Defective Groundwater Protection Practices at the Sandia National Laboratories' Mixed Waste Landfill – The Sandia MWL dump.
- Version December 30, 2010

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Executive Summary - Foreword. Sandia National Laboratories Albuquerque, New Mexico Facility (Sandia) is owned by the U.S. Department of Energy (DOE). The New Mexico Environment Department (NMED) and DOE/Sandia are responsible for the protection of Albuquerque's sole source drinking water aquifer that is essential to the present and future health of citizens and economic development. This report documents the past and current need for revision of groundwater protection practices at the Sandia "Mixed Waste Landfill" (MWL or MWL dump). The Sandia MWL dump lies above the drinking water resource for 600,000 Albuquerque residents.

The Sandia MWL dump was originally named the "TA-3 low-level radioactive waste dump" during the 30 years of nuclear weapons waste disposal operations from April 1959 through December 1988. The term "MWL dump" is used in this report. The required engineered features of a Resource Conservation and Recovery Act (RCRA) "landfill" including liners, leachate collection and a reliable network of monitoring wells were not provided at the Sandia MWL dump from 1959 to the present. See Section ES-3 for a summary of landfill requirements.

Contrary to the statements found in DOE/Sandia and NMED Reports, this report provides substantial evidence that the Sandia MWL dump has contaminated the groundwater with cadmium, chromium, nickel and nitrate. The nature and extent of the groundwater contamination is not known because of the defective groundwater monitoring. The wastes buried in the unlined trenches and pits at the 2.6 acre Sandia MWL dump are a large inventory of commingled hazardous, mixed and radioactive wastes. There is much uncertainty in the type and total inventory of the buried wastes.

The NMED Hazardous Waste Bureau (HWB) has not enforced the requirements in RCRA and the NMED Sandia Consent Order for a reliable network of monitoring wells in two different zones of saturation below the MWL dump. The NMED HWB only required a network of monitoring wells to be installed at the water table below and hydraulically downgradient of the MWL dump, but a reliable network of monitoring wells was not installed for this purpose from the first four monitoring wells installed in 1988 and 1989 to the four new monitoring wells installed in 2008.

The NMED decision in 2005 to leave the commingled hazardous, mixed and radioactive wastes in place below a dirt cover was based on unreliable data. The data came from a network of groundwater monitoring wells that were described by government scientists as being in the wrong locations, insufficient in number and not in compliance with RCRA. The reports were issued during the period from 1991 to 1998 by scientists from the DOE Tiger Team, Los Alamos National Laboratory, NMED and the U.S. Environmental Protection Agency (EPA). Four of the reports that described the requirement to replace all of the seven monitoring wells installed at the MWL dump over the period 1988 to 2007 are summarized in Sections ES-7 to ES-11 in this Executive Summary.

This review of the monitoring wells by Mr. Gilkeson and Citizen Action has determined that only two of the six contaminant detection monitoring wells displayed on Figure ES-2 (i.e., wells MWL-MW1 and -MW3) were at locations that could detect groundwater contamination from the Sandia MWL dump.

A careful and comprehensive review of the water quality data from the two monitoring wells by Mr. Gilkeson and Citizen Action has determined that the wastes buried in the MWL dump have contaminated the groundwater with the RCRA hazardous waste constituents cadmium, chromium, nickel and nitrate. The contamination was present in the first groundwater samples collected in 1990 and over time there was a large increase in the nickel groundwater contamination. The failure of DOE/Sandia and the NMED to recognize the groundwater contamination is a serious issue requiring correction. The evidence of the groundwater contamination in the water quality data collected in the early 1990s up the present time satisfy the RCRA criteria that are the standard industry practice for review of water quality data from monitoring wells.

Important new evidence of the groundwater contamination is the very low concentrations of cadmium, chromium, nickel and nitrate measured in the new background monitoring well MWL-BW2 that was installed in 2008. The very low concentrations measured in well MWL-BW2 compared to the markedly higher concentrations of cadmium, chromium, nickel and nitrate measured in the groundwater samples collected from monitoring wells MWL-MW1 and MW3 in the early 1990s and up to 2007 satisfy RCRA criteria that the Sandia MWL dump has contaminated the groundwater.

An important issue is that the 2007 DOE/Sandia fate and transport computer modeling report (FTM Report) by Ho, et al (2007) omitted the conclusions from the computer modeling that the Sandia MWL dump was contaminating the groundwater with the highly toxic solvent tetrachloroethene (PCE). The conclusions from the computer modeling were ignored in favor of the unreliable water quality data from the six defective monitoring wells that show the groundwater was not contaminated with PCE. DOE/Sandia did not recognize that only the two monitoring wells MWL-MW1 and -MW3 were at locations that could detect the PCE groundwater contamination. In addition, DOE/Sandia disregarded the well known factors that prevented the two wells from being able to detect the PCE groundwater contamination.

An additional important issue is that the limited and incorrectly designed DOE/Sandia 2008 field investigation discovered a large release of tritium contamination in the vadose zone below the Sandia MWL dump. The dirt cover was installed without the required comprehensive study of the nature and extent of the new contamination released from the unlined pits and trenches.

Another important issue is that none of the six contaminant detection monitoring wells in the current monitoring well network on Figure ES-3 are able to detect groundwater contamination from the Sandia MWL dump. The NMED HWB should correct its mistake to approve all of the unreliable monitoring wells and to allow DOE/Sandia to use the unreliable monitoring wells for future long-term monitoring of the Sandia MWL dump.

An April 14, 2010 report by the U.S. EPA Office of Inspector General revealed that EPA Region 6 withheld an Oversight Review from the public that concurred with the valid concerns of Citizen Action and Registered Geologist Robert H. Gilkeson for the unreliable monitoring well network at the Sandia MWL dump.

A 2006 TechLaw, Inc. technical report, released to Citizen Action in late 2009 after a public records lawsuit, disclosed inadequate dirt cover design, inadequate provisions for monitoring for moisture beneath the cover, and an inadequate DOE/Sandia computer model for fate and transport of contaminant movement beneath the MWL dump.

This report - *Defective Groundwater Protection Practices at the Sandia National Laboratories' Mixed Waste Landfill – The Sandia MWL dump, Version December 30, 2010* by Robert H. Gilkeson and David B. McCoy is over 300 pages in length with appendices. The great length of the report was required and is the reason that the Executive Summary is a stand-alone report with Figures, Tables and References.

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<u>Section ES-1.</u> **The wastes buried in the unlined trenches and pits at the Sandia MWL dump have contaminated the groundwater.** The wastes at the Sandia MWL dump were disposed of in unlined trenches up to 20 feet deep and unlined pits up to 25 feet deep (NMED, August 2004). Figure ES-1 shows the locations of the unlined trenches and unlined pits at the 2.6-acre MWL dump. Figures ES-2 and ES-3 show the locations of the eleven monitoring wells installed over the years 1988 through 2008. The monitoring well network installed at the Sandia MWL dump remained defective and unreliable to detect groundwater contamination to the present for many reasons that are described in this report.

Of the seven monitoring wells displayed on Figure ES-2, only two monitoring wells MWL-MW1 and -MW3 were installed at locations that could detect groundwater contamination from the MWL dump. A review of the water quality data from the two monitoring wells MWL-MW1 and -MW3 shows that the wastes buried in the MWL dump have contaminated the groundwater with the RCRA listed wastes cadmium, chromium, nickel and nitrate first seen in groundwater samples collected from 1990 and later. The nickel groundwater contamination from the wastes buried in the dump increased over time.

The determination that the MWL dump has contaminated the groundwater is realized from comparison of the water quality data from monitoring wells MWL-MW1 and -MW3 to the water quality data from 1). the original background water quality monitoring well MWL-BW1 that was installed in 1989 and from 2). the new background water quality monitoring well MWL-BW2 that was installed in 2008. <u>The exact amount of the four contaminants and the presence of other groundwater contamination from the Sandia MWL dump is unknown because a reliable monitoring well network was not installed beginning with the first four monitoring wells installed in 1988 and 1989 to the most recent four new monitoring wells installed in 2008.</u>

The reasons ten of the eleven monitoring wells installed at the MWL dump were defective and did not produce reliable and representative groundwater samples are summarized in Table ES-1. The specific reasons monitoring wells MWL-MW1 and MWL-MW3 did not produce reliable and representative groundwater samples include:

- 1). the corrosion of the Type 304 stainless steel well screens beginning in 1992,
- 2). the high-flow purging and sampling methods that purged the two wells to dryness and collected water samples up to a week later from the aerated water that refilled the wells, and
- 3). the mud-rotary drilling method with bentonite clay drilling muds used for the installation of monitoring well MWL-MW3.

<u>Two DOE/Sandia FTM studies identify that the solvent tetrachloroethene (PCE) wastes buried in the Sandia MWL dump have contaminated the groundwater.</u> However, none of the monitoring wells installed at the MWL dump were/are reliable to detect the highly

toxic PCE groundwater contamination. The DOE/Sandia fate and transport computer modeling (FTM) studies in 1995 (Klavetter, 1995) and 2007 (Ho et al., 2007) identified that the groundwater below the MWL dump was contaminated with PCE. However, the three factors described above prevented the defective monitoring wells MWL-MW1 and -MW3 from producing reliable and representative groundwater samples for the detection and amounts of PCE contamination. For example, research by the DOE/Sandia staff (Collins et al., 2003) concluded that the Bennett[R] high-flow pump that was used for sampling the MWL dump monitoring wells including wells MWL-MW1 and -MW3 prevented reliable detection of PCE contamination and other solvent contamination in the collected water samples.

Section ES-2. **There is great uncertainty in the amount and type of wastes buried in the unlined trenches and pits at the Sandia MWL dump.** A large and poorly documented inventory of commingled hazardous wastes, low-level radioactive wastes, and mixed wastes were buried in unlined trenches and pits at the Sandia MWL dump. The contradictory information on the total quantity of wastes buried in the MWL dump ranges from 100,000 cubic feet to 780,000 cubic feet (WERC, 2003) and up to 1,500,000 cubic feet in the DOE/Sandia Corrective Measures Study (DOE/Sandia, November 2002).

Section ES-3. **The wastes at the Sandia MWL dump were disposed of in unlined trenches and pits with no features to prevent the release of contaminants to the groundwater resource for Albuquerque and the surrounding region. None of the RCRA landfill requirements were provided at the Sandia MWL dump.** The Sandia MWL dump was named the "TA-3 low-level radioactive waste dump" during the 30 years of waste burial operations from March 1959 through December 1988 (Ho et al., 2007). The name of the TA-3 dump was arbitrarily changed to "mixed waste landfill" In DOE/Sandia reports issued after April 1988 (NMED, August 2004). The Sandia MWL dump cannot comply with RCRA regulatory permit requirements to operate as an engineered landfill for disposal of mixed or hazardous wastes. The unlined pits and trenches are therefore most appropriately referred to as the Sandia MWL dump because of the following factors:

- There were no liners installed at the bottom or sides of the trenches or pits to prevent the release of contamination from the buried wastes.
- There was no leachate detection or leachate collection system at the bottom of the unlined trenches and pits.
- No contaminant detection soil gas monitoring wells were ever installed in the unsaturated zone (vadose zone) below the unlined trenches and pits.
- A reliable network of monitoring wells to detect groundwater contamination from the MWL dump was not installed.
- The monitoring well network in the DOE/Sandia long-term monitoring plan is also defective and will mask the detection of contamination in the vadose zone below the unlined trenches and pits and in the groundwater below the MWL dump.

<u>Section ES-4.</u> A reliable, properly located network of monitoring wells was not installed at the Sandia MWL dump. A total of nine contaminant detection monitoring wells and two background water quality monitoring wells were installed at the MWL dump over the years from 1988 to 2008. <u>Ten of the eleven monitoring wells were known to be defective and unable to produce reliable and representative groundwater samples at the time of installation or within two years after installation.</u> None of the defective wells were replaced until 2008. However, the three new contaminant detection monitoring wells installed in 2008 are also defective and require replacement. The history of the monitoring wells at the MWL dump is summarized in Table ES-1. The locations of the eleven monitoring wells are displayed on Figures ES-2 and ES-3.

<u>Section ES-5.</u> RCRA and the NMED Sandia Consent Order require networks of monitoring wells in two different zones of saturation below the Sandia MWL dump. Reliable networks of monitoring wells were not installed in either zone at any time. Figure ES-4 is a geologic cross-section that displays the two zones of saturation below the Sandia MWL dump that both require separate networks of monitoring wells.

- 1). <u>The upper zone that requires a network of monitoring wells is the water table in the fine-grained alluvial fan sediments.</u> The fine-grained alluvial fan sediments have very low permeability (also known as saturated hydraulic conductivity) and do not produce sufficient amounts of groundwater for a water supply (Goering et al., 2002). However, a reliable network of monitoring wells is important at the water table in the fine-grained alluvial fan sediments for the early detection of groundwater contamination from the wastes buried in the unlined trenches and pits at the Sandia MWL dump. The NMED Hazardous Waste Bureau (HWB) has only required DOE/Sandia to install monitoring wells at the water table in the fine-grained alluvial fan sediments. Nevertheless, a reliable network of monitoring wells was not installed at the water table in the fine-grained alluvial fan sediments since the Sandia MWL dump opened in April 1959 to the present time in December 2010.

- 2). <u>The deeper zone that requires a network of monitoring wells is the layer of Ancestral Rio Grande "A" Deposits (ARG Deposits) that are shown below the layer of fine-grained alluvial fan sediments on Figure ES-4</u>. The ARG Deposits are the highly productive aquifer that provides large supplies of groundwater to the Albuquerque drinking water wells and the supply wells at Sandia and at Kirtland Air Force Base. The NMED HWB has not, but should enforce the requirement in RCRA and the NMED Sandia Consent Order for a network of monitoring wells in the ARG Deposits.

Historically, only one monitoring well was installed in the ARG Deposits. This is well MWL-MW6 on Figure ES-2. The intended purpose of well MWL-MW6 was to monitor at the water table in the fine-grained alluvial fan sediments but Figure ES-4 shows that the well screen was installed in the deeper layer of ARG Deposits because of mistakes in installing the monitoring well. The monitoring well MWL-MW6 is too distant for RCRA compliance at over 500 feet from the MWL dump.

<u>Section ES-6.</u> The first network of four monitoring wells were installed at the wrong locations at the Sandia MWL dump because of the incorrect assumption that groundwater flow at the water table below the MWL dump was to the northwest. The first network of monitoring wells installed at the Sandia MWL dump is displayed on Figure ES-2 and includes monitoring wells MWL-MW1, -MW2, -MW3, and -BW1. The first four monitoring wells were installed in 1988 and 1989. The background water quality monitoring well MWL-BW1 was installed 500 feet south of the MWL dump and contaminant detection monitoring wells MWL-MW1 and -MW2 were installed north of the MWL dump because of the incorrect assumption that the direction of groundwater flow was to the northwest. However, the water levels measured in the four monitoring wells in the early 1990s (Rea, 1991) (Moats and Winn, 1993) (EPA, 1994) determined that the direction of groundwater flow at the water table below the MWL dump was not to the northwest but instead to the southwest.

<u>Section ES-7.</u> The Los Alamos National Laboratory (LANL) wrote a report in 1991 (Rea, 1991) that described the southwest direction of the groundwater flow and the failure of the monitoring well network at the Sandia MWL dump to be in RCRA compliance for proper location to detect contamination. The 1991 LANL report was written after the first four monitoring wells MWL-MW1, -MW2, -MW3 and -BW1 were installed at the MWL dump. The pertinent excerpt from page 3 of the LANL report follows:

> It is stated that "three additional wells were installed, two downgradient and one upgradient…" It would be appropriate to mention here that the data from these [four] wells indicated that the network has in fact only one downgradient well [i.e., well MWL-MW3] and no wells that are definitely upgradient.
>
> <u>The data from the present monitoring well network indicates that there is only one downgradient and no upgradient wells. This in itself establishes the inadequacy (under RCRA) of the present well network</u> [Emphasis supplied].

Nevertheless, the monitoring well network recognized by the LANL scientists as not meeting RCRA requirements for proper location continued to be represented by DOE/Sandia as a reliable network of monitoring wells up to the present time. The fact that the direction of groundwater flow at the water table below the MWL dump was to the south or southwest and made the monitoring well network "inadequate" was also described in a 1993 NMED report by NMED staff Mr. Will Moats and Ms. Lee Winn (Moats and Winn, 1993) as follows:

> The hydrogeologic conditions at the MWL have not been adequately characterized. . . Water level data from July 1992 indicate south-directed or southwest directed flow. However, the gradient and direction of ground-water flow are not known with reasonable certainty (p. 3).
>
> The detection monitoring system that currently exists at the MWL is inadequate because the direction and speed of ground-water flow can not be determined with reasonable certainty (p.7).

Unfortunately, the direction and speed of groundwater travel below the MWL dump was not accurately determined to the present. Instead, DOE/Sandia produced many reports up to 2008 (DOE/Sandia, February 2008) that incorrectly represented the direction of groundwater flow at the water table below the MWL dump to be to the northwest. Despite the 1991 LANL report, the 1993 NMED report (Moats and Winn, 1993) and several later reports describing the monitoring well network as "inadequate" for having only one downgradient monitoring well and lacking any upgradient well, the February 2008 DOE/Sandia Annual Groundwater Monitoring Report incorrectly purports that a reliable network of monitoring wells exists:

> Six of the seven monitoring wells at the MWL were sampled including on-site monitoring well MWL-MW4 and downgradient monitoring wells MWL -MW1, MWL-MW2, MWL-MW3, MWL-MW5 and MWL-MW6 [Emphasis supplied] (p. 3-1).

In fact, monitoring well MWL-MW3 was the only monitoring well at an appropriate location hydraulically downgradient of the MWL dump with a well screen installed to monitor contamination at the water table below the MWL dump. The 2008 DOE/Sandia Report is an example of the long-standing practice of DOE/Sandia to incorrectly describe the groundwater flow below the Sandia MWL dump as toward the northwest continuing the **fiction** that monitoring wells MWL-MW1, -MW2 and -MW6 were "downgradient" monitoring wells.

Section ES-8. The February 2008 DOE/Sandia Report continues the incorrect conclusion that the direction of groundwater flow at the water table below the MWL dump is to the northwest even *after* the NMED HWB issued a letter on July 2, 2007 that the direction of groundwater flow was to the southwest. The NMED July 2, 2007 letter (Bearzi, 2007) required the replacement of the defective monitoring wells MWL-MW1 and -MW3. The letter described the direction of groundwater flow to be toward the southwest as follows:

> Additionally, each well [i.e., the new monitoring wells MWL-MW7 and -MW8] shall be installed at locations as close as possible to the western boundary of the landfill, taking into account the footprint of the future landfill cover. This change in well locations, particularly for MWL-MW1, is based on better preparing the MWL for long-term monitoring of the groundwater which flows west-southwest [Emphasis supplied].

The water table contour map in Figure ES-5 shows the incorrect northwest flow of groundwater below the MWL dump that was presented in the DOE/Sandia 2008 Report. However, it is important to note that the water table elevations posted on Figure ES-5 for the three monitoring wells MWL-MW1, -MW2 and -MW3 show that the actual direction of groundwater flow below the MWL dump is to the ***southwest***.

Figure ES-6 presents the best available knowledge on the southwest direction of groundwater flow below the MWL dump because the direction of groundwater flow is based on the water table elevation measured in the three monitoring wells MWL-MW1, -MW2, -MW3 and also in the new monitoring well MWL-BW2 that was installed in 2008. Figure ES-6 shows the continuing important need and RCRA requirement for monitoring wells to be installed on the south side of the Sandia MWL dump.

Section ES-9. **The Environmental Protection Agency (EPA) Region 6 issued a Notice of Deficiency (NOD) Report on September 22, 1994 (EPA, 1994) for the March 1993 DOE/Sandia Phase 2 RCRA Facility Investigation (RFI) Work Plan for the Sandia MWL dump. T**he 1994 EPA Region 6 NOD Report rejected the DOE/Sandia description of a reliable network of monitoring wells in the following pertinent excerpt:

> **Comment no. 11.** On page 2-31 [in the RFI Work Plan], the third paragraph states that regional potentiometric maps indicate that the hydraulic gradient at the MWL is toward the west and northwest. As shown in Figure 2-21, the MWL monitoring well network (i.e., MWL-BW1, MWL-MW1, MWL-MW2, and MWL-MW3) has been installed based on the assumed regional hydraulic gradient. However, the third paragraph further continues to state water level data collected from the MWL monitoring wells suggests the hydraulic gradient is to the southwest (p,5).
>
> Based on the southwest gradient flow of groundwater, the MWL monitoring wells are located cross gradient instead of downgradient from the MWL; therefore, contaminants emanating from the MWL may not be detected in the monitoring wells [Emphasis supplied] (p. 6).

The EPA 1994 NOD Report presented findings that the monitoring well network installed at the MWL dump was not reliable to detect groundwater contamination from the wastes buried in the dump. However, the network of monitoring wells was not improved at any time from the network identified as unreliable in the EPA 1994 NOD Report and in the earlier reports by LANL (REA, 1991) and the NMED HWB (Moats and Winn, 1993).

Section ES-10. **Despite the EPA 1994 NOD Report, DOE/Sandia described the defective and unreliable monitoring well network at the Sandia MWL dump as a reliable network of monitoring wells in the 1996 Phase 2 RCRA Facility Investigation (RFI) Report.** DOE/Sandia continued to describe the defective and unreliable monitoring well network at the Sandia MWL dump as a reliable network of monitoring wells in the 1996 Phase 2 RCRA Facility Investigation (RFI) Report. DOE/Sandia ignored the conclusion in the EPA 1994 NOD Report that ***"contaminants emanating from the MWL may not be detected in the monitoring wells."*** DOE/Sandia issued a Phase 2 RCRA RFI Report in 1996 (DOE/Sandia, 1996) that described the defective monitoring well network with only one downgradient monitoring well as reliable and sufficient to detect groundwater contamination from the wastes buried in the MWL dump.

The monitoring well network that was presented as a reliable and sufficient network in the Phase 2 RCRA Facility Investigation (RFI) Report (DOE/Sandia, 1996) was the same network that was described as not in compliance with RCRA in the 1991 LANL report (Rea, 1991) as "inadequate" in the 1993 NMED Report (Moats and Winn, 1993) and as unreliable to detect contamination in the 1994 EPA Notice of Deficiency Report.

In addition, the DOE/Sandia 1996 Phase 2 RFI Report presented the incorrect conclusion that there was no groundwater contamination from the Sandia MWL dump. However, as described earlier in this Executive Summary, the water quality data presented in the 1996 Phase 2 RFI Report provided evidence that the RCRA wastes buried in the unlined trenches and pits had contaminated the groundwater below the MWL dump with cadmium, chromium, nickel and nitrate.

<u>Section ES-11.</u> In 1998 the NMED HWB issued a Notice of Deficiency (NOD) Report for the 1996 DOE/Sandia Phase 2 RCRA Facility Investigation (RFI) Report. <u>The NMED 1998 NOD Report described the overall failure of DOE/Sandia to install a reliable network of monitoring wells at the Sandia MWL dump.</u> The NMED 1998 NOD Report (Garcia, 1998) identified the following five deficiencies with the 1996 Phase 2 RCRA Facility Investigation (RFI) Report for groundwater protection at the MWL dump:

- #1 deficiency. Well MWL-MW3 was the only downgradient monitoring well. The pertinent excerpt from the 1998 NMED NOD Report follows:

> The water-table map indicated that there is only one downgradient monitor well at the Mixed Waste Landfill [i.e., well MWL-MW3]. Normally, a minimum of three downgradient wells is required for an adequate detection monitoring system (p. 1-2).

The 1998 NMED NOD Report required DOE/Sandia to install two new monitoring wells west of the MWL dump with the well screens installed across the water table in the fine-grained alluvial fan sediments. Accordingly, wells MWL-MW5 and -MW6 were installed west of the MWL dump in 2000. However, the geologic cross-section in Figure ES-4 shows that the screens in the two monitoring wells were installed too deep for the intended purpose to monitor at the water table in the fine-grained alluvial fan sediments.

The NMED HWB has not, but should require replacement of the unreliable monitoring wells as is required by the April 29, 2004 Consent Order (p.63) for monitoring wells that do not serve their intended purpose. Figure ES-3 shows that the two unreliable monitoring wells MWL-MW5 and -MW6 are in the current network of monitoring wells. In addition, DOE/Sandia proposes to use the two unreliable monitoring wells that do not allow accurate assessment of groundwater contamination in the long-term monitoring and maintenance plan for the MWL dump (DOE/Sandia, 2007).

- #2 deficiency. The upper screen in the onsite monitoring well MWL-MW4 was installed too deep below the water table for the well to measure the elevation of the water table or detect groundwater contamination at the water table. The pertinent excerpts from the 1998 NMED NOD Report follow:

> The top of the upper screen of MWL-MW4 is located approximately 22 ft below the water table. Because of the vertical gradient and the way the well is constructed, <u>MWL-MW4 is of **no value** for determining the elevation of the water table (and therefore, the horizontal direction of ground-water flow and the horizontal gradient</u> [Emphasis supplied] (p.7).
>
> Also, because the top of the upper screen of MWL-MW4 is located 22 ft. below the water table, <u>the well is of **little value** for detecting any groundwater contamination (if any exists) that may be present in the saturated zone just below the water table</u> [Emphasis supplied] (p.7).

The installation of the upper screen in well MWL-MW4 too deep below the water table is displayed on Figure ES-4. The NMED has not, but should require replacement of the defective monitoring well. <u>Many DOE/Sandia reports present the unreliable water quality data collected from the defective well MWL-MW4 for the incorrect conclusion that the MWL dump has not contaminated the groundwater below the Sandia MWL dump.</u>

- **#3 deficiency.** The NMED 1998 NOD Report required DOE/Sandia to prove on a technical basis that the high nickel concentrations measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 were only from the corrosion of the stainless steel well screens as follows:

> DOE/SNL must support their position on a technical basis that the elevated nickel levels detected in groundwater samples from monitor well MWL-MW1 (and MWL-MW3) are a result of the corrosion of 304 stainless steel well screen; otherwise, such elevated levels of nickel will be attributed to a release of contaminants from the landfill [Emphasis supplied] (p.3).

DOE/Sandia did not prove that the high nickel concentrations in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 were not from the nickel wastes buried in the MWL dump. DOE/Sandia continued the incorrect assumption and unproven conclusion that the high concentrations of dissolved nickel were only from corrosion of the stainless steel well screens.

The nickel concentrations measured in the groundwater samples collected from the four monitoring wells at the MWL dump that had stainless steel screens are listed in Table ES-2. The nickel data in Table ES-2 show the remarkably high dissolved nickel concentrations measured in the groundwater samples collected from the contaminant detection monitoring wells MWL-MW1 and -MW3 located close to the MWL dump compared to the low dissolved nickel concentrations measured in the groundwater samples collected from the two background monitoring wells MWL-BW1 and -MW2 located distant from the MWL dump.

The high dissolved nickel concentrations measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 are statistically significant evidence under RCRA criteria of groundwater contamination from the nickel wastes buried in the unlined pits and trenches at the Sandia MWL dump.

Table ES-2 shows the high dissolved nickel concentrations measured in the first groundwater samples collected from monitoring well MWL-MW1 in the early 1990s before the assumed onset of corrosion in the stainless steel well screens beginning in 1992 (Pruett, 2005). RCRA requires replacement of monitoring wells with corroded screens that prevent reliable detection of contamination. The NMED HWB continued acceptance of the unreliable data that were not in compliance with RCRA and the NMED Consent Order up to the DOE/Sandia Report issued in 2008. The NMED HWB did not require replacement of the unreliable monitoring wells MWL-MW1 and -MW3 until a letter issued by NMED HWB Chief James Bearzi on July 2, 2007 as follows:

> Additionally, both wells are also constructed with stainless steel screens, which are suffering corrosion to such a degree that the wells can longer produce water samples that are representative of aquifer conditions for chromium, iron, and nickel (p. 1).

In fact, the NMED knew in 1992 that the two corroded monitoring wells MWL-MW1 and -MW3 did not produce reliable and representative groundwater samples for detection of chromium, nickel, other RCRA metals and many radionuclides including americium and plutonium. Nevertheless, NMED relied on 12 years of data from the unreliable monitoring wells to recommend leaving the MWL dump wastes buried below a dirt cover. This is shown by Finding of Fact 81 in the Hearing Officer's Report (Pruett, 2005) as follows:

> 81. Elevated levels of nickel and chromium have been detected since 1992 in MWL-MW1, MWL-MW2, MWL-MW3 and MWL-BW1, which wells are all constructed with stainless steel well screens. NMED attributes these elevated levels to corrosion of the stainless steel well screens.

<u>There are four issues in Finding of Fact 81:</u>

- First, DOE/Sandia did not provide a technical basis for the incorrect assumption that the elevated levels of nickel measured in groundwater samples collected from wells MWL-MW1 and -MW3 were only from corrosion. Therefore, the NMED 1998 NOD Report attributed the elevated levels of nickel in the water samples collected from the two wells to groundwater contamination from the wastes buried in the MWL dump.

- Second, the very low median dissolved nickel concentration of 1.2 ug/L measured in the groundwater samples collected from the new background monitoring well MWL-BW2 DOE/Sandia, 2009, 2010) satisfy RCRA criteria that the high dissolved nickel concentrations measured beginning in the early 1990s from monitoring wells MWL-MW1 and -MW3 are evidence of nickel groundwater contamination from the wastes buried in the MWL dump.

- Third, beginning with the first water samples collected in 1990, RCRA criteria identified that the elevated levels of cadmium, chromium, nickel and nitrate in the water samples collected from wells MWL-MW1 and -MW3 compared to the low or not detected concentrations in the background monitoring well MWL-BW1 as evidence of groundwater contamination from the wastes buried in the MWL dump.

- Fourth, The corroded well screens prevented the four monitoring wells from producing reliable and representative groundwater samples. RCRA and the NMED Sandia Consent Order require replacement of monitoring wells that do not produce reliable and representative water samples. The above Finding of Fact 81 in the Hearing Officer's Report is evidence that RCRA required replacement of the defective monitoring wells MWL-MW1 and -MW3 in 1992. However, the two unreliable monitoring wells were not replaced until 2008 (The replacement wells are also unreliable – see Section ES-15).

- #4 deficiency. The NMED 1998 NOD Report recognized that the data collected from pumping tests were unreliable and not usable to calculate the speed of groundwater travel below the MWL dump as follows:

> The pumping tests for monitor wells MWL-MW1, MWL-MW2, MWL-MW3, and MWL-MW4 appear to have failed because the yield of each well was too small to permit a successful pumping test to be conducted. The pumping test conducted on MWL-MW4 (Lower) also appears to have failed, . . . none of the drawdown curves appears to have a form which matches that of a type curve. <u>Therefore, the reported values for hydraulic conductivity and transmissivity are not considered by the HRMB [now the NMED HWB] to be reliable</u> [Emphasis added](p. 7-8).

In addition, the NMED 1993 Report (Moats and Winn, 1993) recognized that the three mud-rotary monitoring wells MWL-MW2, -MW3 and -BW1 did not produce reliable data on hydraulic properties as follows:

> The use of mud-rotary drilling methods should be avoided in any future monitor well installations at the MWL. Mud rotary is not a preferred drilling technology due to its potential detrimental impacts to ground-water quality and the hydraulic characteristics of an aquifer (p. 3).

Nevertheless, DOE/Sandia used the unreliable pumping test data that was rejected by the NMED 1998 NOD report and the unreliable hydraulic properties measured in the three mud-rotary wells (Moats and Winn, 1993) to calculate <u>incorrect values</u> for the speed of groundwater travel below and away from the MWL dump (Goering et al., 2002).

- #5 deficiency. The NMED 1998 NOD Report required a risk assessment of the potential impacts of the Sandia MWL dump on local and regional groundwater quality as follows:

> The nature and extent of subsurface contamination indicate that some contaminants are a potential threat to ground-water quality beneath and downgradient (west) of the MWL. A simple screening comparison of contaminant concentrations in subsurface soils against available EPA soil screening levels (SSL's) developed for the protection of ground-water resources demonstrates exceedences for cadmium and nickel (U. S. EPA, 1996, *Soil Screening Guidance: Technical Background Document,* EPA/540/R-95/128. Office of Emergency and Remedial Response, Washington, DC. PB96-963502) (p.4).
>
> Therefore, the risk assessment for the MWL must evaluate potential impacts of cadmium, nickel, and other contaminants (metals such as cobalt and copper, and radioactive materials such as uranium and tritium, for which SSL's are not available at this time) on local and regional ground-water quality (p.4-5).

<u>The risk assessment required by the NMED 1998 NOD Report was not performed.</u> The risk assessment is a requirement under RCRA because the MWL dump has contaminated the groundwater. The nature and extent of the groundwater contamination is not known because a reliable network of monitoring wells was not installed at any time. The risk assessment should be performed after the required networks of monitoring wells are installed in the two zones of saturation and sufficient water quality data are collected from the two networks.

<u>Section ES-12.</u> None of the deficiencies in the NMED 1998 NOD Report (or in the EPA 1994 NOD Report) were resolved. A public hearing was held in December 2004 for the NMED recommendation to leave the toxic wastes buried in unlined trenches and pits at the Sandia MWL dump below a dirt cover (Pruett, 2005). <u>The unreliable water quality data from the defective monitoring well network in the DOE/Sandia Phase 2 RCRA Facility Investigation (RFI) Report were an important part of the NMED recommendation to leave the wastes below a dirt cover.</u>

The staff of NMED and DOE/Sandia presented **incorrect testimony** at the December 2004 public hearing that

- 1). the direction of groundwater flow at the MWL dump was to the northwest;
- 2). there was a reliable network of five downgradient monitoring wells and one onsite monitoring well; and
- 3). the extensive water quality data from the monitoring wells showed there was no evidence of groundwater contamination from the MWL dump.

The testimony at the December 2004 public hearing **ignored**

- 1). the 1991 LANL report (Rea,1991) that the monitoring well network was not in compliance with RCRA because there was only one downgradient monitoring well and no upgradient monitoring well;
- 2). the NMED 1993 report (Moats and Winn, 1993) that the groundwater flow below the MWL dump was directed southward or to the southwest and the monitoring well network was "Inadequate;"
- 3). the EPA Region 6 1994 NOD report that described the direction of groundwater flow below the MWL dump to be towards the southwest and the monitoring well network is unreliable to detect groundwater contamination from the wastes buried in the MWL dump; and
- 4). the NMED 1998 NOD report that described many deficiencies listed above in the DOE/Sandia Phase 2 RCRA Facility Investigation (RFI) Report including that
  - 1). there was only one downgradient monitoring well;
  - 2). the onsite monitoring well MWL-MW4 was not reliable and required replacement;
  - 3). the NMED considered the high nickel concentrations measured in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 as contamination from the wastes buried in the MWL dump;
  - 4). the pumping test data were not usable to calculate the speed of groundwater travel below and away from the MWL dump; and
  - 5). a risk assessment was required to evaluate the impacts of the wastes buried in the MWL dump on local and regional groundwater quality.

Section ES-13. **The U. S. Congress commissioned a study of contamination issues at the Sandia MWL Dump by WERC.** WERC (A Consortium for Environmental Education and Technology Development at the New Mexico State University) performed two expert reviews of contamination issues at the Sandia MWL dump (WERC, 2001, 2003). DOE/Sandia and the NMED HWB provided incorrect information to the two WERC Expert Panels that 1). There was a reliable network of monitoring wells at the MWL dump and 2). The MWL dump has not contaminated the groundwater.

The large number of documents in the references of the two WERC reports do not include the four reports written over the years 1991 to 1998 that described the monitoring well network as unreliable to detect groundwater contamination from the MWL dump. The four reports [(Rea, 1991), (Moats and Winn, 1993) (EPA, 1994), (Garcia, 1998)] are described above in Sections ES-7 to ES-11. The two WERC Expert Panels relied on information from DOE/Sandia and NMED as follows from page ii in the Executive Summary from the WERC 2003 Final Report:

> High professional standards and extraordinary technical knowledge demonstrated by the SNL staff during public hearings and in the preparation of the Draft CMS document helped the [WERC] Panel substantially in learning, understanding, and accepting information related to the MWL history, design, and operation. The limited time factor for this review, however, did not allow the Panel to perform a complete review of all documents pertaining to the site. The principal documents reviewed were the *Draft Corrective Measures Study*, the *Mixed Waste Landfill Phase 2 RCRA Facility Investigation*, and documentation provided by presenters [from DOE/Sandia and the NMED HWB] [Emphasis supplied].

Note that the NMED 1998 NOD Report described many deficiencies with the MWL dump monitoring well network in the *Mixed Waste Landfill Phase 2 RCRA Facility Investigation Report* that the WERC EXPERT Panel relied on. The two WERC Expert Panels were not provided the NMED 1998 NOD Report or the other three reports listed above in Sections ES-7 to ES-11. Moreover, the deficiencies in the NMED 1998 NOD Report were not resolved by the time of the NMED 2004 public hearing on the dirt cover remedy or afterwards.

The 2003 WERC Final Report on pages 7 to 8 described the MWL dump monitoring well network as follows:

> To monitor for groundwater contamination, 7 monitoring wells were drilled around the perimeter of the landfill, one of which was in a generally upgradient location. Additionally, one monitoring well was placed inside the unclassified area of the landfill. Monitoring well locations are presented in Figure 11 and penetrate the underlying aquifer a minimum of 110 feet to a maximum of 160 feet.

The above statement in the WERC 2003 Final Report is entirely incorrect as shown above in Sections ES-7 to ES-11. Figure ES-2 shows that only two of the monitoring wells (i.e., wells MWL-MW1 and -MW3 were at locations "drilled around the perimeter" of the MWL dump. The intercomparison of Figures ES-2, ES-4 and ES-6 shows that well MWL-MW3 was the only hydraulically downgradient monitoring well installed at the water table and there was no hydraulically upgradient monitoring well for background water quality. The NMED 1998 NOD Report recognized that the monitoring well installed inside the unclassified area (i.e., well MWL-MW4) was not reliable to detect groundwater contamination from the MWL dump.

The statement in the WERC report that monitoring wells were installed in the "underlying aquifer" is incorrect. The intended purpose of all of the eleven monitoring wells installed at the MWL dump was to monitor contamination at the water table in the poorly productive fine-grained alluvial fan sediments that are located above the underlying highly productive aquifer in the ARG Deposits (see the geologic cross-section in Figure ES-4). A monitoring well network was not installed in the underlying aquifer in the highly productive ARG Deposits. Installation of a network of monitoring wells in the productive ARG Deposits is a requirement of RCRA and the NMED Sandia Consent Order.

In summary, the two WERC Reports approved the incorrect and unreliable ground-water monitoring data that was used by DOE/Sandia and NMED for decision making because the WERC Expert Panels were not aware of 1). the existing groundwater contamination under RCRA criteria and 2). the deficiencies and incapability of the groundwater monitoring network to reliably detect the nature and extent of groundwater contamination at the Sandia MWL dump.

<u>Section ES-14.</u> The New Mexico Environment Department (NMED) described the defective and unreliable monitoring well network at the Sandia MWL dump as a reliable network of monitoring wells in the NMED November 2006 Moats Report. In November of 2006 the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) published the report titled *Evaluation of the Representativeness and Reliability of Groundwater Monitoring Well Data, Mixed Waste Landfill, Sandia National Laboratories* by William P. Moats, David L. Mayerson and Brian L. Salem (Moats et al., 2006).

- The NMED November 2006 Moats Report makes the incorrect conclusions that
- 1). all of the seven monitoring wells at the Sandia MWL dump that are displayed on Figure ES-2 provided reliable and representative water quality data and
- 2). there is no evidence of groundwater contamination from the wastes buried in the Sandia MWL dump.

The monitoring well network that was presented as a reliable and sufficient network in the NMED November 2006 Moats Report was the same network that was described as <u>unreliable and not in compliance with RCRA</u> in 1). the 1991 LANL report (Rea, 1991), 2). the 1993 NMED Report (Moats and Winn, 1993), 3). the 1994 EPA Region 6 Notice of Deficiency (NOD) Report (EPA 1994) and the 4). 1998 NMED HWB NOD Report (Garcia 1998).

The four reports listed above described the reasons that it was necessary to replace all of the seven defective monitoring wells that were described as a reliable network in the NMED November 2006 Moats Report. The methodology and conclusions of the NMED November 2006 Moats Report lack scientific basis, are known to be incorrect and the Moats Report requires retraction.

An important reason the NMED November 2006 Moats Report is without any value and the NMED should retract the report is that the evaluation methodology only studied the impact of the bentonite clay contamination from the mud-rotary drilling method and from mistakes in well construction on the ability of the four monitoring wells MWL-BW1, -MW2, -MW3 and -MW5 to produce reliable and representative water samples. The Moats Report ignored the effects of the corroded well screens. In addition, the incorrect locations for five of the seven monitoring wells was ignored. <u>Of the four monitoring wells evaluated in the 2006 Moats Report, only well MWL-MW3 was at a location that could detect groundwater contamination from the MWL dump.</u>

However, the evaluation methodology used in the 2006 Moats Report for the bentonite clay contamination in the four monitoring wells including the mud-rotary well MWL-MW3 was rejected by the scientific community including the EPA Kerr Lab and the National Research Council (NRC). <u>The NMED November 2006 Moats Report ignored the conclusions in the expert reports from EPA and NRC that water quality data could not be used to determine the four wells produced reliable and representative water samples.</u>

The NMED November 2006 Moats Report made the incorrect conclusion that there was no groundwater contamination from the wastes buried in the Sandia MWL dump. The

Moats Report did not recognize that the groundwater chemistry data are evidence under RCRA criteria that the MWL dump has contaminated the groundwater with cadmium, chromium, nickel and nitrate. Other contamination may be present in the groundwater but may not be detected by the defective and unreliable monitoring well network.

<u>**Section ES-15.**</u> **The six contaminant detection monitoring wells in the current monitoring well network at the Sandia MWL dump do not provide knowledge of groundwater contamination and require replacement.** The six defective monitoring wells in the current monitoring well network are displayed on Figure ES-3 and include wells MWL-MW4, -MW5, -MW6, -MW7, -MW8 and -MW9. The intended purpose of the six monitoring wells is to 1). monitor contamination at the water table below and hydraulically downgradient from the MWL dump; 2). measure the elevation of the water table; and 3). determine the lateral direction and speed of groundwater flow at the water table. <u>None of the six wells meet the intended purpose.</u>

As described above, Figure ES-4 shows that the screens in wells MWL-MW4, -MW5, and -MW6 are installed too deep below the water table. The three defective wells require replacement. The NMED HWB has not enforced the requirement in the Sandia Consent Order**,** the 1998 NMED NOD Report and RCRA for replacement of the three defective monitoring wells.

The water levels measured in the three new monitoring wells installed in 2008 (wells MWL-MW7, -MW8, and -MW9) are approximately 20 feet below the known elevation of the water table along the western side of the MWL dump. The erroneous deep water levels measured in the three new monitoring wells are because of mistakes that include: 1). use of the incorrect air-rotary casing hammer (ARCH) drilling method, 2). the improper drilling operations and 3). the 30-foot long well screens in noncompliance with the 10 foot limitation to prevent sample dilution and inaccurate water level measurements, as required by the EPA (US EPA, 1992) and the NMED Sandia Consent Order. The mistakes are because the NMED HWB did not enforce the requirements in the NMED Sandia Consent Order for 1). drilling method, 2). drilling operations and 3). well design.

In the current network of seven monitoring wells on Figure ES-3, the six contaminant detection monitoring wells MWL-MW4, -MW5, -MW6, -MW7, -MW8 and -MW9 are not usable 1). to monitor contamination at the water table below and downgradient from the MWL dump or 2). to measure the elevation of the water table below and hydraulically downgradient of the MWL dump. Except for well MWL-MW6, the six wells are unusable for any purpose. The NMED Sandia Consent Order requires that the six defective wells be plugged and abandoned and replaced as follows:

> ”if a well or piezometer is any way unusable for its intended purpose, it must be replaced with an equivalent well or piezometer” (p. 63).

The NMED HWB has not, but should require replacement of the six defective monitoring wells in the current monitoring well network at the MWL dump. Instead, the NMED has approved the DOE/Sandia reports that describe the defective network as reliable and sufficient to determine that wastes from the MWL dump have not contaminated the groundwater.

<u>Section ES-16.</u> The DOE/Sandia proposed long-term monitoring and maintenance plan does not provide knowledge of contamination in the vadose zone below the unlined trenches and pits or in the groundwater below the Sandia MWL dump. The DOE/Sandia 2007 proposed *Long-Term Monitoring and Maintenance Plan* (LTMMP) (DOE/Sandia, 2007) is not protective of human health and the environment with regard to the protection of the groundwater below the Sandia MWL dump for all long-term monitoring activities including the following:

1. The existing defective groundwater monitoring well network. The overall failure of the groundwater monitoring well network below and downgradient from the MWL dump is described above.

2. The existing dirt cover installed over the wastes buried in the MWL dump is defective because it is not the required design and does not have the required instrumentation to recognize the travel of water through the dirt cover and into the buried wastes (TechLaw, 2006).

3. The proposed soil gas monitoring well network in the vadose zone is inadequate and unacceptable because it does not monitor below the unlined pits and trenches.

4. The existing soil moisture probe holes below the MWL dump are inadequate because they only monitor below a small number of the unlined pits and trenches, they do not monitor continuously and they do not monitor the breakthrough of moisture at the base of the dirt cover (TechLaw, 2006).

5. The existing defective DOE/Sandia Fate and Transport Computer Model (FTM) will be used to assess the performance of the long-term monitoring**.** The DOE/Sandia FTM is unacceptable because it does not recognize that the groundwater below the MWL dump is presently contaminated with cadmium, chromium, nickel and nitrate from the wastes buried in the MWL dump. The defective and unreliable DOE/Sandia FTM is discussed in Section ES-18.

<u>Section ES-17.</u> Data in the limited and incorrectly designed DOE/Sandia 2008 field investigation show a new large release of tritium and solvent contamination from the unlined trenches and pits at the Sandia MWL dump that was not investigated. DOE/Sandia performed a limited and incorrectly designed field investigation in 2008 that discovered a 10-fold increase of tritium contamination released from the wastes buried in the unlined trenches and pits at the MWL dump. The new release of contamination should have required implementing a comprehensive investigation to determine the nature and vertical and horizontal extent of the contamination in the vadose zone below the MWL dump before the dirt cover was installed over the wastes that were releasing the contamination.

The required careful investigation of the new contamination discovered in the vadose zone below the unlined trenches and pits was not performed. Instead, DOE/Sandia issued a final report (DOE/Sandia, August 2008) that did not recognize the new contamination and recommended the installation of the dirt cover above the buried wastes. The pertinent incorrect conclusion in the DOE/Sandia Report follows:

> Because the findings of this investigation are consistent with the conceptual model of the MWL, the [dirt] cover should be constructed (p. ii).

The findings of the 2008 field investigation were **not** consistent with the conceptual model of the Sandia MWL dump. The conceptual model was that the 10-fold increase in tritium contamination in the vadose zone below the MWL dump that was discovered in the 2008 field investigation was evidence that the unlined pits and trenches were *still* releasing contamination which may include other contaminants in addition to tritium. The dirt cover should not have been constructed until the nature and extent of the new contamination in the vadose zone below the MWL dump was fully understood.

The large increase in tritium concentrations measured in the DOE/Sandia 2008 field investigation is displayed in Figure ES-7 and is direct evidence of a new large release of tritium contamination and possibly other contamination including VOCs and heavy metals from the wastes buried in the unlined pits and trenches at the MWL dump. The actual increase in tritium and other contamination below the MWL dump is not known because of the sparse number of boreholes in the 2008 field investigation. None of the six boreholes were

- 1). located close to the previous boreholes where high tritium concentrations were measured,

- 2). located close to Trench A in the unclassified area and the 12 pits in the classified area where the large inventory of tritium wastes are buried or

- 3). drilled to a sufficient depth to characterize the vertical extent of tritium and VOC contamination.

A new comprehensive investigation of the nature and extent of contamination in the vadose zone below the MWL dump is a requirement to protect public health and the environment and to ensure that the required network of monitoring wells are installed in the vadose zone below the unlined trenches and pits at the MWL dump for early detection of new releases of contamination for the required long-term monitoring.

Section ES-18. The DOE/Sandia 2007 Fate and Transport Modeling (FTM) Report does not recognize and report the groundwater contamination from the highly toxic nuclear weapon wastes buried in the Sandia MWL dump. The May 26, 2005 NMED Final Order selecting the dirt cover remedy for the Sandia MWL dump (Curry, 2005) required DOE/Sandia to design and perform a comprehensive fate and transport computer model to determine if contaminants will move from the unlined pits and trenches at the MWL dump down through the vadose zone to groundwater. The Second Edition of the DOE/Sandia Fate and Transport Modeling (FTM) Report was issued in 2007 (Ho et al., 2007).

NMED should order DOE/Sandia to retract the DOE/Sandia 2007 FTM Report because the report does not include the analytical data from the monitoring wells that show the wastes buried in the MWL dump have contaminated the groundwater with cadmium, chromium, nickel and nitrate. In addition, the 2007 FTM report arbitrarily excluded the computer modeling results that identified the groundwater was contaminated with the highly toxic solvent tetrachloroethene (PCE).

The DOE/Sandia 2007 FTM Report does not recognize the groundwater contamination that has been present for longer than the past 20 years from the wastes buried in the Sandia MWL dump. The available groundwater analytical data from 1990 to the present time show that the groundwater below the Sandia MWL dump is contaminated with cadmium, chromium, nickel and nitrate wastes released from the unlined pits and trenches in the MWL dump. The scientific basis for the groundwater contamination is from the comparison of analytical results for groundwater samples collected from monitoring wells MWL-MW1 and -MW3 to the analytical results from the new background monitoring well MWL-BW2 that was installed in 2008 (DOE/Sandia, 2009, 2010). Previous to 2008, the MWL dump had no upgradient groundwater monitoring well for assessment of background water quality.

The 2007 FTM Report does not recognize the cadmium groundwater contamination that is known to be a release from the wastes buried in the MWL dump. Cadmium was not detected in the groundwater samples collected from the new background monitoring well MWL-BW2 at a method detection limit of 0.11 ug/L (DOE/Sandia, 2009, 2010). Therefore, the repeated detection of cadmium in monitoring wells MWL-MW1 and -MW3 is evidence of cadmium groundwater contamination from the cadmium wastes buried in the MWL dump. The repeated detection of cadmium in the groundwater samples collected from the MWL dump monitoring wells is Finding No. 82 in the Hearing Officer's Report for the NMED December 2004 Public Hearing (Pruett, 2005) as follows:

> 82. Low levels of cadmium have been detected in approximately one-third of all groundwater samples collected since 1990, some above the EPA Maximum Contaminant Level ("MCL"). NMED attribute these elevated levels to laboratory error, due to evidence of quality control issues and subsequent sampling at lower levels [Emphasis supplied].

The repeated detection of cadmium in the groundwater samples collected from monitoring wells MWL-MW1 and -MW3 was also described in the NMED November 2006 Moats Report and in the DOE/Sandia 2007 FTM Report (Ho et al., 2007). However, there is uncertainty if the amount of the cadmium contamination in the groundwater below the MWL dump exceeds the EPA Drinking Water Standard MCL of 5 ug/L because the monitoring well network at the MWL dump was defective and did not produce reliable and representative groundwater samples for cadmium or other trace metals. The nature and extent of the RCRA listed cadmium contamination and other RCRA listed contamination in the groundwater below the MWL dump is *still* not known because a reliable network of monitoring wells was not installed at any time.

The detection of cadmium in the groundwater samples collected from the MWL dump monitoring wells is described in the DOE/Sandia 2007 FTM Report as follows:

> Cadmium has occasionally been detected in MWL groundwater at concentrations above the EPA MCL, although these detections are sporadic and unpredictable [Emphasis supplied]. Because the cadmium detections above the MCL are inconsistent, it is believed that these detections do not indicate contamination from the MWL. Nevertheless, cadmium is considered a contaminant of concern, and the fate and transport of cadmium was modeled (p. 14).

A contradiction in the DOE/Sandia 2007 FTM Report is that the report ignores the cadmium groundwater contamination that is described in Pruett (2005), the NMED

November 2006 Moats Report and even in the DOE/Sandia 2007 FTM Report. The DOE/Sandia 2007 FTM Report acknowledges that cadmium is occasionally detected in the groundwater below the MWL dump at concentrations above the EPA Drinking Water Standard of 5 ug/L. Despite the reports that describe the repeated detection of cadmium in the groundwater below the MWL dump, the 2007 FTM Report makes the incorrect conclusion that the cadmium waste buried in the MWL dump will not reach the groundwater for a period longer than 10,000 years as follows:

> Neither lead nor cadmium were simulated to reach the groundwater in all 100 realizations for 1,000 years. Extended simulation periods (>10,000 years) also did not yield any breakthrough of lead or cadmium to the water table (p. 52).

The Monte Carlo simulations in the DOE/Sandia 2007 FTM Report did not recognize the well documented existing contamination of cadmium in the groundwater from the MWL dump. Therefore, the DOE/Sandia FTM Report can not make accurate conclusions based on the unreliable Monte Carlo simulations that the groundwater below the MWL dump is not contaminated with cadmium, lead, other heavy metals, and the radionuclides that are heavy metals including americium-241, cesium-137, cobalt-60, plutonium-238, plutonium-239, radium-226, strontium-90, thorium-232, and uranium-238.

The 2007 FTM Report rejected the new computer calculations and the earlier computer calculation in 1995 (Klavetter, 1995) that identified the groundwater is contaminated with the highly toxic solvent tetrachloroethene (PCE) from the wastes buried in the MWL dump. The toxic solvent PCE is a contaminant in the vadose zone below the MWL dump but the nature and extent of the PCE contamination is not accurately known either in the vadose zone or in the groundwater.

The PCE has probably contaminated the groundwater but is masked from detection by the defective monitoring well network at the MWL dump. The several reasons the unreliable monitoring well network at the Sandia MWL dump was not reliable to detect the PCE groundwater contamination are described earlier in the Executive Summary and include only two monitoring wells at locations that can detect groundwater contamination, corroded well screens and purge-to-dry sampling methods.

The Monte Carlo simulations in the DOE/Sandia 2007 FTM Report identified that the groundwater below the MWL dump is presently contaminated with PCE, possibly at concentrations above the current EPA MCL of 5 ug/L. The conclusion in earlier computer modeling studies (Klavetter, 1995) was also that the groundwater below the Sandia MWL dump would become contaminated from the PCE contamination that was known to be released into the vadose zone below the MWL dump. The DOE/Sandia 2007 FTM Report summarizes the findings in the earlier 1995 computer modeling study by Klavetter (1995) as follows:

> The potential downward vertical transport of six organic compounds to groundwater by both aqueous-phase transport and vapor-phase transport was evaluated in 1995 (Klavetter, 1995). The study showed that PCE could eventually migrate to groundwater through vapor-phase transport. Although the modeling predicted that the most likely PCE concentrations in groundwater would be considerably lower than the detection limit of 0.5 ppb, sensitivity analyses suggested that PCE concentrations could potentially reach 1 to 5 ppb [i.e., 1 to 5 ug/L] within 50 years.

The Environmental Protection Agency (EPA) has determined that PCE in drinking water at the current Drinking Water Standard (DWS) Maximum Contaminant Level (MCL) of 5 ug/L may cause cancer. Therefore, the EPA will promulgate a new DWS MCL in 2011 (Federal Register, 2010). The EPA has indicated that the new DWS MCL for PCE will be set at 0.05 ug/L which is a hundred fold tightening of the current standard of 5 ug/L. The EPA standard is tightened because PCE at any concentration in drinking water may cause cancer. Accurate knowledge of the amount of PCE contamination in the groundwater below the Sandia MWL dump is very important.

The DOE/Sandia 2007 FTM Report predicted that the groundwater below the Sandia MWL dump is contaminated at the present time with PCE at concentrations above 0.05 ug/L and possibly above 0.5 ug/L as follows:

- 87 of the 100 Monte Carlo computer modeling simulations in the 2007 FTM Report predict the groundwater below the MWL dump to be contaminated with PCE at concentrations greater than 0.05 ug/L.
- 59 of the 100 Monte Carlo computer modeling simulations in the 2007 FTM Report predict the groundwater below the MWL dump to be contaminated with PCE at concentrations greater than 0.5 ug/L.

The DOE/Sandia 2007 FTM Report makes the following statement about the computer modeling Monte Carlo simulations that determined the groundwater below the MWL dump is contaminated at the present time with PCE:

> The majority of the realizations [i.e., Monte Carlo simulations] show the aquifer [PCE] concentrations peaking before 50 years. Depending on the time of disposal, this corresponds to peak [PCE] concentrations [in groundwater] occurring by 2010 – 2040. *So far, no detectable amounts of PCE have been found in the groundwater at the MWL*. This is still consistent with the simulations, which show a large amount of variability in the simulated concentrations resulting from uncertainty included in the input parameters [Emphasis supplied] (p. 55).

The above statement shows the arbitrary rejection by DOE/Sandia of the computer modeling in favor of the water quality data from the defective monitoring wells that were not reliable to detect PCE contamination in the groundwater below the MWL dump. The above statement also shows that DOE/Sandia were aware that the computer modeling should not have been performed because of the great uncertainty that existed in the input parameters.

At the Sandia MWL dump, the NMED HWB has allowed DOE/Sandia to implement an arbitrary use of the unreliable "Monte Carlo" computer modeling results instead of requiring accurate water quality data from a reliable network of monitoring wells.

- DOE/Sandia use the unreliable computer modeling to reject the cadmium groundwater contamination that is documented in NMED reports (Pruett, 2005, Moats et al., 2006) and in the DOE/Sandia report (Ho et at., 2007). In addition, cadmium was detected in the DOE/Sandia MWL dump groundwater reports issued in 2006, 2007 and 2008.

- DOE/Sandia use the unreliable monitoring well data to reject the computer modeling reports (Klavetter, 1995, Ho et al, 2007) that document the PCE contamination in the groundwater below the MWL dump.

The NMED should order DOE/Sandia to retract the badly flawed and unreliable DOE/Sandia 2007 FTM Report and not issue a revised FTM report. New computer modeling studies should not be performed until an unknown time in the future after sufficient data are collected from reliable networks of monitoring wells.

The present knowledge of the nature and extent of the groundwater contamination from the Sandia MWL dump is not sufficient. Fate and transport computer modeling studies based on incorrect and insufficient data do not provide protection of the valuable groundwater resource below the Sandia MWL dump from groundwater contamination from the large inventory of commingled wastes buried in unlined trenches and pits.

<u>Section ES-19.</u> Executive Summary References

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Table ES-1. Sandia MWL Dump Monitoring Wells*

*** The locations of the monitoring wells are displayed on Figures ES-2 and ES-3.**

Year of Installation	Well No. / Current Status
- 1988	– well MWL-MW1 / The defective monitoring well was plugged and abandoned in 2008.
- 1989	– wells MWL-MW2, -MW3 and -BW1 / The three defective monitoring wells were plugged and abandoned in 2008.
- 1993	– well MWL-MW4 / The defective monitoring well is in the current network.
- 2000	– wells MWL-MW5 and -MW6 / The two defective monitoring wells are in the current network.
- 2008	– wells MWL-MW7, -MW8 and -MW9 / The three defective monitoring wells are in the current network.
- 2008	– well MWL-BW2 / The new background water quality well may be defective because the drilling and well construction requirements in the NMED 2004 Consent Order were not followed

- Reasons the monitoring wells are defective.

- **Wells MWL-MW1 and -MW3 were the only two monitoring wells with any capability to detect contamination from the MWL dump.**
- **Wells MWL-MW2, -MW5, -MW6 and -BW1 – four wells installed at incorrect locations and too distant from MWL dump to detect groundwater contamination.**
- **Wells MWL-MW1, -MW2, -MW3 and -BW1 – corroded stainless steel well screens mask the detection of many contaminants.**
- **Wells MWL-MW2, -MW3 and -BW1 – mud-rotary drilling method contaminated the three wells with bentonite clay drilling muds that masked the detection of many contaminants and prevented collection of reliable data on speed of groundwater travel.**
- **Wells MWL-MW4, -MW5 and -MW6 – three wells with screens installed too deep to detect contamination at water table and measure elevation of water table.**
- **Well MWL-MW5 – screen installed across two zones of saturation prevented the well from having any use. In addition, the screen is contaminated with bentonite clay/cement grout with properties to mask the detection of contamination and prevent collection of reliable data on speed of groundwater travel.**
- **Wells MWL-MW7, -MW8 and -MW9 – three wells installed in 2008 were drilled with improper methods with 30-ft screens installed too deep to detect contamination and measure the elevation of the water table below the MWL dump.**
- **Wells MWL-MW1, -MW2, -MW3, -MW4, -MW7, -MW8, -MW9 and -BW1 – the high-flow pumping methods purged the wells dry and highly aerated water samples were collected up to a week later. This sampling method removes volatile and trace metal contaminants from the collected water samples.**

Table ES-2. Total and Dissolved Nickel Measured in the Water Samples Produced From Monitoring Well MWL-MW1, -MW-3, -BW1 and - MW2 at the Sandia MWL dump. The four wells have stainless steel screens.

- Date	- Well MW1 Nickel (ug/L) [A] T [B] / D [C]	- Well MW3 Nickel (ug/L) T / D	- Well BW1 Nickel (ug/L) T / D	- Well MW2 Nickel (ug/L) T / D
- 09 - 90	46 / 43	ND [D] <40 / ND < 40	ND <40 / ND <40	ND <40 / ND <40
- 01 - 91	NA [E] / NA	NA / NA	NA / NA	NA / NA
- 04 - 91	NA / NA	NA / NA	NA / NA	NA / NA
- 10 - 91	NA / NA	NA / NA	NA / NA	NA / NA
- 07 - 92	150 / 63	66 / 43	ND <40 / ND <40	ND <40 / ND <40
- 01 - 93	78 / NA	26 (j) [F] / NA	ND <40 / NA	ND <40 / NA
- 04 - 93	97 / 94	37 (j) / 33 (j)	7.5 / 16	14 (j) / 13 (j)
- 11 - 93	95 / NA	ND < 40 / NA	ND < 40 / NA	ND < 40 / NA
- 05 - 94	110 / NA	ND <40 / NA	NA / NA	ND <40 / NA
- 10 - 94	130 / NA	ND <40 / NA	9.8 (j) / NA	ND <40 / NA
- 04 - 95	120 / NA	NA / NA	9.3 (j) / NA	7.5 (j) / NA
- 10 - 95	107 / NA	7.99 (j) / NA	1.96 (j) / NA	NA / NA
- 04 - 96	145 / NA	3.67 (j) / NA	ND < 0.81 / NA	3.42 (j) / NA
- 04 - 97	NA / NA	NA / NA	NA / NA	NA / NA
- 10 - 97	NA / NA	NA / NA	NA / NA	NA / NA
- 04 - 98	398 / 538	36.2 / 28.5	2.9 (j) / NA	5 (j) / 4
- 11 - 98	490 / 467	18 / 18.3	7.19 / 9.47	4.49 / 3.42
- 04 - 99	266 / 313	31 / 31.3	12.8 / 14.3	5.31 / 4.37
- 04 - 00	279 / 281	25.1 / NA	16.5 / NA	124 / NA
- 04 - 01	252 / NA	14.1 / NA	191 / NA	88.2 / NA
- 04 - 02	265 / NA	96.1 / NA	13.6 / NA	89.7 / NA
- 04 - 03	374 / NA	NA / 69.4	26.6 / NA	52 / NA
- 04 - 04	401 / NA	56 / NA	33.2 / NA	10.5 / NA
- 04 - 05	424 / 405	17.3 / 11.5	35.5 / NA	8.02 / 7.11
- 04 - 06	477 / NA	157 / NA	68 / NA	6. 76 / NA
- 04 - 07	436 / 284	84.8 / 120	NA / NA	7.34 / 5.41

[A] ug/L = micrograms per liter or parts per billion
[B] T = Concentration of total nickel measured in an unfiltered water sample
[C] D = Concentration of dissolved nickel measured in a filtered water sample
[D] ND = nickel was not detected at the listed minimum detection level
[E] NA = nickel was not analyzed in samples collected on this date
[F] (j) = the listed value is an estimated value

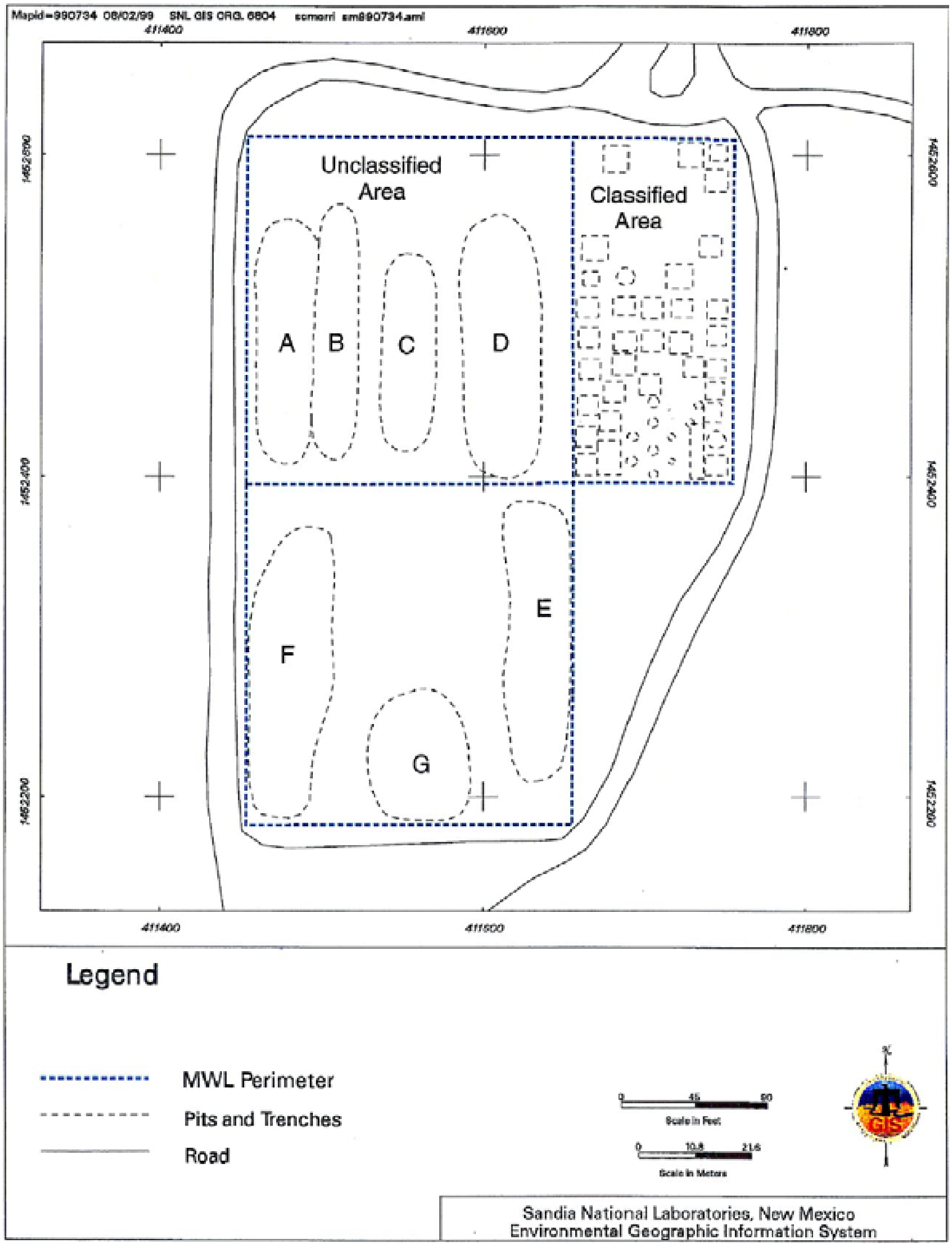
- A median dissolved nickel concentration of 1.2 ug/L was measured in water samples collected on seven dates in 2008 and 2009 from the new background water quality monitoring well MWL-BW2 with a range from 0.82 to 1.7 ug/L.

- The NMED proposed trigger concentration for total and dissolved nickel in groundwater below the Sandia MWL dump is 50 ug/L.

- The EPA recommends that nickel concentration in drinking water does not exceed 100 ug/L.

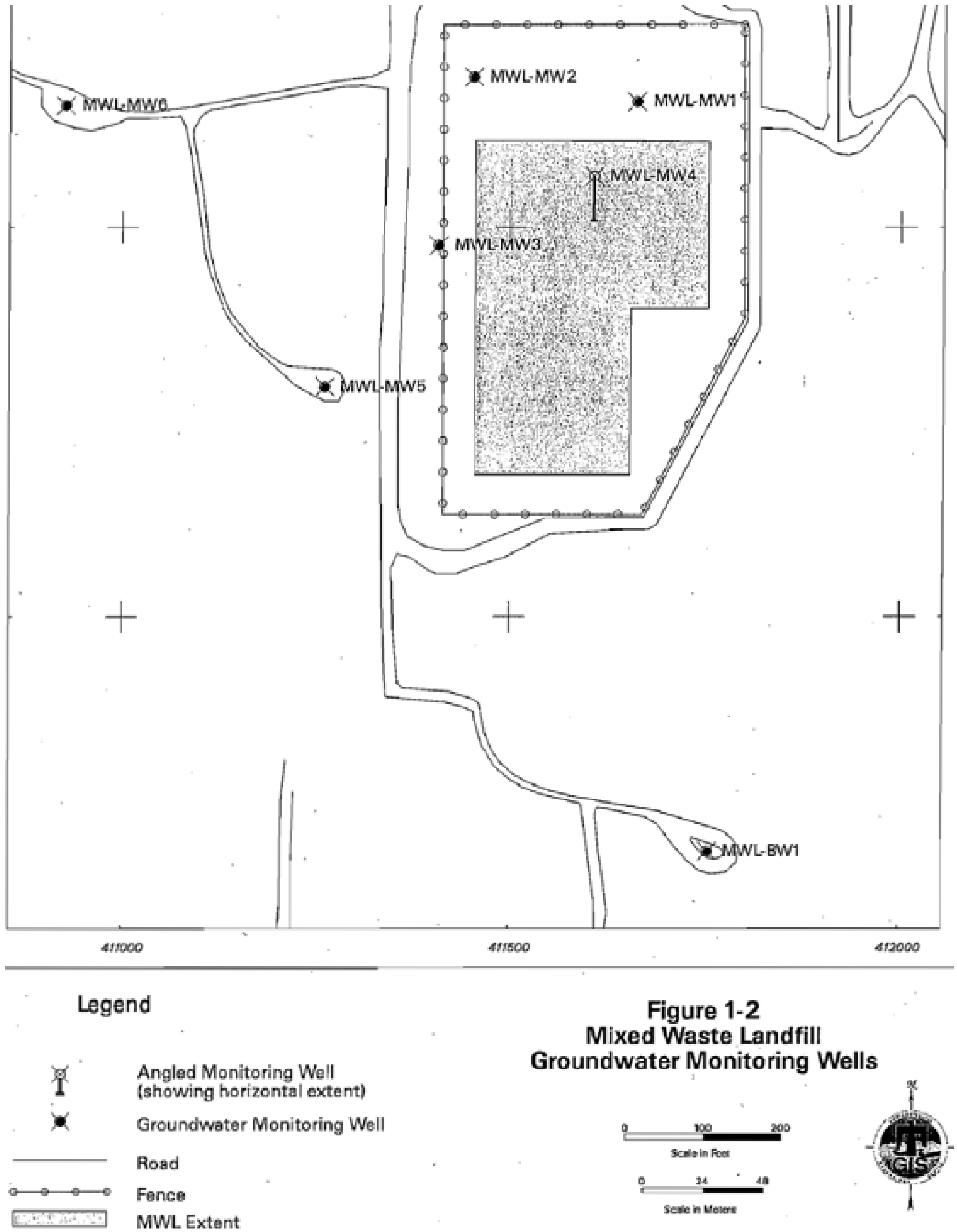
- <u>Sources for Nickel Data</u>: Data from 1990 – 2001; Table 4-2 in Goering et al., 2002; Data from 2002 – 2007; Sandia Annual Reports for groundwater monitoring at the Sandia MWL Dump

Figure ES-1. Map of the 2.6 acre Sandia Mixed Waste Landfill (Sandia MWL dump) showing the locations of the unlined disposal pits in the 0.6-acre Classified Area and the unlined disposal trenches in the 2-acre Unclassified Area.



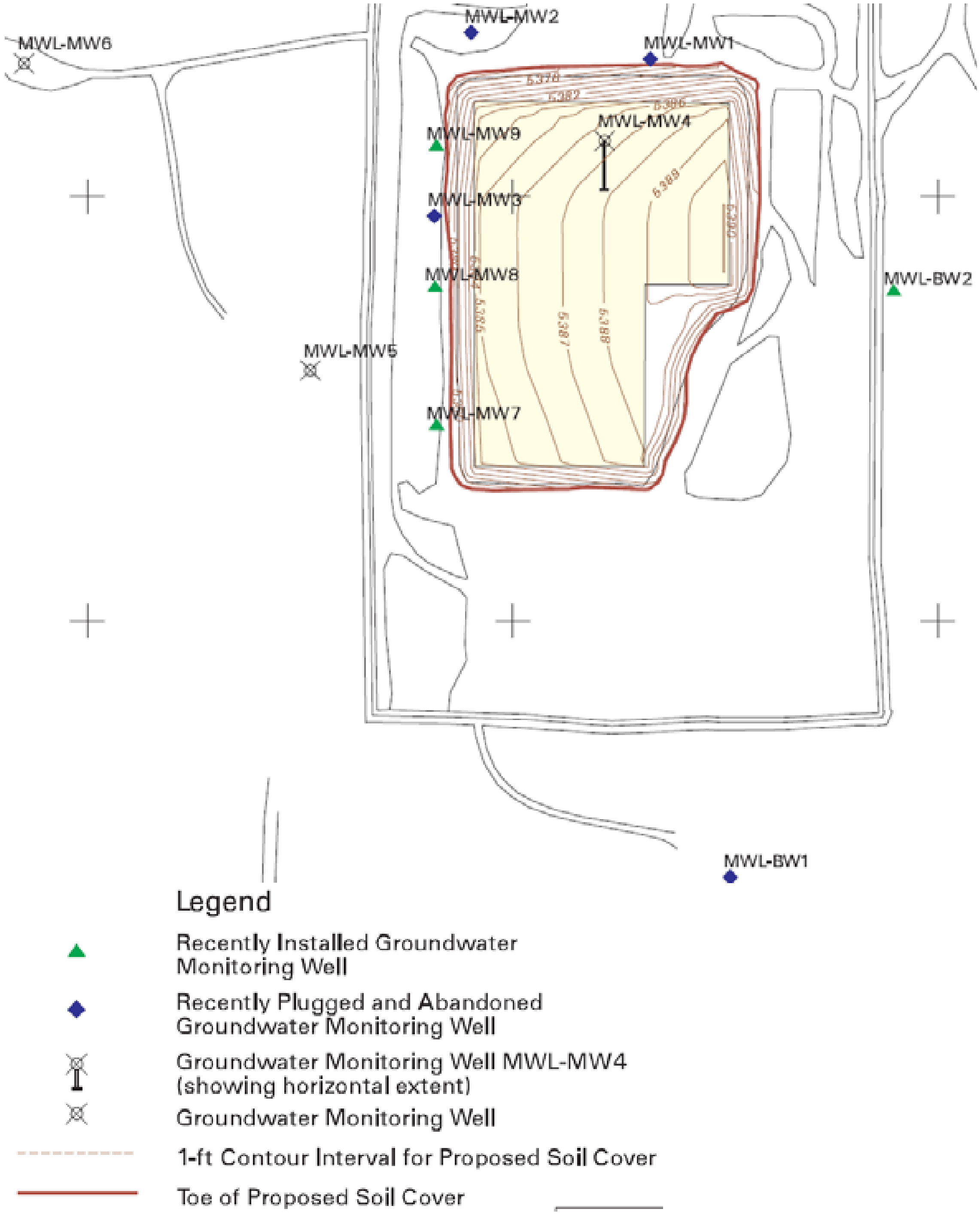
Source: Figure 1-3 in Sandia Report SAND 2002-4098 (Goering et al., 2002).

Figure ES-2. Map of the Sandia Mixed Waste Landfill (Sandia MWL dump) showing the monitoring well network in 2007 of the six monitoring wells MW1 to MW6 and the background water quality well BW1 500 feet south of the dump.



Source: Figure 1-2 in *Mixed Waste Landfill Annual Groundwater Monitoring Report April and June 2007 Sampling Event,* Sandia National Laboratories/New Mexico, Report issued in February 2008.

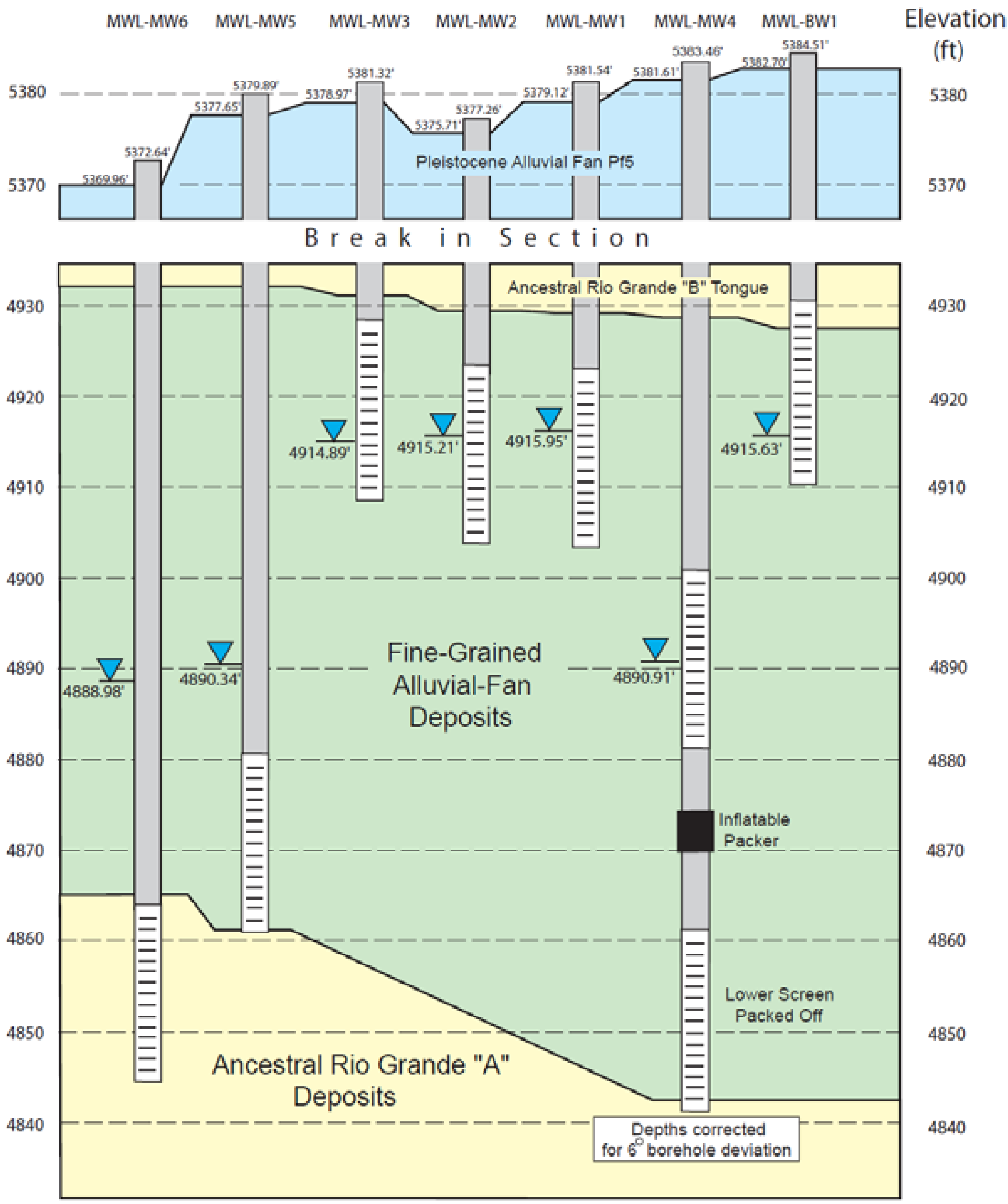
Figure ES-3. Location of the new detection monitoring wells MWL-MW7, -MW8 and -MW9 along the western boundary of the Sandia MWL Dump and the new background monitoring well MWL-BW2 200 feet east of the MWL Dump. The four new monitoring wells were installed in 2008.



Scale 0………………...200 feet

Source: Figure 1-2 in Mixed Waste Landfill Groundwater Monitoring Report Calendar Year 2008, Sandia National Laboratories, May 27, 2009

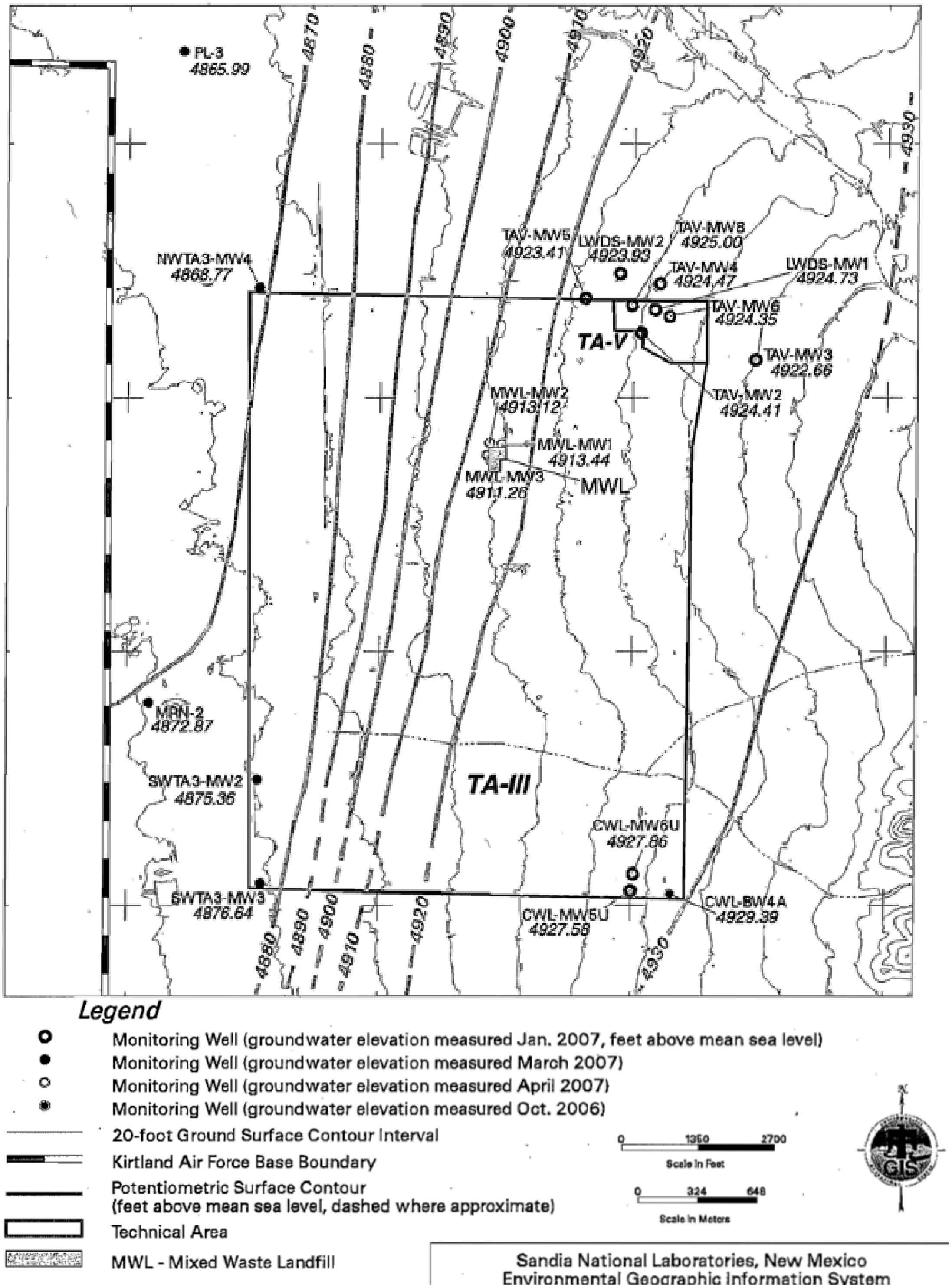
Figure ES-4. Schematic of the Monitoring Wells and the Hydrogeologic Setting at the Sandia MWL dump. The permeable sands and gravels in the Ancestral Rio Grande "A Deposits (ARG deposits) are the valuable groundwater resource for Albuquerque and the surrounding region.



(Note: Water Levels as of 12/4/01)

Source: Figure 3-13 in *Mixed Waste Landfill Groundwater Report, 1990 through 2001, Sandia National Laboratories, Albuquerque, New Mexico* SAND 2002-4098 (Goering et al., 2002).

Figure ES-5. The regional water level contour map in the *Sandia 2008 Mixed Waste Landfill Annual Groundwater Monitoring Report.* The map incorrectly shows the direction of groundwater travel below the MWL dump is to the northwest. The MWL dump is at the center of the figure.



SOURCE: Figure 4.1-2 in *Mixed Waste Landfill Annual Groundwater Monitoring Report, Spring 2007 Sampling Event* Report Issued in February 2008.

Figure ES-6. Water table contour map for the southwest direction of the groundwater flow at the water table below the Sandia MWL dump.

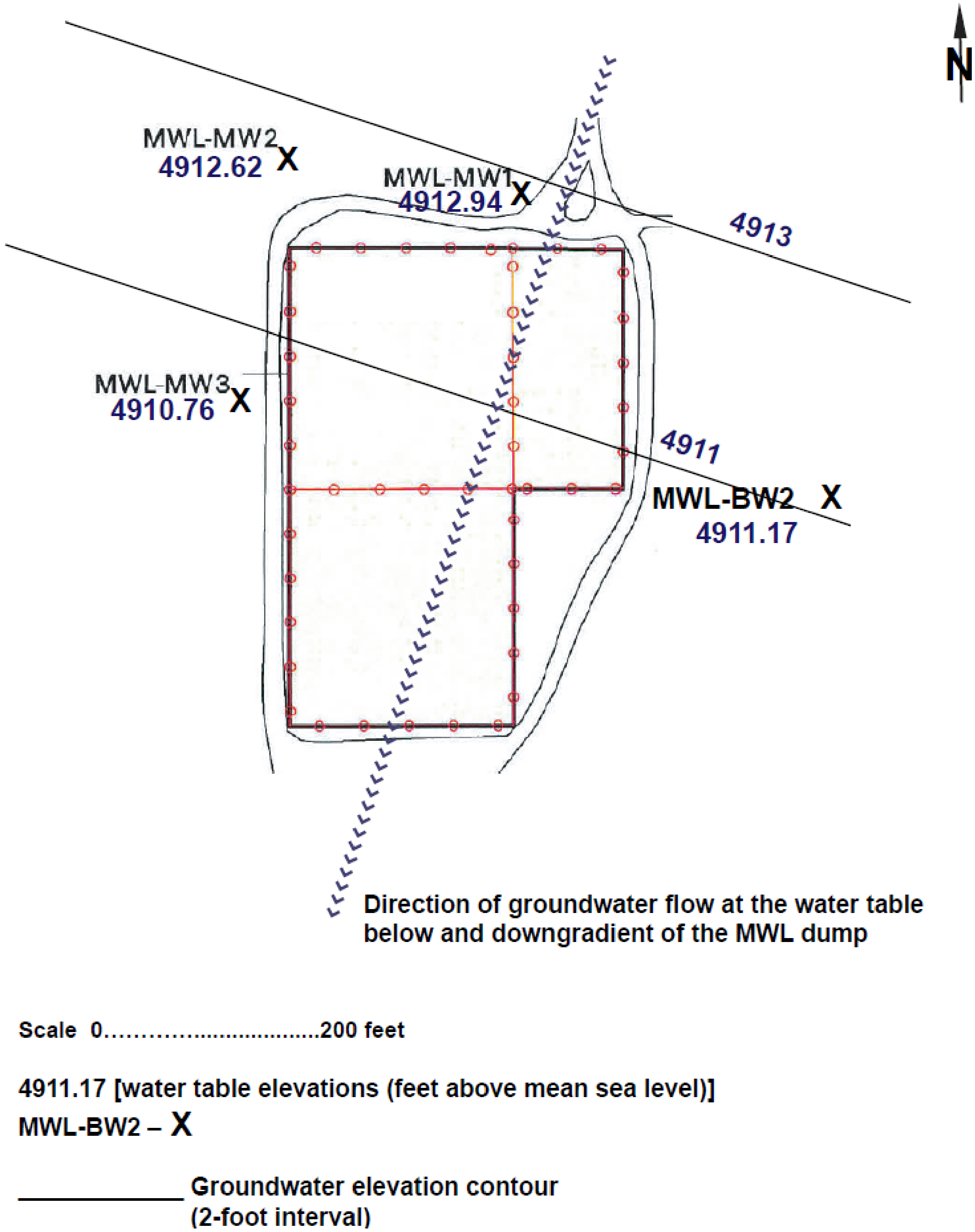
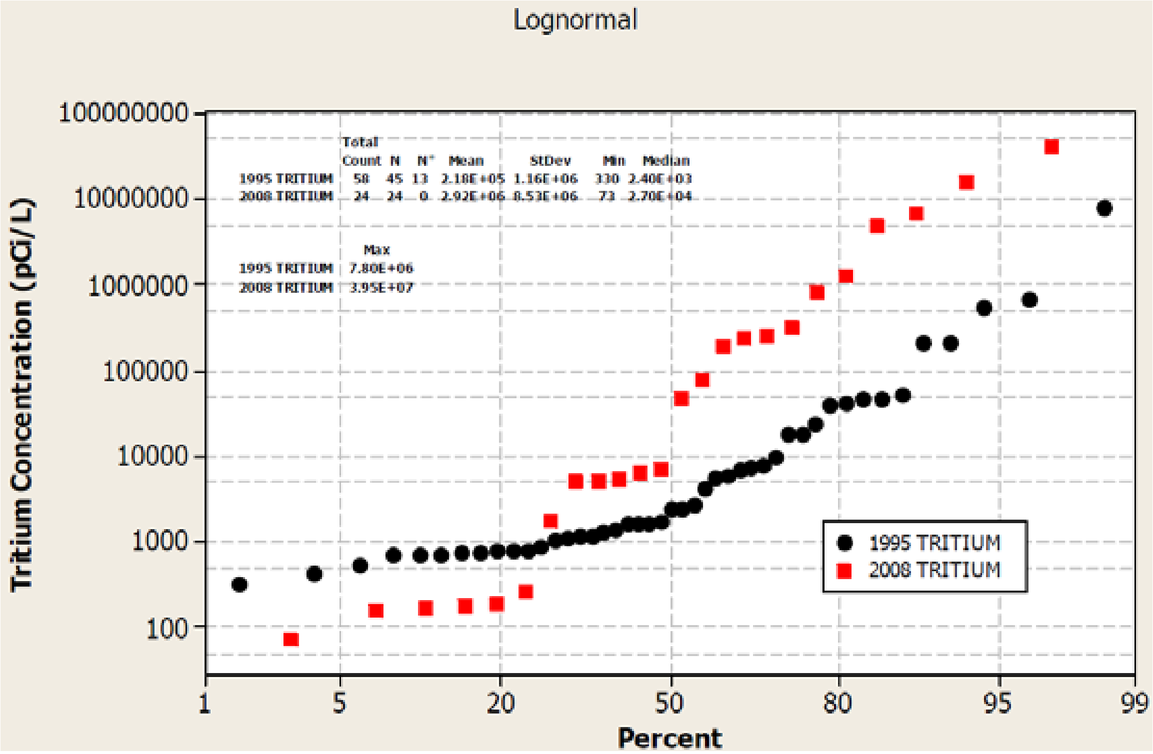


Figure ES-7. Comparison of 1995 and 2008 Tritium sediment sample analytical results for the 10-, 30- and 50-foot depth samples at the Sandia MWL dump.



- **An enlarged view of the Tritium Maximum Concentration Data posted on the above figure is below:**

- **7,800,000 pCi/L = Maximum Tritium Concentration in 1995 Sediment Samples**
- **39,500,000 pCi/L = Maximum Tritium Concentration in 2008 Sediment Samples**
- **3,900,000 pCi/L = Expected Maximum Tritium Concentration in 2008 Sediment Samples**

Note: The half-life of tritium is 12.3 years. Therefore, the maximum tritium concentration measured in the 2008 soil samples was expected to be 50% less than the maximum value measured 13 years earlier in 1995. The maximum value expected to be measured in the 2008 study was approximately 3,900,000 pCi/L.

However, the maximum tritium concentration measured in 2008 was 39,500,000 pCi/L and ten times greater than the expected maximum concentration. The high tritium concentrations measured in the 2008 samples is evidence of a new release of contamination from the wastes buried in the MWL dump.

Source: Figure 6-6 in *Investigation Report on the Soil-Vapor Volatile Organic Compounds, Tritium, and Radon Sampling at the Mixed Waste Landfill, August 2008* SNL/NM Environmental Restoration Project