MWL

ENTERED

Kieling, John, NMENV

From: Bearzi, James, NMENV
Sent: Friday, June 01, 2007 1:22 PM
To: Kieling, John, NMENV; Moats, William, NMENV
Subject: FW: NMED Failure to Characterize Contamination at the Sandia Mixed Waste Landfill
Attachments: NMED Failure to Characterize Contamination at the Sandia MWL Dump.Gilkeson.doc

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From: Dave McCoy [mailto:dave@radfreenm.org]
Sent: Friday, June 01, 2007 6:02 AM
To: Curry, Ron, NMENV; Padilla, Cindy, NMENV; Bearzi, James, NMENV; Goldstein, Jon, NMENV; Fox, Tannis, NMENV; De Saillan, Charles, NMENV; Hughes, Tracy, NMENV
Subject: NMED Failure to Characterize Contamination at the Sandia Mixed Waste Landfill

June 1, 2007

Citizen Action New Mexico is providing the attached report on nickel contamination by Registered Geologist Robert Gilkeson in further support of our allegations that the well monitoring network at the Sandia National Laboratories' Mixed Waste Landfill Dump:

- does not furnish reliable and representative water samples;
- does not comply with the Resource Conservation and Recovery Act (RCRA) for groundwater monitoring under 40 CFR 264/265 Subpart F;
- does not provide a viable long-term monitoring network for RCRA post closure of the MWL Dump;
- has not provided data to justify the decision to leave the radioactive and hazardous wastes in the ground in unlined pits and trenches without liners, leachate collection or for early detection of contamination of groundwater.

Administrative records for the Sandia National Laboratories' Mixed Waste Landfill demonstrate that as early as 1991, it was known by NMED, SNL/DOE and the EPA that:
The direction of flow of groundwater at the dump was to the southwest rather than the northwest. This meant that three of the four installed wells at the dump were cross-gradient to the flow of groundwater and that there was not 1 upgradient (background) well and 3 downgradient wells. The well monitoring system at the dump thus did not comply with the Resource and Conservation Recovery Act (RCRA) requirements for well monitoring.

The Final Mixed Waste Landfill RFI Work Plan Summary Report (September 6, 1994) stated: "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).

The October 30, 1998 NMED Notice of Deficiency stated: "The water-table map indicates that there is only one downgradient monitor well at the Mixed Waste Landfill. Normally, a minimum of three downgradient wells is required for an adequate detection monitoring system."

Later, in 2000, monitoring wells MW5 and MW6 were installed as two downgradient wells. However, MW5 was heavily contaminated with bentonite clay that was dumped into the well screen. Another problem is that the well screen is installed across differing flow strata. MW6 was placed over 500 feet from the dump. This was careless work that did not meet the need for appropriately installed downgradient monitoring wells.

Nevertheless, Sandia has represented in all its Annual Groundwater Monitoring Reports up to 2007 that water samples were representative of a RCRA compliant monitoring system and the NMED accepted the monitoring reports.

Despite the known lack of a reliable well monitoring network, the SNL March 2007 Annual Ground Monitoring Report takes credit for one background well, five downgradient wells, and one onsite well. At the time the report was written, it was known:

- that the background well was cross-gradient and had gone dry;
- that the only downgradient well MW3 at the dump boundary had gone dry and had a corroded well screen;
- that MW1 had a corroded well screen and that MW1 and MW2 were cross-gradient and not downgradient.
- the onsite well screen for MW4 was installed too deep to monitor the critical need for knowledge of contamination at the water table. (See, October 30, 1998 NMED Notice of Deficiency: Mixed Waste Landfill RFI Report, Enclosure B, p.7).

The Annual Groundwater Monitoring Report SNL/NM (March 2000, p.1-4) stated "Specific requirements for groundwater monitoring activities at ER sites [including the MWL] are 40 CFR 264, Subpart F and 40 CFR 265, Subpart F, and are defined in SNL's HSWA Permit."

Rather than applying the requirements of Subpart F (40 CFR 264/265.90-100) to the dump, the NMED and SNL/DOE continued to ignore the requirements for at least one upgradient background well and 3 downgradient wells at the "point of compliance" at the dump boundary. This all begs the question of what requirements do apply to the dump for providing reliable monitoring information.

It was no wonder then that rather than applying Subpart F well monitoring requirements, the NMED recently stated in response to public comments by Citizen Action and Robert Gilkeson that the wells do not have to comply with RCRA Subpart F requirements. Eighteen years of collecting water samples from the defective network showed "no detection of contamination" and supported the conclusion that the dump was "well-behaved" and "too safe to bother to excavate." The monitoring network was not qualified to support these statements based on the records.

The flawed monitoring data was used as a justification by the NMED for a remedy decision to put a dirt cover over and leave in place the 700,000 cu ft of radioactive and hazardous wastes at the dump.

In March 2007, NMED requested that SNL/DOE propose new monitoring locations where hot spots of contaminants had earlier been discovered by soil gas sampling in the early 1990s. SNL/DOE replied that new well monitoring would damage the integrity of the soil cover. In April 2007, an NMED letter asked SNL/DOE to replace the background monitoring well and acknowledged that the new background well must be upgradient and not cross-gradient. These requests come after years of spurious sampling data that both NMED and SNL/DOE knew was from a defective well monitoring system.

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June 1, 2007

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Re: The long history of failure of NMED to characterize contamination of the groundwater resource beneath the Sandia MWL Dump for nickel, chromium, cadmium, other trace metals, other chemical contaminants including VOCs, and radionuclides.

Dear Mr. Bearzi

This letter is a discussion of letters and reports from the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) including the following:

- March 23, 2007 letter ordering DOE/SNL to replace monitoring well MWL-BW1 at the Sandia MWL Dump because of screen corrosion.
- March 26, 2007 letter to Citizen Action that criticizes a report by Robert H. Gilkeson, Registered Geologist, that brought attention to the nickel contamination in groundwater beneath the Sandia MWL Dump.
- April 5, 2007 letter ordering DOE/LANL to replace wells where there is speculation that high levels of nickel and chromium are because of corrosion of stainless steel well screens.
- November 2006 report entitled *"Evaluation of the Representativeness and Reliability of Groundwater Monitoring Well Data, Mixed Waste Landfill, Sandia National Laboratories" i.e., "the Moats Evaluation."*

The March 26, 2007 letter claims that a report I have written about the nickel contamination in the groundwater beneath the Sandia Mixed Waste Landfill (MWL) is *"not based on a technically sound analysis of extant data."* Quite the opposite. It is the New Mexico Environment Department (NMED) that has a history over the past decade of decisions at the Sandia MWL Dump that are technically unsound and without basis to the extant data in the reports by the Sandia National Laboratories (SNL), in the NMED Administrative Record, and in the data files provided to Citizen Action by Mr. William Moats, a staff person in the NMED Hazardous Waste Bureau (HWB).

At a December 14, 2006 public meeting of the Groundwater Protection Advisory Board for the City of Albuquerque, attended by Environmental Protection Agency Inspector General Agent Edward Baldinger, the GPAB minutes record that James Bearzi, Chief of the NMED Hazardous Waste Bureau, discussed the issue of nickel in the Sandia Mixed Waste Landfill monitoring wells MW1 and MW3:

> "2) Elevated nickel and chromium from corroded well screens have been detected in wells 1 and 3. Once the screens were replaced, elevated chromium and nickel have not been detected."

The representation of the NMED at the meeting was clearly contrary to fact. No replacement of monitoring wells MW1 and MW3 has been ordered by the NMED despite knowledge of the elevated nickel and chromium.

Contrary to the statement to the GPAB of no releases of contamination from the MWL, the presence of metal contaminants (nickel, cadmium cobalt, copper, zinc) has been observed at the MWL at depths which can exceed 100 feet. These were noted in a NMED Notice of Deficiency (10/1998) that stated the indication that liquid wastes were disposed of at the MWL. In addition, the NOD stated that "The MWL inventory is not complete. **Data derived from soil sampling beneath the landfill indicate that nickel is a possible contaminant at the MWL.**" (Emphasis supplied).

Other statements by Chief Bearzi at the 12/14/06 GPAB meeting were that

> *"All the wells were at appropriate locations and provided reliable data."*

> "The hydraulic conductivity is very low in the upper aquifer. As a result, the wells must be purged and allowed to refill; there is no alternative."

Each of these statements as will be shown below are incorrect.

The long history of failure of the NMED HWB to require a reliable network of monitoring wells at the Sandia MWL Dump is revealed by the letter dated March 23, 2007 that now orders the Department of Energy (DOE) and the Sandia National Laboratories (SNL) to replace one of the monitoring wells at the MWL. The March 23rd letter describes the factors that require the replacement of the well. However, the cited factors should also require the replacement of six of the seven monitoring wells at the Sandia MWL Dump. In addition, the factors that require replacement of the monitoring wells were known for over the past seven to ten years without timely action taken to replace the wells. The factors are described below on page 4 in this letter.

The misguided decision of the NMED Secretary Ron Curry to leave the dangerous wastes permanently buried at the Sandia MWL Dump was based on the spurious data from the monitoring wells. Furthermore, the replacement of the wells is also a requirement of the Resource Conservation and Recovery Act (RCRA) and the NMED Sandia Consent Order that was signed by DOE/SNL and NMED on April 29, 2004.

This instant letter describes the failure of the NMED HWB to enforce RCRA and the NMED Sandia Consent Order for the characterization of groundwater contamination beneath the Sandia MWL Dump. In addition, this letter discusses the incorrect criticism of my report titled *"Nickel Contamination in the Regional Aquifer from Nickel Wastes Buried in the Sandia Mixed Waste Landfill, Version January 23, 2007".* This letter is organized by the topics presented in the criticism of my report in the March 26th letter.

Corrosion of the stainless steel well screen in the Sandia MWL Dump monitoring well MW1.

Concerning the source of the nickel contamination in the groundwater produced from the monitoring well MWL-MW1, the March 26th letter makes the following statement without basis to the extant data:

> *"The Department stands by its previous conclusion that the elevated concentrations of nickel are a result of corrosion (leaching) of the type 304 stainless-steel screen that was installed in the well."*

There are many issues with the speculation of both the NMED and the DOE/SNL that the nickel and chromium contamination measured in the water samples produced from well MWL-MW1 are only because of corrosion. In fact, the nickel and chromium contamination is probably from a combination of factors that include:
1). a plume of contamination from the Sandia MWL Dump,
2). the corrosion of the stainless steel screen, and
3). the high turbidity in some of the collected groundwater samples.

The NMED has not enforced either the requirements of RCRA or the NMED Sandia Consent Order for the replacement of monitoring well MWL-MW1 even though DOE/SNL have speculated over the past fifteen years that corrosion of the well screen was responsible for the high levels of nickel measured in the water samples produced from the well.

It is well understood in the technical literature that the corrosion of well screens will mask the detection of the presence of a plume of nickel, chromium, cadmium and other contaminants including radionuclides from the Sandia MWL Dump.
From page 63 of the NMED Sandia Consent Order:

> "Groundwater monitoring wells and piezometers must be designed and constructed in a manner that will yield high quality, representative samples. Each well or piezometer must be constructed such that it will last the duration of the planned monitoring need (i.e., last long enough to gather enough samples for purposes of establishing concentration trends for Contaminants or potential Contaminants; determining if releases from SWMUs or AOCs will impact groundwater; monitoring post VCA, VCM, or corrective measure activities to ensure efficacy; and monitoring for post-closure care). In the event of a well or piezometer failure, or if a well or piezometer is any way no longer usable for its intended purpose, it must be replaced with an equivalent well or piezometer" [emphasis added].

The above statement from the Consent Order is clear instruction for the NMED HWB to order DOE/SNL to replace well MW1. In fact, the NMED HWB letter of March 23, 2007 has used the above statement to order DOE/SNL to replace the background water quality well MWL-BW1 at the Sandia MWL Dump because of corrosion problems with the stainless steel well screen. From the March 23rd letter:

> ***"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."***

> ***"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 NMED HWB concern for the corrosion of stainless steel well screens also requires replacement of monitoring wells MW1 and MW3 at the Sandia MWL Dump because these wells also have stainless steel screens. The levels of nickel and chromium measured in the most recent water samples from both wells MW1 and MW3 exceed the New Mexico Water Quality Standard. The levels of chromium exceed the EPA MCL for drinking water. The recently published DOE/SNL groundwater monitoring report (Sandia

Report SAND 2007-1199P, March 2007) speculates that the high chromium and nickel levels in the two wells are because of corrosion of the stainless steel well screens.

Furthermore, the NMED HWB requires the replacement of corroded screens at the Los Alamos National Laboratory (LANL). On April 5, 2007, the HWB sent a letter to LANL that requires the replacement of stainless steel well screens where the LANL scientists speculate that the high nickel and chromium levels in groundwater are because of corrosion of the well screens. From page 5 of the April 5th letter:

> *"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).*

As Chief of the NMED HWB, you should adhere to timely and uniform enforcement at both Sandia and LANL, and uniform enforcement for all of the problem monitoring wells at the Sandia MWL Dump. The historical record reveals NMED enforcement activities at the Sandia MWL Dump have been inconsistent and haphazard. Over the past fifteen years, the speculation by DOE/SNL that the high chromium and nickel levels measured in the Sandia MWL Dump monitoring wells are due to corrosion of the stainless steel screens has been accepted uncritically.

The NMED HWB should have ordered the replacement of the well MWL-MW1 when DOE/SNL made the first speculation that the elevated levels of nickel and chromium were because of corrosion. At a minimum, NMED should have ordered a study of nickel isotopes in the water produced from well MW1 to investigate the Sandia MWL Dump as a source of the nickel contamination in the groundwater. The isotope study was not done.

The stainless steel well screens at the Sandia MWL Dump are only one of many factors that have prevented accurate characterization of many contaminants in the groundwater. Some of the factors that have prevented the collection of reliable and representative water samples and that were acknowledged in the March 23rd letter to DOE/SNL include

- corrosion of stainless steel well screens – *i.e.,* Sandia MWL Dump wells BW1, MW1, MW2, and MW3.
- wells have gone dry – *i.e.,* Sandia MWL Dump wells BW1 and MW3.
- cross-gradient location – *i.e.,* Sandia MWL Dump wells BW1, MW1, and MW2,
- mud-rotary drilling method – *i.e.,* Sandia MWL Dump wells BW1, MW2, and MW3, and
- wells that do not meet their intended purpose must be replaced – *i.e.,* Sandia MWL Dump wells BW1, MW1, MW2, MW3, MW4, and MW5.
  - The screen in well MW4 was installed too deep below the water table for the intended purpose of monitoring contamination at the water table.
  - The mistakes in the installation of well MW5 include installation of the screen across strata with a large contrast in hydraulic conductivity and water levels (*i.e.,* hydraulic head), and contamination of the screen with a large amount of bentonite/cement grout that was not cleaned from the screened interval by well development activities.

A position paper published by the NMED HWB in 2001 identifies that monitoring 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 mixed water produced from the wells is not reliable for the detection of contamination.

Another factor that has prevented five of the monitoring wells at the Sandia MWL Dump from producing reliable and representative water samples is the use of high-flow pumping methods that purge the wells dry. Samples are collected up to seven days later from the water that trickles into the wells. The improper sampling methodology is discussed later in this letter.

Corroded well screens mask the detection of many contaminants. The NMED Sandia Consent Order has the following requirements for the design and construction of monitoring wells at the Sandia MWL Dump: *"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" [emphasis added].

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."

The poor quality of the water data collected from monitoring well MWL-MW1.

On many occasions, the DOE/SNL and the NMED HWB have made the unsupported claim that the extensive collection of high quality data over the past fifteen years have established that wastes from the Sandia MWL Dump have not contaminated the groundwater. The overarching factors that cause well MW1 to produce water samples of poor quality that mask the detection of contamination are the corrosion of the stainless steel well screen and the improper high-flow sampling methodology that is used to collect water samples.

Table 1 is a summary of the water quality data collected from well MWL-MW1. The table shows large data gaps for measurement of the basic water parameter turbidity. Note that the table shows no measurement of turbidity during the first five years of collecting water samples from well MW1. The missing turbidity data is based on data files provided to Citizen Action by Mr. Moats.

A review of the water quality data collected from well MWL-MW1 and all of the monitoring wells at the Sandia MWL Dump reveals that the data are of poor quality

Table 1. Water Quality Data From Sandia MWL Dump Well MW1

Sample Date	Iron (ug/L) T / D	Manganese (ug/L) T / D	Chromium (ug/L) T / D	Nickel (ug/L) T / D	Cadmium (ug/L) T / D	Cadmium* (ug/L) T	Turbidity NTU T
09-27-90	NA / NA	NA / NA	< 10 / < 10	46 / 43	46 / 43	46	NA
01-24-91	440 / NA	19 / NA	< 10 / 21	NA / NA	< 5 / < 5	2.5	NA
05-07-91	760 / NA	15 / NA	< 10 / 15	NA / NA	< 5 / < 5	2.5	NA
07-31-91	710 / NA	19 / NA	< 10 / 11	NA / NA	< 5 / < 5	2.5	NA
10-15-91	490 / NA	17 / NA	< 10 / 19	NA / NA	< 5 / < 5	2.5	NA
07-28-92	190 / NA	5 / NA	11 / < 10	150 / 63	< 5 / < 5	2.5	NA
01-19-93	NA / 90	11 / NA	11 / NA	78 / NA	8.6 / NA	8.6	NA
04-27-93	118 / NA	10 / 12	< 10 / < 10	97 / 94	< 5 / < 5	2.5	NA
11-09-93	220 / NA	5 / NA	10 / NA	95 / NA	< 5 / < 5	2.5	NA
05-03-94	110 / NA	12 / NA	< 10 / NA	150 / NA	< 5 / NA	2.5	NA
05-04-94[D]	48 / NA	8 / NA	< 10 / NA	130 / NA	< 5 / NA	2.5	NA
10-25-94	58 / NA	NA / NA	< 10 / NA	100 / NA	< 5 / NA	2.5	NA
10-25-94[D]	< 10 / NA	11 / NA	< 10 / NA	130 / NA	< 5 / NA	2.5	NA
04-19-95	94 / NA	3 / NA	< 3 / NA	120 / NA	< 5 / NA	2.5	1.38
10-20-95	565 / NA	13 / NA	42.8 / NA	107 / NA	0.13(j) / NA	0.13	7.16
04-18-96	272 / NA	11 / NA	11.6B / NA	145 / NA	< 0.1 / NA	0.05	3.78
04-23-97	NA / NA	NA / NA	1,100 / NA	NA / NA	0.57(j) / NA	0.57	18.9
10-15-97	NA / NA	NA / NA	47.4 / 1.94 (j)	NA / NA	< 0.22 /< 0.22	0.105	4.9
10-15-97[D]	NA / NA	NA / NA	40.5 / 2.07 (j)	NA / NA	< 0.22 /< 0.22	0.105	4.9
04-01-98	NA / NA	NA / NA	326 / < 0.73	398 / 538	< 0.22 /< 0.22	0.105	7.11
04-01-98[D]	NA / NA	NA / NA	260 / NA	500 / NA	< 0.6 / NA	-	7.11
08-27-98	260 / NA	NA / NA	NA / NA	NA / NA	NA / NA	NA	NA
08-27-98[D]	1,800 / NA	NA / NA	NA / NA	NA / NA	NA / NA	NA	NA
11-06-98	NA / NA	NA / NA	69.4 / 4.53	490 / 467	0.86(j) / 0.52(j)	0.86	6.09
04-14-99	583 / 111	8 / 3.73	63.4 / 4.22	266 / 313	< 0.22 / < 0.22	0.11	6.78
04-14-00	960 / NA	NA / NA	11.3 / < 8.5	279 / 281	< 0.6 / < 0.6	0.32	3.04
04-14-00	NA / NA	NA / NA	8.67 / 2.39 (j)	228 / NA	< 0.6 / NA	-	3.25
04-14-00[D]	NA / NA	NA / NA	11.3 / NA	270 / NA	< 2.3 / NA	1.2	3.25
04-13-01	409 / NA	7 / NA	34.9 / NA	252 / NA	< 0.25 / NA	0.13	7.38
04-30-02	272 / NA	6 / NA	17.6 / NA	265 / NA	0.387 / NA	0.387	NA
04-21-03	464 / NA	6 / NA	14.1 / NA	374 / NA	2.22 / NA	2.22	3.36
04-16-04	886 / NA	17 / NA	42 / NA	401 / NA	0.096 / NA	0.096	6.59
04-11-05	697 / 135	19 / 5.6	36.8 (j) / 1	424 / 405	< 0.1 / < 0.1	-	6.42
04-11-05[D]	135 / NA	NA / NA	NA / NA	NA / NA	< 0.1 / < 0.1	-	NA
04-12-06	1,670 / NA	24 / NA	219 / NA	477 / NA	< 0.1 / NA	-	14
04-12-06[D]	1,640 / NA	23 / NA	208 / NA	477 / NA	< 0.1 / NA	-	14

Cadmium* = examples of the data values used in the NMED *Moats Evaluation* report to calculate a median value for total cadmium in water samples of 1.2 ug/L. When cadmium was not detected, a value of ½ the method detection limit was posted as the assumed concentration of cadmium in the water sample.

T = measured value on unfiltered sample, D = measured value on filtered sample
ug/L = micrograms/liter or parts per billion, NTU = nephelometric turbidity units
< 5 = constituent was not detected at the listed method detection limit – *i.e.,* 5 ug/L
NA = not analyzed or measured value not available in NMED records
(j) = estimated value

NMED HWB Approved Background - Source: Dinwiddie, 1997.
- Chromium – 43 ug/L
- Nickel – 28 ug/L
- Cadmium – 0.47 ug/L

All data in Table 1 are from DOE/SNL reports and the data files of the NMED HWB.

because of the large data gaps in measurement of critical parameters including analysis of filtered water samples and measurement of turbidity. For many reasons, the collected data are not reliable for assessment of groundwater contamination from the Sandia MWL Dump.

The standard industry practice is to measure turbidity each time water samples are collected from monitoring wells because a low turbidity (e.g., < 5 NTU's) is one of the critical factors that the water samples are representative of the *in situ* groundwater. In fact, the high chromium levels measured in the water samples collected from wells MWL-MW1 and MWL-MW-3 in 2006 may be because of the high turbidity measured in the water samples (e.g., well MW1@14 NTU's, well MW3 @76.2 NTU's).

From page 6-48 of the RCRA Manual:

> "If a well is not producing low turbidity ground-water samples [e.g., <5 NTU's], the owner/operator should demonstrate to the satisfaction of the appropriate regulatory agency that proper well completion and development measures have been employed, and that the turbidity is an artifact of the geologic materials in which the well is screened, and not the result of improper well construction or development. Failure to make such a demonstration could result in a determination by the Agency that the well must be redrilled."

There is no record of such a demonstration by SNL/DOE to NMED of proper well completion and development. The well development records on file at the NMED show that neither well MW1 nor Well MW3 were properly developed following installation of the wells. The development of Sandia MWL Dump monitoring well MW1 was terminated with the well producing a final turbidity of 21 NTU's. Of even greater concern is the fact that the development of well MWL- MW3 was terminated with the well producing a final turbidity of 1000 NTU's. The EPA RCRA Manual cautions against the termination of well development at such high turbidity levels. From page 6-36 of the RCRA Manual:

> "The development of a well is extremely important to ensuring the collection of representative ground-water samples. Turbid samples from an improperly constructed and developed well may interfere with subsequent analyses."

It was a mistake that DOE/SNL did not continue the development of wells MWL-MW1 and MWL-MW 3 in the attempt for the wells to produce water with a turbidity of < 5 NTU's. The desired low turbidity may not have been possible. Nevertheless, the termination of development activities at a turbidity level of 1000 NTU's is unacceptable.

Nickel, chromium and cadmium water quality data measured in well MWL-MW1.

A second example of the poor quality of the data for well MW1 is the sparse data on dissolved levels of nickel, cadmium and chromium in the groundwater samples.
The dissolved levels of nickel are only available for eight of the dates that water samples were collected. The collection of both filtered and unfiltered water samples for trace metals should have been a routine activity when the presence of elevated levels of nickel and cadmium was discovered in the first water sample collected from well MW1 but this was not the practice. The level of dissolved nickel in the first water sample was 46 ug/L compared to the NMED approved background concentration of 28 ug/L. The

level of dissolved cadmium was 43 ug/L or nearly ten times above the EPA Maximum Contaminant Level (MCL) of 5 ug/L.

Evidence of nickel and cadmium contamination in groundwater below the Sandia MWL Dump.

Table 1 presents the levels of nickel, chromium, and cadmium that were measured in water samples collected from well MW1 over the 17-year period from 1990 to 2006. The dissolved nickel levels show a large increase from 43 ug/L in 1990 to 405 ug/L in 2005. For comparison, the dissolved chromium levels decrease from 21 ug/L in 1991 to a very low value of 1 ug/L in 2005. The marked difference in the behavior of nickel and chromium is one line of evidence that indicates the high level of dissolved nickel contamination in the water samples is because of contamination from the buried wastes in the Sandia MWL Dump.

In fact, the anomalously low level of dissolved chromium measured in the 2005 water sample is probably because of the removal of chromium and other trace metals from groundwater by the corrosion products with strong sorption properties that have built up over time on the well screen. At this time, the corrosion products may even be lowering the measured levels of the nickel contamination from the Sandia MWL Dump. The corrosion of stainless steel well screens is summarized in a recent LANL report (LA-UR-07-2852, May 2007). From page 36 of the report:

> "Corrosion tends to start in the form of pits or microcracks where the metal was subjected to the greatest stress, and grows along intergranular boundaries. The iron in the steel begins to dissolve into solution as the metallic iron species, and is immediately oxidized to ferric hydroxide if dissolved oxygen is present. The iron hydroxide precipitates, removing it from solution (although it may remain suspended in colloidal form), which allows more iron metal to dissolve. This process continues as long as the supply of DO is continually renewed." As the iron matrix dissolves, other metal components of the stainless steel are also released."
>
> "The dominant species, in order of decreasing total concentrations, are iron, chromium, and nickel (Herting et al. 2005, 094897) as well as manganese. Under oxidizing conditions, the oxidized forms of chromium and nickel are highly soluble, whereas manganese, like iron, may form an insoluble oxide phase."

The research by Herting et al. determined that corrosion produces high levels of both dissolved chromium and nickel. This is in contrast to the very low levels of dissolved chromium in the water samples produced from well MW1 and is evidence that the high levels of nickel may be from the wastes that are buried in the Sandia MWL Dump.

A journal article that presents important information relative to the corrosion of the stainless steel well screens at the Sandia MWL Dump is *"Dynamic Study of Common Well Screen Materials"* by Alan D. Hewitt (Ground Water Monitoring Review, 1994). From pages 94 and 93 of the Hewitt article:

> "Common stainless steel well screens significantly affect solution metal concentrations under dynamic conditions consistent with typical ground water sampling protocol. The magnitude of the influence appears directly correlated with the presence of corrosion products on stainless steel casings, and concentrations of nickel (and perhaps chromium) could approach those that would affect regulatory

compliance. Along with leaching, surface corrosion also causes significant sorption losses for metals such as lead and cadmium" [emphasis added].

> "By the time of the second and third experiments, approximately 20 percent and 5 percent of the external surfaces of the SS 304 and SS 316, respectively, were rusted. These sites of corrosion started with black or dark green centers rimmed by bands of orange, and were located on welds at points where the coiled screen connected to vertical rods or where the end caps were attached. This observation, along with the low dissolved oxygen state of the groundwater is consistent with the precipitation of ferrous hydroxide ($Fe[OH]_2$) by galvanic corrosion, thus providing a mechanism for the loss of ferrous iron from the solution. With time, the hydrated ferrous oxide slowly oxidized further to hydrated ferric oxide" [emphasis added].

The evidence that corrosion is causing essentially total removal of cadmium from the groundwater samples produced from well MW1 is discussed in detail later in this letter. The hydrated iron oxides formed by the corrosion have very strong adsorption properties for trace metals including cadmium and lead and many of the radionuclide contaminants of concern for the buried wastes in the Sandia MWL Dump.

In the research by Hewitt, it is important to note that the time span to the third experiment represented an immersion of the stainless steel in water of only 130 days and over this short period of time, 20 % of the external surfaces of the SS 304 were coated with the iron oxide precipitates. The stainless steel screens in the Sandia MWL Dump monitoring wells are grade 304 SS and immersed in water for over fifteen years.

The coatings of hydrated ferrous oxide and hydrated ferric oxide have strong properties to adsorb and coprecipitate contaminants of concern from the buried wastes in the Sandia MWL Dump. The properties of the oxides are described on page 538 in *"Aqueous Environmental Geochemistry"* by Donald Langmuir, 1997 by Prentice-Hall, Inc., Upper Saddle River, New Jersey:

> "Among common minerals, the strongest sorbents for most actinide cations (e.g., cations of uranium, plutonium, americium) are the ferric oxyhydroxides and especially hydrous ferric oxide."

Even the Moats Evaluation, a report by the NMED HWB in November 2006 that makes the unsupported claim that the MWL wells produce reliable and representative water quality data, recognized the strong properties of iron and manganese oxides to mask the measurement of groundwater contaminants. Unfortunately, the Moats Evaluation did not acknowledge the chemical processes associated with corrosion that have precipitated the iron and manganese oxides as coatings on the well screens.

Instead, on pages 5 and 6, the Moats Evaluation made the mistake of claiming that well MW1 produced reliable and representative groundwater samples as follows:

> "-- the NMED compared the median value of each analyte for each mud rotary well to the median value for the same analytes from groundwater samples from wells MW1 and MW4. As stated above, these two wells are completed in the same AF facies, but were drilled without the use of mud or organic additives. Thus, neither of the two wells can possibly demonstrate any of the possible adverse effects of

residual drilling mud and or organic additives, including the formation of iron or manganese precipitates that could mask the measurement of groundwater contaminants" [emphasis added].

In fact, the corrosion of the stainless steel screen in well MW1 does demonstrate adverse effects from the formation of iron and manganese precipitates as coatings on the screen that are masking the measurement of groundwater contaminants. The evidence is the declining trend over time in the measured levels of cadmium in the groundwater samples produced from well MW1. The cadmium data are presented in Table 1. The data for analyses on filtered water samples show a large decline from 43 ug/L in the first water sample collected in 1990 to a very low level of < 0.1 ug/L for a sample collected in 2005. Very low values were also measured in the unfiltered samples collected for the years of 2004 to 2006.

The RCRA Facility Investigation identified cadmium as a waste that was released from the Sandia MWL Dump. The level of dissolved cadmium that was measured in the first water sample collected from well MW1 of 43 ug/L is two orders of magnitude greater than the NMED HWB background level for cadmium of 0.47 ug/L.

The EPA has set the drinking water standard maximum contaminant level (MCL) for cadmium at 5 ug/L because of the following health concerns:

> "Short-term: EPA has found cadmium to potentially cause the following health effects when people are exposed to it at levels above the MCL for relatively short periods of time: nausea, vomiting, diarrhea, muscle cramps, salivation, sensory disturbances, liver injury, convulsions, shock and renal failure."
>
> "Long-term: Cadmium has the potential to cause the following effects from a lifetime exposure at levels above the MCL: kidney, liver, bone and blood damage."

The high level of dissolved cadmium that was measured in the first water sample collected from well MW1 is another important reason for the NMED HWB to order DOE/SNL to replace well MW1. The presence of a high level of dissolved cadmium is supported by the slightly higher level of cadmium that was measured in the unfiltered split of the water sample. The data collected from monitoring well MW1 are best interpreted as evidence of nickel and cadmium contamination in the groundwater at the water table beneath the Sandia MWL Dump and that corrosion of the well screen is masking the detection of the cadmium and perhaps other contaminants of concern including chromium and other trace metals, organic contaminants, and radionuclides.

The corrosion began immediately after the well MW1 was installed and the well has never produced reliable and representative water samples. The well was installed in October 1988, but the first water quality data were not collected until two years later after extensive corrosion of the well screen was present to mask the detection of contamination.

The Hewitt article documented the large amount of cadmium removed from groundwater after development of corrosion for only a period of 130 days. Given the two year period before water samples were collected from the monitoring well MW1, it is possible that very high levels of cadmium are present in the groundwater, but identification of this contamination is masked by the corrosion of the well screen. The cadmium contamination may be wide spread in the groundwater below the Sandia MWL Dump but is masked from detection because there are too few monitoring wells. Monitoring well MW3 is the only other well at an appropriate location besides well MW1 for detection of the contamination at the water table. The corroded well screen and the mud rotary drilling method are factors that have masked detection of contamination at well MW3.

The Moats Evaluation assumed that well MW1 produced reliable and representative water samples simply because the well was not drilled with muds or organic agents. Unfortunately, the Moats Evaluation overlooked the adverse effects on water quality because of corrosion of the stainless steel well screen.

Because the Moats Evaluation ignored the well screen corrosion, the Moats Evaluation made a mistake in using the water quality data from well MW1 as reliable and representative and as a measure for comparison to the wells at the Sandia MWL Dump that were drilled with the mud rotary method. All of the mud rotary wells also are installed with stainless steel screens that are now extensively corroded and the wells require replacement for the multiple factors listed above on page 4.

An important mistake in the Moats Evaluation is the failure to examine the trends over time in the analytical data. Instead, the Moats Evaluation was based on the median values for the entire data set collected over time for a given analyte. The study of median values was technically unsound for the intended purpose. Instead, as the data in Table 1 illustrate, it was important to do a trend analysis of the variation in the measured values as a function of time from the first samples to the most recent. The trend analysis is evidence that well MWL-MW1 has never produced reliable and representative water quality data. Nevertheless, the trend analysis is evidence that the Sandia MWL Dump has released nickel and cadmium contamination to the groundwater.

The scheme used in the Moats Evaluation was to calculate a median value for a selected set of constituents including cadmium from each monitoring well. The median value was calculated for the unfiltered analyses because of the sparse data on filtered water samples. Table 1 shows that cadmium was not detected in most of the analytical data. However, when cadmium was not detected, the Moats Evaluation assumed that cadmium was always present in the water and arbitrarily set the level for each discrete water sample at ½ the method detection limit.

Table 1 presents the assumed values for cadmium that were used in the Moats Evaluation. For example, when cadmium was not detected at a method detection limit of 5 ug/L, the Moats Evaluation assumed cadmium was present in the water sample at a level of 2.5 ug/L. The population of assumed values and measured values were used to calculate a median value.

The Moats scheme to compare cadmium levels in a corroded well screen with cadmium levels in mud rotary drilled wells fails because the effects of removal of cadmium by corrosion is not examined and is hidden by the "median values". With this scheme, the Moats Evaluation calculated the median value for cadmium in the groundwater produced from well MW1 to be 1.2 ug/L. Furthermore, the Moats Evaluation assumed the calculated level of cadmium to be representative of the background level in the *in situ* groundwater. Of course, the trend analysis is evidence that the range of measured levels are not representative of the natural background. The very high level in the first water sample is an indication of cadmium contamination from the Sandia MWL Dump.

The declining trend to disappearance of cadmium in the most recent samples are evidence that the corroded well screen is removing cadmium from the water samples produced from the well.

I recommend for the NMED HWB to retract the Moats Evaluation. If NMED disagrees with my recommendation, then I recommend for the Moats Evaluation to be sent to the scientists in the EPA Kerr Research Laboratory in Ada, Oklahoma for peer review. The scientists in the EPA Kerr Lab performed an important review of the LANL *Well Screen Analysis Report*, a similar report to the Moats Evaluation. I invite the NMED HWB to request the EPA Kerr Lab to review this instant letter.

Improper high-flow sampling methodology masks the detection of contamination.

The letter of March 26, 2007 continues to support the high-flow sampling methods that are one of the factors that prevent the monitoring wells at the Sandia MWL Dump from producing reliable and representative water quality data. The letter misrepresents the ability of the alluvial fan sediments to produce a continuous flow of water during low-flow pumping. The letter also misrepresents the ability of low-flow pumps to produce a continuous flow of water from the 460 ft depth below ground surface (bgs) of the water table below the Sandia Dump. There are economical low-flow pumps that produce a continuous flow of water from the required depth.

Table 2 presents the sampling record in 1991 for all of the monitoring wells that were installed with stainless steel screens across the water table in the alluvial fan sediments.

Table 2. The Sampling Record* for Water Samples Collected in 1991 From the Sandia MWL Dump Monitoring Wells Installed in the AF Facies.

Well No.	Date Sampled	Well Casing Volume (gallons)	Pumping Rate (gal/min)	Pumping Rate (L/min)	Pumping Period (minutes)	Volume Evacuated (gallons)	No. of Well Volumes Evacuated
BW1	01/24/91	16.5	0.98	3.71	56	55	3.33
BW1	05/07/91	16.6	0.77	2.91	107	82	4.94
BW1	08/06/91	16.4	0.64	2.42	134	86	5.24
BW1	10/16/91	16	0.46	1.74	163	75	4.69
MW1	01/24/91	20.2	1.03	3.90	68	70	3.46
MW1	05/07/91	20.3	0.64	2.42	119	76	3.74
MW1	07/31/91	18.8	0.95	3.60	77	73	3.88
MW1	10/15/91	19	0.52	1.97	163	84	4.42
MW2	01/28/91	23.8	0.96	3.63	54	52	2.18
MW2	05/02/91	23.8	0.87	3.29	90	78	3.27
MW2	08/01/91	21.9	0.44	1.67	123	54	2.46
MW2	10/14/91	22	0.68	2.57	80	54	2.45
MW3	01/28/91	18.3	1.06	4.01	33	35	1.91
MW3	05/02/91	19.1	0.77	2.91	58	45	2.36
MW3	08/05/91	17.6	1.00	3.78	63	63	3.58
MW3	10/15/91	20	0.59	2.23	61	36	1.8

* The sampling data are from the NMED Administrative Record for the Sandia Mixed Waste Landfill.

The data in Table 2 are indisputable evidence that in the early years all of the wells were capable of high-flow pumping that evacuated more than three well volumes during the production of a continuous flow of groundwater from each well. The high-flow pumping rates varied between 0.5 to 1 gallon/minute.

The damage caused to the screened intervals by the high-flow pumping is well documented in the technical literature including a position paper of the NMED HWB that was published in 2001. From page 3 of the HWB position paper:

> "**High Flow Rate Sampling:** Evacuation of water from the screened interval of a monitoring well at a rate that significantly exceeds natural flow through the screen (Barcelona, Wehrman, and Varljen, 1994) or the groundwater flow velocity for which the well was designed. High pumping rates of groundwater from the monitoring well may cause undue stress on the well screen or sand pack, shorten the usability and life span of the well, cause excessive turbidity, or may cause other damage to well construction" [emphasis added].

In fact, the wisdom in the HWB position paper is proven by the damage that the high-flow pumping has caused to the screened intervals of the wells listed in Table 2. Over time, the high flow pumping of the monitoring wells at the Sandia MWL Dump reduced the ability of the wells to produce a continuous flow of groundwater with the result that the current sampling practice is to purge the wells dry with samples collected from the water that trickles into the wells over periods of up to seven days. This sampling methodology is well known to strip contaminants of concern from the collected water samples. From Page 7-8 of the RCRA Manual:

> "A low purge rate also will reduce the possibility of stripping VOCs [volatile organic contaminants] from the water, and will reduce the likelihood of mobilizing colloids in the subsurface that are immobile under natural flow conditions. The owner/operator should ensure that purging does not cause formation water to cascade down the sides of the well screen. At no time should a well be purged to dryness if recharge causes the formation water to cascade down the sides of the screen, as this will cause an accelerated loss of volatiles. This problem should be anticipated; water should be purged from the well at a rate that does not cause recharge water to be excessively agitated. Laboratory experiments have shown that unless cascading is prevented, up to 70 percent of the volatiles present could be lost before sampling" [emphasis added].

Continued from Page 7-8 of the RCRA Manual:

> "Purging should be accomplished by removing ground water from the well at low flow rates using a pump. The rate at which ground water is removed from the well during purging ideally should be less than approximately 0.2 to 0.3 L/min (Puls and Powell, 1992; Puls et al.,1991; Puls and Barcelona,1989a; Barcelona, et al., 1990)."

From page 7-19 of the RCRA Manual:

> "Ideally, the rate of sample collection should be approximately the same as the actual ground-water flow rate. Because this is typically not possible, low sampling rates, approximately 0.1 L/min, are suggested. Low sampling rates will help to ensure that particulates, immobile in the subsurface under ambient conditions, are not entrained in the sample and that volatile compounds are not stripped from the

sample (Puls and Barcelona, 1989b; Barcelona, et al., 1990; Puls et al., 1991; Kearl et al., 1992; USEPA,1991b). Pumps should be operated at rates less than 0.1 L/min when collecting samples for volatile organics analysis" [emphasis added].

"Ground-water samples should be collected as soon as possible after the well is purged. Water that has remained in the well casing for more than about 2 hours has had the opportunity to exchange gases with the atmosphere and to interact with the well casing material (USEPA, 1991b) [emphasis added]."

For the five wells at the Sandia MWL Dump that are purged dry, no care is taken to collect samples as soon as possible. This is especially important for volatile constituents and trace metals. The general practice is to collect samples seven days after the well is purged. The exception is well MW4 that is sampled one day after purging.

In summary, the improper high-flow methods that are used to produce water samples from the monitoring wells installed across the water table in the alluvial fan sediments below the Sandia MWL Dump are another factor that has prevented the collection of reliable and representative water samples over the entire groundwater monitoring program. In fact, a study performed by Sandia scientists is evidence that the high-flow sampling has stripped volatile contaminants from the water samples as compared to the order of magnitude higher levels of TCE and PCE that were measured in water samples collected with low-flow pumping methods – *"Review of Low-Flow Bladder Pump and High-Volume Air Piston Pump Groundwater Sampling Systems at Sandia National Laboratories, New Mexico"* by S.S. Collins et al. Waste Management Conference, 2003.

The hydrogeologic setting below the Sandia MWL Dump is well suited for sample collection with low-flow pumping methods.

From page 5 of the NMED HWB March 26th letter:

"Gilkeson does not consider that the depth to groundwater at the MWL (approximately 460 feet bgs) places practical limitations on the type and performance of pumps capable of raising water to the surface from such depths."

The above statement shows that NMED is unaware of the capabilities of low-flow pumping, specifically that the very Bennett[R] pumping system used over the past seventeen years for the high-flow sampling of the Sandia MWL Dump wells will accomplish the low flow pumping. It is a serious mistake that the Bennett[R] pumping system was not used to best advantage to collect reliable and representative water samples.

The Bennett[R] sampling pump that was used for the high-flow sampling to collect the nonrepresentative water samples was also capable of producing low-flow water samples of best achievable water quality. The flow rate of the Bennett pump is infinitely variable over a range of less than 0.1 L/min to greater than 5 L/min for the depth of the wells at the Sandia MWL Dump. The statement in the March 26th letter about the difficulty in operating the Bennett sampling pump at flow rates of less than 0.5 gal/min (2 L/min) is incorrect based on information I have received from the Bennett Company.

A flow control valve installed at the end of the discharge pipe can be used to meter a continuous uniform flow of water from the Bennett[R] pumps down to flow rates of less than 0.1 L/min. It appears that the Bennett[R] pump that is used for sampling the monitoring wells at the Sandia MWL Dump and other locations across the SNL and Kirtland Air Force Base (AFB) is not equipped with the flow control valve. I recommend that the pump be modified and the sampling activities be changed to low-flow pumping.

The paper by Collins et al. that is cited above is evidence that low-flow bladder pumping systems have been in routine use for the collection of water samples from monitoring wells installed across SNL and the Kirtland AFB. The depth of the wells that were sampled with the low-flow bladder pumps range to depths of 620 feet below ground surface (bgs), over 100 feet deeper that the required depth for monitoring wells at the Sandia MWL Dump.

In conclusion, I stand by my position that the groundwater monitoring program for the Sandia MWL Dump has not produced valid knowledge of groundwater contamination and the spurious data has misguided the decision of Secretary Ron Curry to leave the dangerous wastes permanently buried in the dump. There is a need to install a network of new monitoring wells within and surrounding the Sandia MWL Dump. The new wells should be a design for monitoring both the unsaturated zone and the groundwater. A phased approach should be used to determine the total number of new wells that are required. However, the available information shows a need for a minimum of 10 new monitoring wells. The decision on the closure of the Sandia MWL Dump must be based on data collected from the network of new monitoring wells over a minimum period of five years. Please contact me with any questions.

Sincerely

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