REVIEW OF GROUND-WATER MONITORING AT SANDIA NATIONAL LABORATORIES'S MIXED WASTE LANDFILL

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1. INTRODUCTION

Sandia National Laboratories' Mixed Waste Landfill (MWL) was established in 1959 as a land disposal facility for radioactive, mixed, and hazardous wastes (Anonymous, 1991). The MWL occupies approximately 2.6 acres and is located in the north-central portion of Technical Area 3. The MWL is subject to requirements of the Hazardous and Solid Waste Amendments (HSWA) of the Resource Conservation and Recovery Act (RCRA). Sandia National Laboratories (SNLA) is conducting a phased RCRA Facility Investigation (RFI) of the landfill.

The MWL consists of two adjoining, but discrete areas: the classified waste area located on the northeast corner of the facility, and the unclassified area, comprising the rest of the landfill (Figure 1). Classified wastes were buried in small pits which were typically capped with concrete pads. Unclassified wastes were disposed in seven trenches, each estimated to be roughly 32 feet wide by 140 ft long by 25 ft deep (Anonymous, 1991).

The MWL accepted low-level radioactive waste, mixed waste, and hazardous waste from 1959 to 1988. Between 1959 and 1962, chemical wastes were disposed in Pit 1, located in the southeast corner of the classified area, which is the oldest part of the MWL. SNLA believes that little hazardous waste was actually disposed in the unclassified area of the landfill, because the Chemical Waste Landfill (CWL) was established in 1962 specifically for the disposal of such wastes. SNLA estimates 100,000 cubic feet of radioactive waste containing approximately 6300 Curies of activity (at the time of disposal) have been disposed of at the MWL (Anonymous, 1991). The site is currently used for above-ground storage of containerized low-activity radioactive and mixed wastes.

Hazardous, mixed, and radioactive wastes thought to have been disposed at the MWL include acids, heavy metals, organic solvents (such as trichloroethene and carbon tetrachloride), liquid scintillation cocktails, uranium, thorium, transuranic wastes, fission products, and tritium (Anonymous, 1991). In 1967, approximately 270,000 gallons of coolant wastewater from the Sandia Engineering Reactor Facility were discharged into Trench D. In June 1975, 5000 gallons of potable water were used to extinguish a

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fire burning in Trench B. Liquid radioactive wastes were disposed in the MWL without solidification or other treatment prior to 1975 (Anonymous, 1991).

2. Existing Monitor Well Network

A total of five ground-water monitor wells have been installed at the MWL (Figure 1). A fairly detailed report describing the installations of monitor wells MWL-MW2, MWL-MW3, and MWL-BW1 was prepared for SNLA by Ecology and Environment, Incorporated (Anonymous, 1989). This same report also describes the installation of MWL-MW1, which was drilled similarly and at about the same time period as the 1988 CWL monitor wells. The first well, MWL-MW1, was installed at the MWL in 1988 by air-rotary casing-driven drilling methods. Monitor wells MWL-MW2, MWL-MW3, and MWL-BW1 were completed by September 1989 using mud-rotary drilling (Anonymous, 1989). In general, installation of the latter three wells consisted of drilling exploratory pilot holes for soil sampling and geophysical logging, followed by reaming of the pilot holes to facilitate construction of the wells.

All four of the 1988/1989 monitor wells are constructed across the water table with 20 ft of #304 stainless steel screen. Each well was constructed initially with approximately 15 feet of screen below the water table and about 5 feet of screen above the water table (Anonymous, 1989).

An additional monitor well, MWL-MW4, has been recently completed in early 1993 using sonic drilling technology. MWL-MW4, an angle well, reportedly has two separate screened intervals and intersects the water table at a point located beneath Trench D. An as-built well construction diagram of MWL-MW4 is not available for NMED's review at this time.

2.1 Assessment of Well Construction at the MWL

The EPA suggests well intakes (screened intervals) should be "typically 2 to 10 feet in length, and rarely equal or exceed 20 feet in length" (Allen and others, 1991). The screened intervals of the conventional monitor wells at the MWL are at the recommended upper limit, but are appropriate for the site conditions at the MWL.

Although monitor wells MWL-MW1, MWL-MW2, MWL-MW3, and MWL-BW1 generally meet the requirements of EPA guidance, well construction diagrams show that the primary filter packs of MWL-MW2 and MWL-MW3 extend about five feet below their well screens (Anonymous, 1989). U. S. Environmental Protection Agency (EPA) guidance suggests that a "filter pack should generally extend from the bottom of the well intake to approximately 2 to 5 ft above the top of the well intake provided the interval above the well intake does not result in cross-connection with an overlying zone" (Allen and others, 1991).

Additional EPA guidance recommends to the extent possible that a filter pack should coincide with the screened interval of a monitor well to minimize potential dilution of water quality samples.

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.

3. Hydrogeology of the MWL Site

The hydrogeologic conditions at the MWL have not been adequately characterized. As primarily shown by fairly extensive drilling within 100 ft of the surface, the MWL is situated on a thick heterogenous sequence of alluvial fan sediments (Anonymous, 1991). These sediments consist chiefly of fine-grained to medium-grained silty sands which are interlayered with subordinate discontinuous lenses of silty clays and silty, sandy-gravels. Clasts within the gravels consist mainly of quartz, feldspar, quartzite, limestone, dolomite, and a wide variety of metamorphic and igneous granitic rocks. Caliche occurs as thin coatings on some clasts and as small isolated masses within 20 feet of the surface (Anonymous, 1989). The strike and dip of the strata are not known; however, some upper Santa Fe Group beds cropping out in Tijeras Arroyo have dips ranging from 0.5 to 1.5° eastward towards the mountain front (Anonymous, 1989).

The uppermost aquifer beneath the MWL may occupy alluvial sediments which are similar to those located within 100 feet of the surface. Depth to ground water at the MWL averages 460 ft. The water table beneath the landfill is dropping approximately 1 foot per year due to dewatering of the regional aquifer by well fields operated by the City of Albuquerque, and to a much lesser extent, production wells operated by Kirtland Air Force Base (KAFB). 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.

4. Ground-water Flow at the Mixed Waste Landfill

Research by AIP/DOE Oversight staff members has not yet located any site-specific contour maps of the water table at the MWL. An adequate water level map is basic to the understanding of a site's hydrogeologic system. Water level maps should be prepared by SNLA on at least a quarterly basis.

4.1 Horizontal Gradient

The horizontal gradient and direction of ground-water flow are not known with reasonable certainty. Data suggest that the water table may be mounded near the northeast boundary of the site. Additional wells installed at the MWL at greater distances from the facility than the existing wells would better define the horizontal gradient and direction of ground-water flow.

4.2 Vertical Gradient
The vertical component of ground-water flow at the MWL has not been assessed by SNLA. Vertical flow may be significant at the MWL due to the influence of production well pumping. A plan to assess suspected vertical flow at the MWL has been developed by SNLA for future implementation.

5. Lack of Flow Nets Depicting Ground-water Flow Paths
The EPA recommends that flow nets be constructed to identify and depict potential contaminant migration pathways (Anonymous, 1986, p. 28). No flow nets representative of conditions specific to the MWL have been located by the AIP/DOE Oversight Program. Additional monitor wells would need to be installed at the MWL in order to construct adequate flow nets for the facility.

6. Concerns with MWL-MW4
SNLA's objectives for drilling MWL-MW4 include determination of: 1.) direction and gradient of ground-water flow, 2.) extent of contamination beneath the likeliest source area (Trench D), 3.) ground-water quality directly beneath the landfill, and 4.) aquifer and vadose zone characteristics (Anonymous, 1991). Although SNLA deserves credit for the innovative angled well design which conceptually has a greater probability of intersecting any contamination beneath the trench, the installation of MWL-MW4 will not by itself adequately address the stated objectives. Specific concerns with the proposed design of the new well include the following:

1. Monitor well MWL-MW4 will not prevent unavoidable random errors associated with Depth-to-Water (DTW) measurements. Although DTW averages about 460 ft, wells MWL-MW1, MWL-MW2, and MWL-BW1 have static water levels which typically differ by only 0.1 foot or less. Even with well casing deviation surveys, errors in DTW measurements will likely exceed the differences in static water levels between monitor wells. Thus, it is doubtful that the horizontal direction and gradient of ground-water flow can be reliably determined using the existing monitor well network, even with the addition of MWL-MW4. Additional monitor wells will have to be installed at the MWL which are located at greater distances from the landfill to adequately resolve this problem.

2. If ground-water contamination is not detected in MWL-MW4, this fact in itself does not disprove the existence of ground-water contamination at the MWL. Other characterization work may be required. Because of the layered heterogeneity of the sediments comprising the relatively thick vadose zone, contaminant plumes may not necessarily develop in ground water lying immediately below Trench D or any other trench at the MWL.

3. In Anonymous (1991), there is no mention of any mechanism in the design of MWL-MW4 to separate the lower from the upper screened intervals. The two intervals must be separated during ground-water sampling. If ground-water contamination is found in MWL-MW4, the monitoring intervals should be isolated at all times to prevent cross-contamination between shallow and deeper ground water.

4. The total design length of the primary and the secondary filter packs for MWL-MW4 is 65 feet. The two screened intervals have a combined length of 40 feet. As mentioned previously, EPA guidance suggests that filter packs should not extend more than 2 to 5 feet above their screened intervals (Allen and others, 1991). To the extent possible, filter packs should coincide with their respective screened intervals to minimize potential dilution of water quality samples. Because the screened intervals of all MWL wells are already relatively large for monitoring purposes (equal to or exceed 20 feet), the extension of filter packs above the well intakes for any new wells constructed at the MWL should be limited to no more than 5 feet. A secondary filter pack can be substituted as part of that 5 feet extension to prevent contamination of the primary filter pack by grout or bentonite/volclay seals.

5. MWL-MW4, by itself, will not adequately address the issue of vertical ground-water flow at the MWL (see related discussion of vertical gradient in Section 4.2).

6. As designed, MWL-MW4 is an unconventional monitor well and does not meet strict RCRA well construction guidance criteria.

7. Additional Concerns with SNLA's Hydrogeologic Characterization
Additional problems have been identified with the hydrogeologic characterization of the MWL site:

1. No field measurements of transmissivity or hydraulic conductivity have been made for the uppermost aquifer. SNLA plans to conduct an aquifer pumping test at the MWL in the future (see Anonymous, 1991).

2. Detailed geologic data are lacking for the MWL, particularly for the saturated zone. The saturated zone should be continuously cored or sampled at short intervals with a split spoon (or similar method) during any new monitor well installations. Geologic cross-sections of the MWL site should be constructed parallel and perpendicular to the horizontal direction of ground-water flow. Vertical flow nets should also be generated parallel to the horizontal direction of ground-water flow.

3. SNLA has not done an adequate amount of testing of the mechanical/physical properties of soils located in either the saturated or unsaturated zones. Lithologic descriptions reported in the geologic logs are based on visual observations and are not backed up by the inclusion of data derived from standard soil testing methods. Soil tests for grain size, laboratory hydraulic conductivities, and moisture contents should be routinely performed on geologic samples from all future exploratory trenches, soil borings, and monitor well installations. Additionally, other periodic tests for Atterburg Limits are highly recommended.

4. Contour maps showing the distributions, concentrations, and extents of any identified contaminant plumes should be constructed for each analyte of concern on a semi-annual basis, or at least quarterly should a ground-water assessment program be invoked.

8. Sampling Procedures

Observations of SNLA's field sampling procedures confirm that they are nearly identical to those employed at the CWL. The following minor criticisms of SNLA's field sampling procedures were noted:

1. No plastic drop cloth is used during sampling.

2. A photoionization detector is not a suitable method for checking for the presence of nonaqueous-phased liquids (NAPLs). The presence of dense and light NAPLs should be checked for using a colorless plastic bailer and the procedures described by EPA guidance (anonymous, 1986). Monitoring for the presence of NAPLs should be done at least once per year as part of the current detection monitoring program.

3. Observations show that ground-water samples are not always screened in the field for radioactivity.

9. Conclusions

The detection monitoring system that currently exists at the MWL is inadequate because the direction and gradient of ground-water flow can not be determined with reasonable certainty. If ground-water contamination is not found directly beneath Trench D (in well MWL-MW4), this fact in itself, does not definitely disprove the existence of ground-water contamination at the MWL. Uncertainties regarding the horizontal gradient and direction of ground-water flow will not likely be resolved as a result of the installation of MWL-MW4 due to random errors in water level measurements. Furthermore, MWL-MW4 can not by itself be used to adequately characterize suspected vertical ground-water flow at the MWL. In conclusion, there exists a need for more detailed hydrogeologic information for the MWL.

10. Acknowledgments

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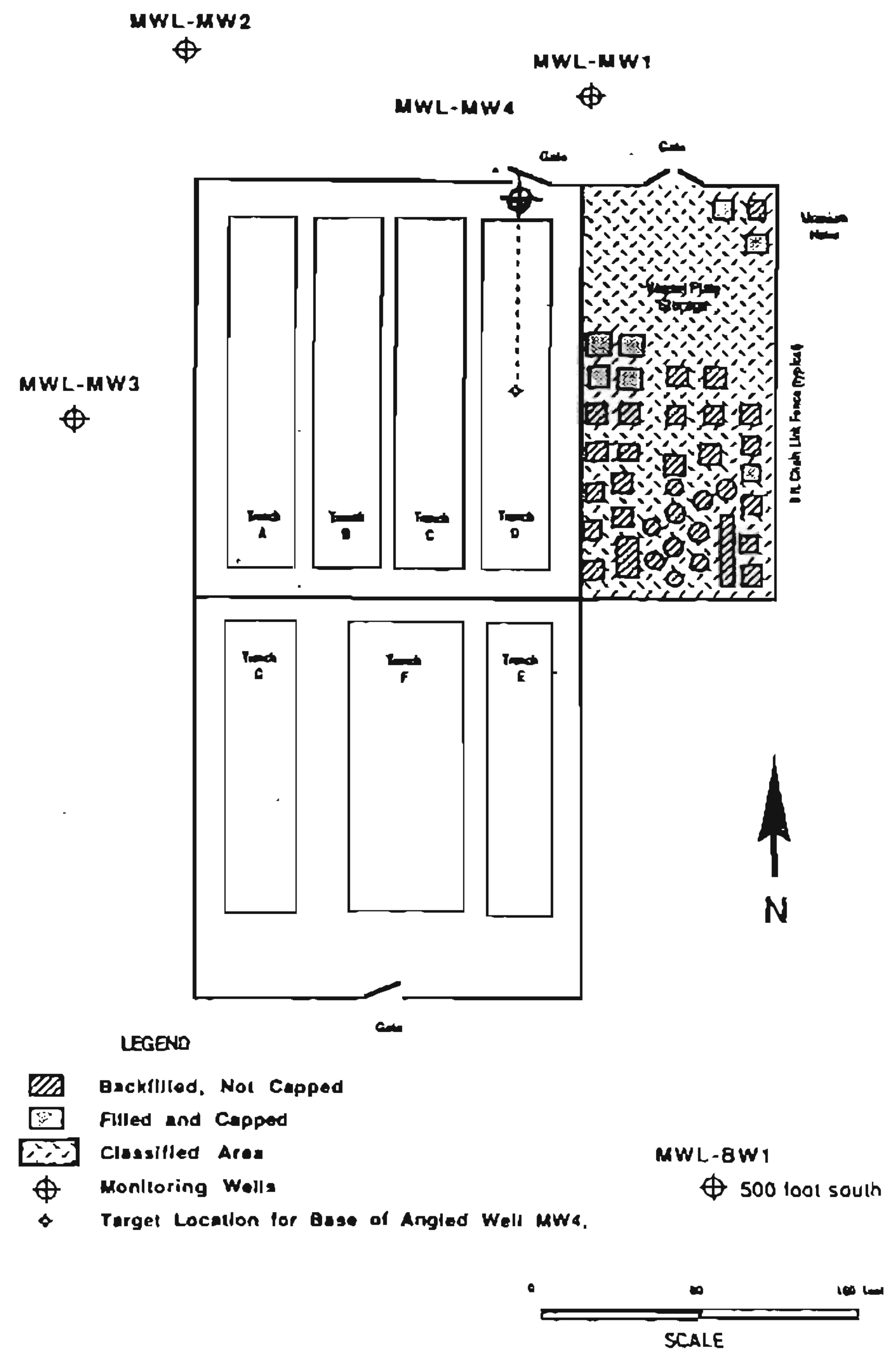

Figure 1. Map of Mixed Waste Landfill showing monitor wells, trenches, and waste pits (modified from Anonymous, 1991).