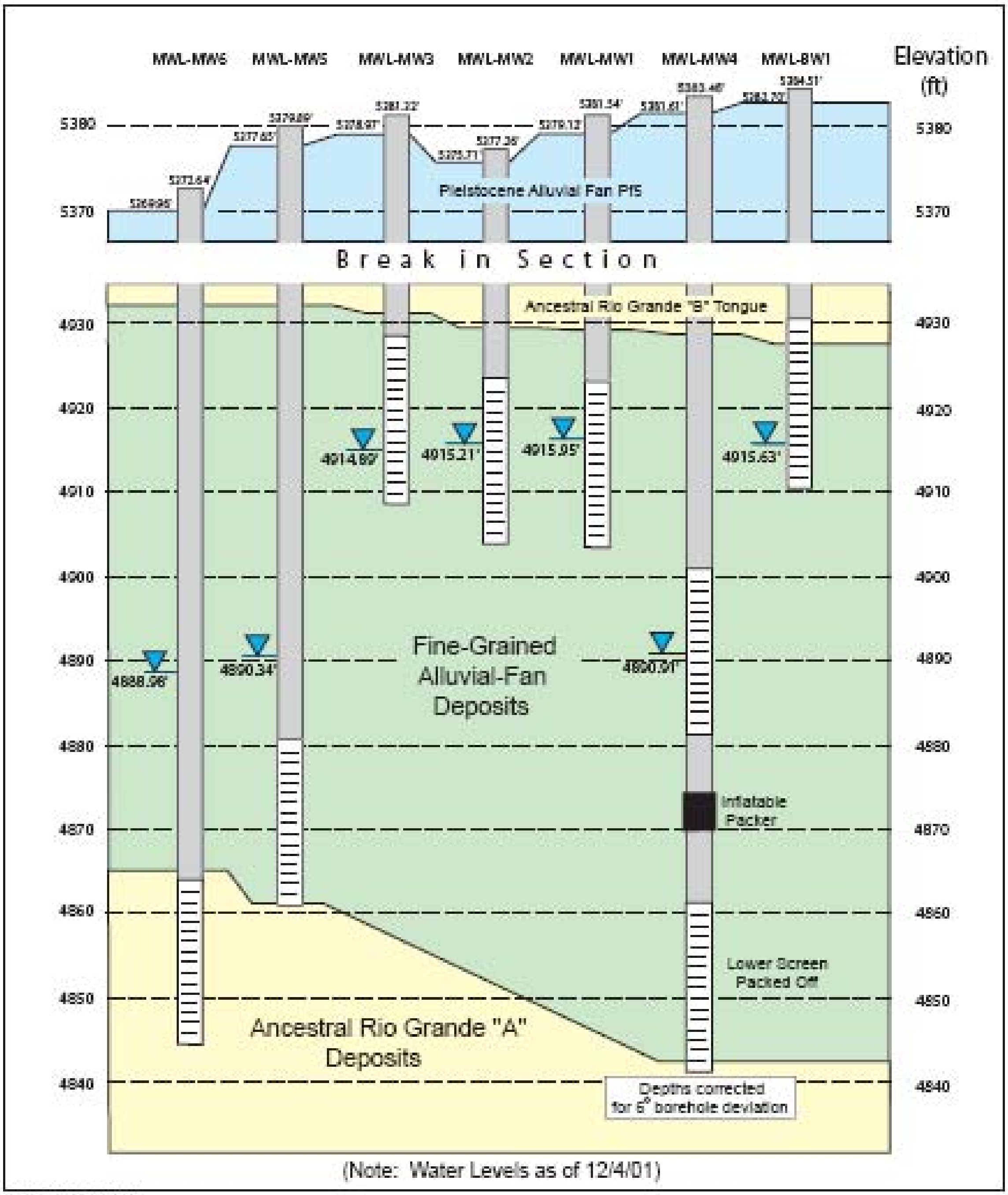


Figure 6. Schematic of the Monitoring Wells and the Hydrogeologic Setting at the Sandia Mixed Waste Landfill. The permeable sands and gravels in the *Ancestral Rio Grande "A Deposits are the "Uppermost Aquifer"* in RCRA Terminology and are the valuable groundwater resource for Albuquerque and the surrounding region.



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From Sandia Report SAND 2002-4098

Figure 7. Water Level Map Showing the Southwest Direction of Groundwater Travel at the Water Table in the Alluvail Fan Sediments (the AF Facies) Below the Sandia Mixed Waste Landfill.

- Wells BW1, MW1, and MW2 are *cross-gradient* to the direction of groundwater flow in the AF Facies beneath the MWL.

- Well MW3 is the only well in the AF Facies that is located downgradient of the MWL. <u>RCRA requires a minimum of three wells at downgradient locations near the MWL</u>.

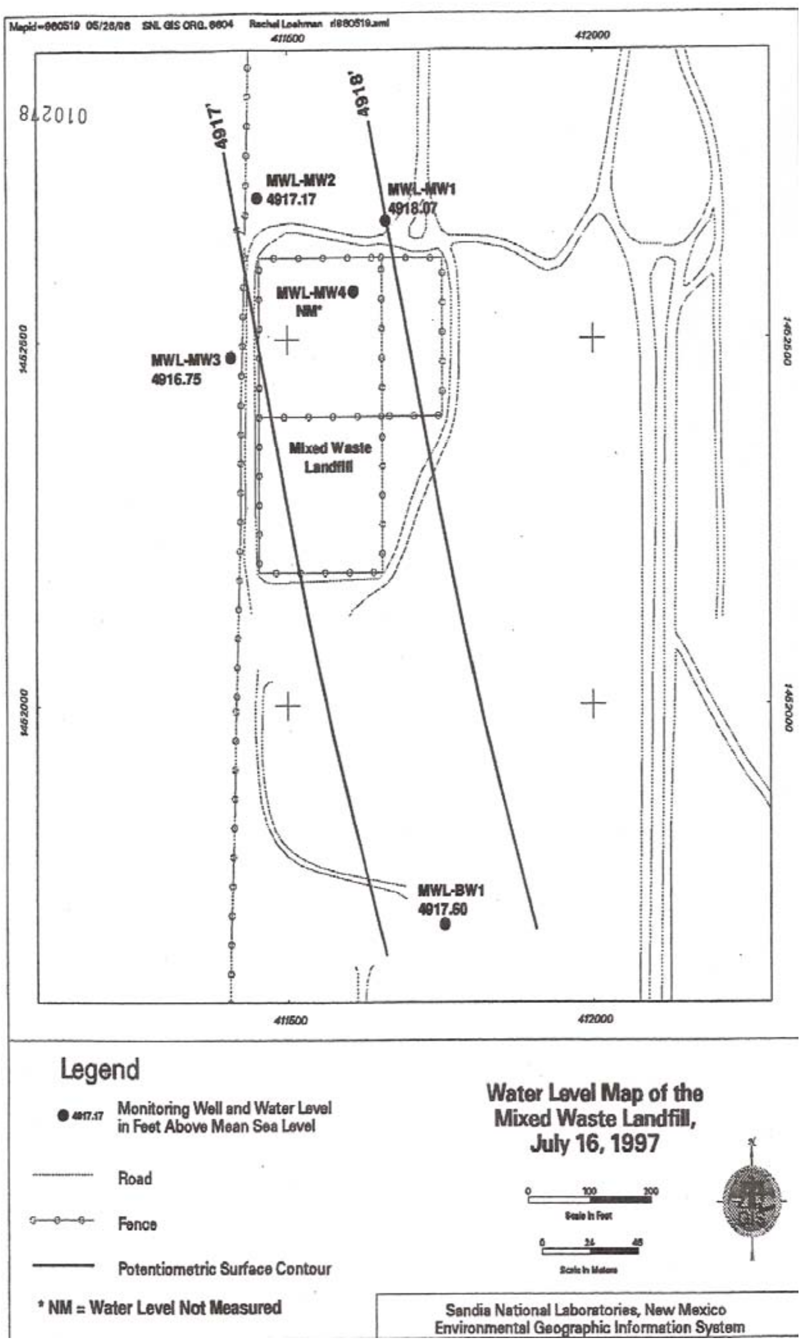

Figure 7 is NMED Administrative Record No. 010278.