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Closure and Post-Closure Care Plan Municipal and Asbestos Areas Main Post Landfill

White Sands Missile Range

December 2008

White Sands Missile Range
Environment and Safety Directorate
White Sands Missile Range, New Mexico 88002
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This Closure and Post-Closure Care Plan has been developed to meet the requirements of New Mexico Administrative Code 20.9.6. This plan includes construction quality assurance, groundwater monitoring, and post-closure care plans.

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CLOSURE AND POST-CLOSURE CARE PLAN
MUNICIPAL AND ASBESTOS AREAS
MAIN POST LANDFILL

Submitted to:

U.S. Army
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Directorate of Public Works - Environment Division
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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AL	Asbestos Landfill
C&D	Construction and Demolition [waste]
CQA / CQC	Construction Quality Assurance / Construction Quality Control
DoD	Department of Defense
HELP	Hydrologic Evaluation of Landfill Performance
Mg/L	milligrams per liter
MPL	Main Post Landfill
MSW	Municipal Solid Waste
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
STP	Sewage Treatment Plant
SWB	Solid Waste Bureau
SWMU	Solid Waste Management Unit
USCS	Unified Soil Classification System
WSMR	White Sands Missile Range

CLOSURE AND POST-CLOSURE CARE PLAN
MUNICIPAL AND ASBESTOS AREAS
MAIN POST LANDFILL

1.0 INTRODUCTION

White Sands Missile Range (WSMR) has developed this Closure and Post-Closure Care Plan to meet the New Mexico Environment Department Solid Waste Bureau (NMED SWB) requirements for closure of portions of the Main Post Landfill (MPL) and Asbestos Landfill (AL).

The MPL and AL is located within Dona Ana County, approximately three miles east by southeast of the WSMR Main Post and occupies portions of Sections 21, 22, 27, and 28 of Township 22 South, Range 5 East (Figure 1). The complete facility, including the AL, occupies approximately 37 hectares (92 acres) of land owned by the Department of Defense (DoD).

NMED SWB requires all solid waste facilities to provide Closure and Post-Closure Care Plans at the time of application for a permit. WSMR submitted such a plan in 2001, when reapplying for a renewal of the MPL operating permit. That permit application was administratively denied in December 2005 and NMED has since issued new solid waste regulations. Municipal solid waste disposal activities ceased in 1996. Thus, WSMR is now submitting an updated Closure and Post-Closure Care Plan for relevant portions of the MPL, to wit, the older construction and demolition (C&D) and municipal solid waste (MSW) disposal areas and the AL.

This plan has been prepared in accordance with the requirements of the New Mexico Solid Waste Management Regulations (20.9.6NMAC), effective date 2 August 2007; and NMED's *Guidance Document for Performance Demonstration for an Alternate Cover Design under Section 502.A.2 of the New Mexico Solid Waste management Regulations (20 NMAC 9.1) Using HELP Modeling*, April 1998.

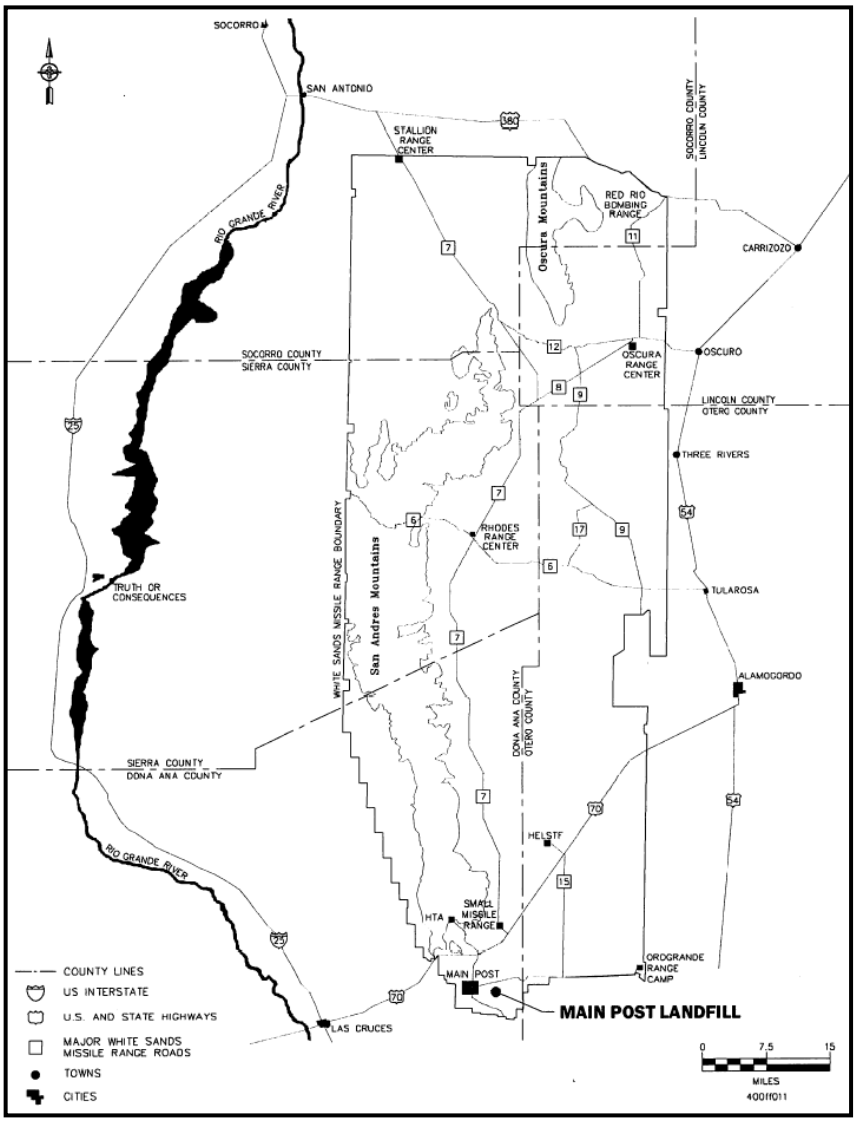


FIGURE 1: LOCATION OF MAIN POST LANDFILL

This plan describes closure actions for the older C&D, MSW, and AL areas. Included are a Construction Quality Assurance / Construction Quality Control (CQA/CQC) Plan and a Post-Closure Care Plan.

2.0 SITE DESCRIPTION

The WSMR Main Post Landfill was registered with NMED in April 1982 and at that time contained three disposal pits—residential refuse or municipal solid waste (MSW), dead animals, and construction and demolition (C&D) debris. The landfill has been in operation since 1983. MPL covers an area of approximately 82.9 acres, although only approximately 38.6 acres have actually been utilized to dispose of waste material. MPL ceased receiving MSW in 1996, and now only accepts C&D waste. Based on these dates MPL qualifies as a "category 3 landfill" as defined by 20.9.2.7.L(1) NMAC. A separate landfill, the AL, located immediately to the east of the MSW and C&D landfill area, is designated for disposal of asbestos containing material. The AL is approximately 4.7 acres and is near capacity. All waste cells at MPL are unlined and a leachate collection system was not installed.

The immediate area around MPL is undeveloped, with the exception of the Scrap Yard (metal recycling facility) to the south. The Main Post Sewage Treatment Plant (STP) is located 0.7 miles west by southwest and the Main Post Headquarters, including residential area, is located approximately three miles west by northwest of MPL. A map of the surrounding area is provided in Figure 2.

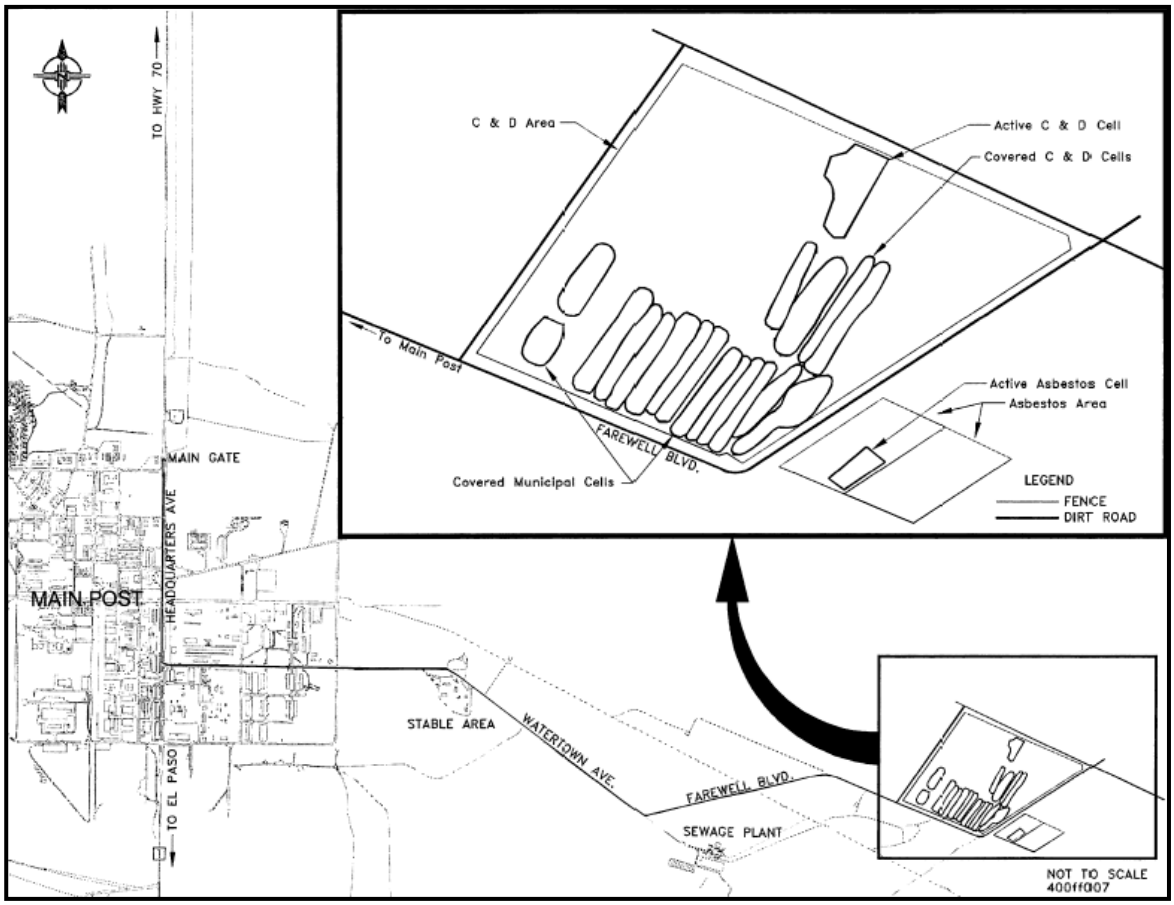


FIGURE 2: MAIN POST LANDFILL AND VICINITY (FIGURE REPRESENTS PAST OPERATIONS)

Groundwater monitoring activities began in 1996 with installation of four monitor wells and five quarters of sampling to establish background concentrations. Following development of background, groundwater monitoring has been conducted since 2000. Depth to groundwater in the area of MPL is approximately 180 to 200 feet below ground surface. Monitoring for methane, previously conducted on a quarterly basis with negative results, has been suspended.

2.1 Geology

Summaries of the area geology and hydrogeology were included in the *Main Post Landfill Background Groundwater Monitoring Plan* (Radian, 1995) and the *Summary Report of Geology and Hydrogeology at the Main Post Landfill* (Exhibit Y of the 2001 *Solid Waste Permit Application* developed by MEVATEC Corp., 2001). Also pertinent to the groundwater situation is legacy contamination from discharges to the WSMR STP. This contamination was not detected until 1996, when background groundwater monitoring was begun for MPL. This contamination and its effect on MPL are detailed in the *Site Characterization Report for the Former Sewage Treatment Plant (STP) Percolation Ditches* (MEVATEC, 1999). Portions of these reports are summarized in section 2.1 and 2.2 of this closure plan.

WSMR lies within the Mexican Highland Section of the Basin and Range Province. This province is characterized by a series of tilted fault blocks forming longitudinal, asymmetric ridges, or mountains, and broad intervening basins. The geologic setting of WSMR consists predominantly of the Tularosa Basin and surrounding mountain ranges. The majority of WSMR property, including most test facilities, is located within the Tularosa Basin (WSMR, 1998). The San Andres, San Augustin, and Oscura Mountains border the Tularosa Basin on the west while the Sacramento Mountains form the eastern border. A narrow region of north-south-trending, large-displacement normal faulting separates the mountains from the basin resulting in the change in relief across the range. The average elevation of the Tularosa Basin is 4,000 ft above mean sea level. Specific soil information was collected from the *Soil Survey of White Sands Missile Range, New Mexico* (USDA, 1976)

2.1.1 General Geology

Basin deposits consisting of piedmont alluvium, fine-grained lake and playa sediments, coarse-grained river deposits, and aeolian material can exceed 5,000 feet in thickness. Gypsum dissolved from the surrounding mountains is concentrated in the intermittent dry lakebed of Lake Lucero and then transported by winds to form the gypsum dunes of White Sands National Monument in the center of the Tularosa Basin.

2.1.2 Site Specific Geology

MPL is located along the western edge of the Tularosa Basin approximately 3 miles from the Organ Mountains. The facility is located on the distal portion of the alluvial fan extending eastward from the Organ Mountains. Sediments consist of varying layers of sands and clays to below the zone of interest, becoming somewhat more fine-grained to the east (toward the center of the basin).

According to the soil survey for WSMR, MPL is located within the soil grouping, “Dune land-Dona Ana complex” (USDA, 1976). This complex consists of approximately 40 percent Dune land (mainly loamy fine sand or fine sand), 25 percent Dona Ana sandy loam (gently undulating to undulating soil between dunes), and 20 percent Bluepoint loamy fine sand (gently undulating soil near low dunes). Runoff from this complex is slow with a slight hazard for water erosion, while wind erosion potential is high. Vegetation is scattered mesquite, chamiza, soaptree yucca, sand dropseed, broom snakeweed, and annuals (USDA, 1976). In 1999, seven soil samples were collected from borings through the existing cover. Results from this analysis appear in Table 1. Cross-sections of the near-surface geology under the MPL, based on these borings, are provided in Figure 3 on the following page.

Site-specific geology can be further characterized based on the well logs developed when the monitor wells were installed in the immediate area. Typical of alluvial fans, the unconsolidated alluvial material underlying the site consists of layers of sand, silt, and clay in various proportions and intermixed with gravel. Monitor wells and test wells in the vicinity of the site have not reached bedrock (Dept. of the Army, 1976). A fence diagram has been developed based on logs from all of the monitor wells in the vicinity; it is included as Appendix A. These logs demonstrate that sand is the principal soil type of the top 30 to 75 feet. Clay layers exist at multiple locations in the subsurface and may be 4 to 75 feet thick depending on location.

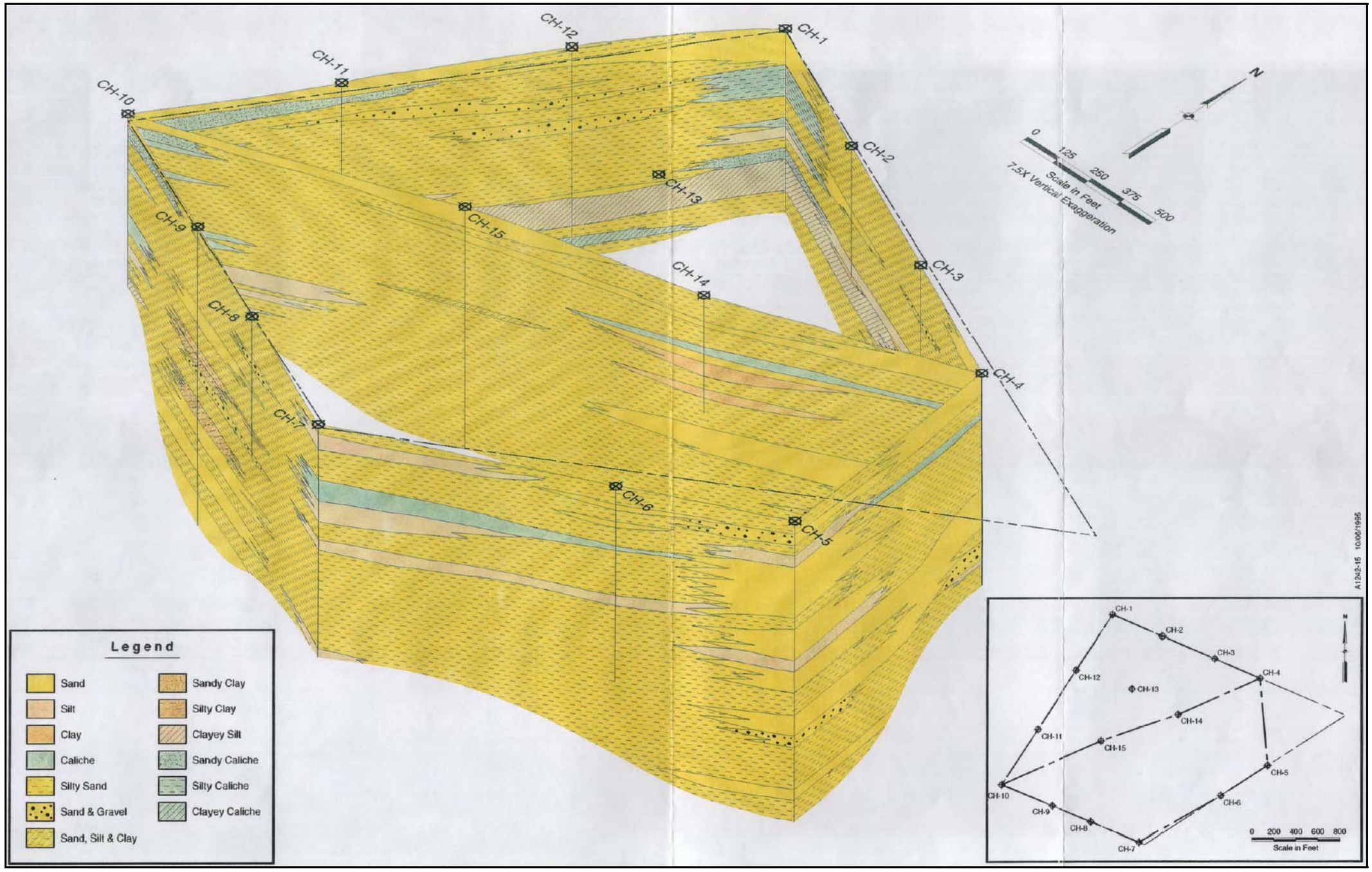


FIGURE 3: GEOLOGIC CROSS-SECTIONS

TABLE 1: PROPERTIES OF IN-SITU SOILS AT MAIN POST LANDFILL							
Sample	**Soil Type**	**USCS**	**AASHTO**	**Max Dry Density (pcf)**	**Percent moisture**	**Percent compaction**	**k_{20} (cm/sec)**
MPL 1	Silty sand	SM	A-2-4	125.3	10.3	92.0	2.8×10^{-5}
MPL 2	Silty sand	SM	A-2-4	121.4	12.2	92.0	2.4×10^{-5}
MPL 3	Silty sand	SM	A-4	127.3	8.7	91.8	2.6×10^{-6}
MPL 4	Silty sand	SM	A-2-4	125.0	9.9	92.3	4.2×10^{-5}
MPL 5	Silty sand	SM	A-2-4	112.9	11.8	92.0	4.0×10^{-4}
MPL 6	Silty sand	SM	A-2-4	120.6	12.5	91.9	5.8×10^{-6}
MPL 7	Silty sand	SM	A-2-4	124.9	9.8	92.0	1.1×10^{-4}

USCS – Unified Soil Classification System
AASHTO – American Association of State Highway and Transportation Officials
k_{20} – coefficient of permeability, measured in centimeters per second

2.2 Hydrogeology

Hydrogeology in the area has been carefully studied because of a nearby occurrence of cyanide contamination unrelated to MPL. This contamination is related to the former STP Percolation Ditches (Solid Waste Management Unit (SWMU) 82) as shown in Figure 4. Measured potentiometric surface elevations suggest a groundwater flow direction to the southeast. The configuration of the land surface and the water table (based on measurements taken in 1999) is shown in Figure 5 (unpublished MEVATEC Corporation graphic). As a conceptual model, little change appears to have occurred in the interim. Current configuration of the water table and inferred groundwater flow direction are shown on Figure 6.

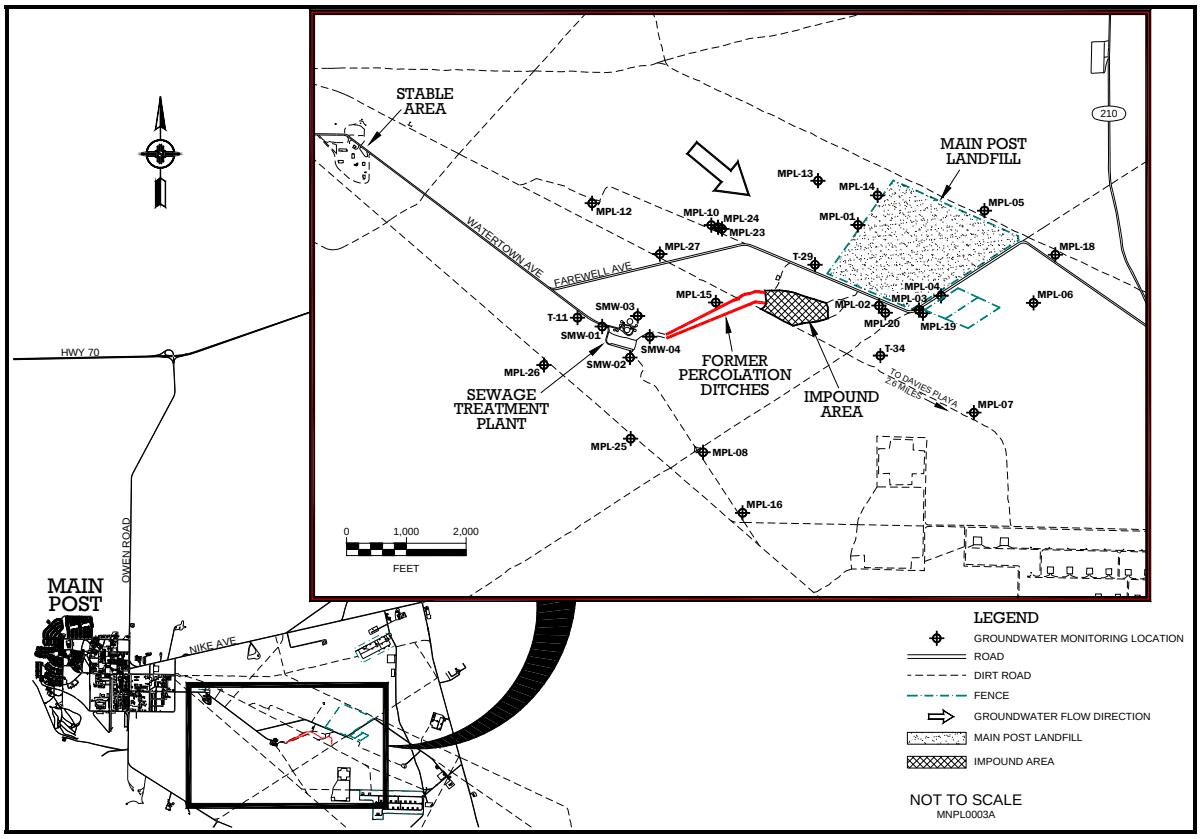


FIGURE 4: MPL & SWMU 82 SITE MAP

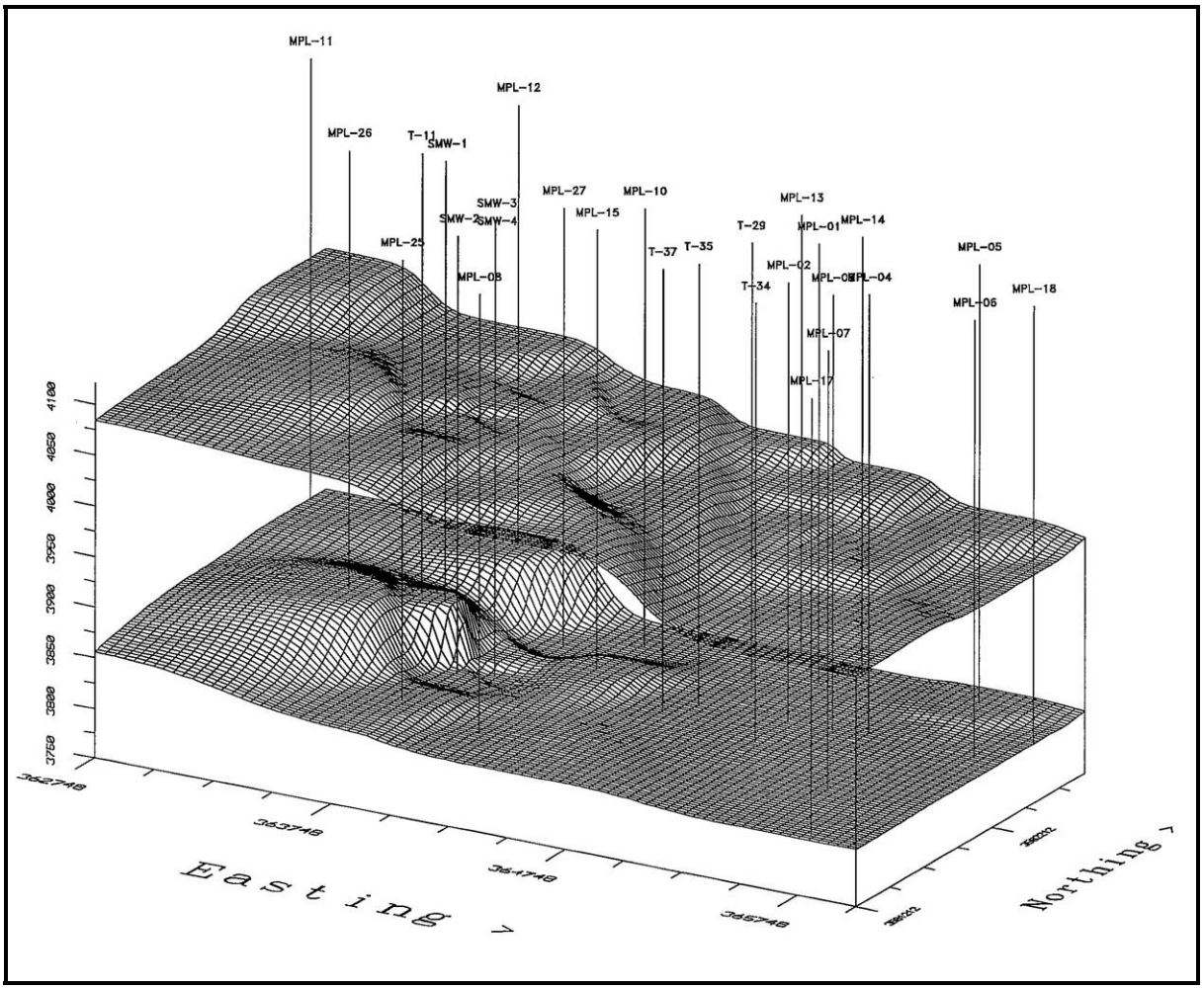


FIGURE 5: TOPOGRAPHY OF LAND SURFACE AND WATER TABLE IN THE VICINITY OF MPL

2.2.1 Groundwater

Based on recent groundwater measurements (June 2008) the water table has a gradual slope (0.0013 ft/ft) to the southeast. Figure 6 notes groundwater flow direction and gradient based on recent measurements to the water table.

TABLE 2: MONITOR WELL CONSTRUCTION DETAILS

Well	Date Installed	Total Depth (ft)	Elevation Brass Cap (ft)	Screen Length (ft, bgs)	Groundwater Elevation (ft)
MPL-01	05/17/1996	220.6	4012.56	195-215	3813.77
MPL-02	05/19/1996	220.5	4004.55	195-215	3811.59
MPL-03	05/22/1996	228.5	3997.75	203-223	3810.96
MPL-04	05/30/1996	225.0	3993.50	200-220	3810.98

Construction details given in "Groundwater Monitoring at the Main Post Landfill" (MEVATEC, 1997). Groundwater elevation based on water level measurements collected 3 February 1997.

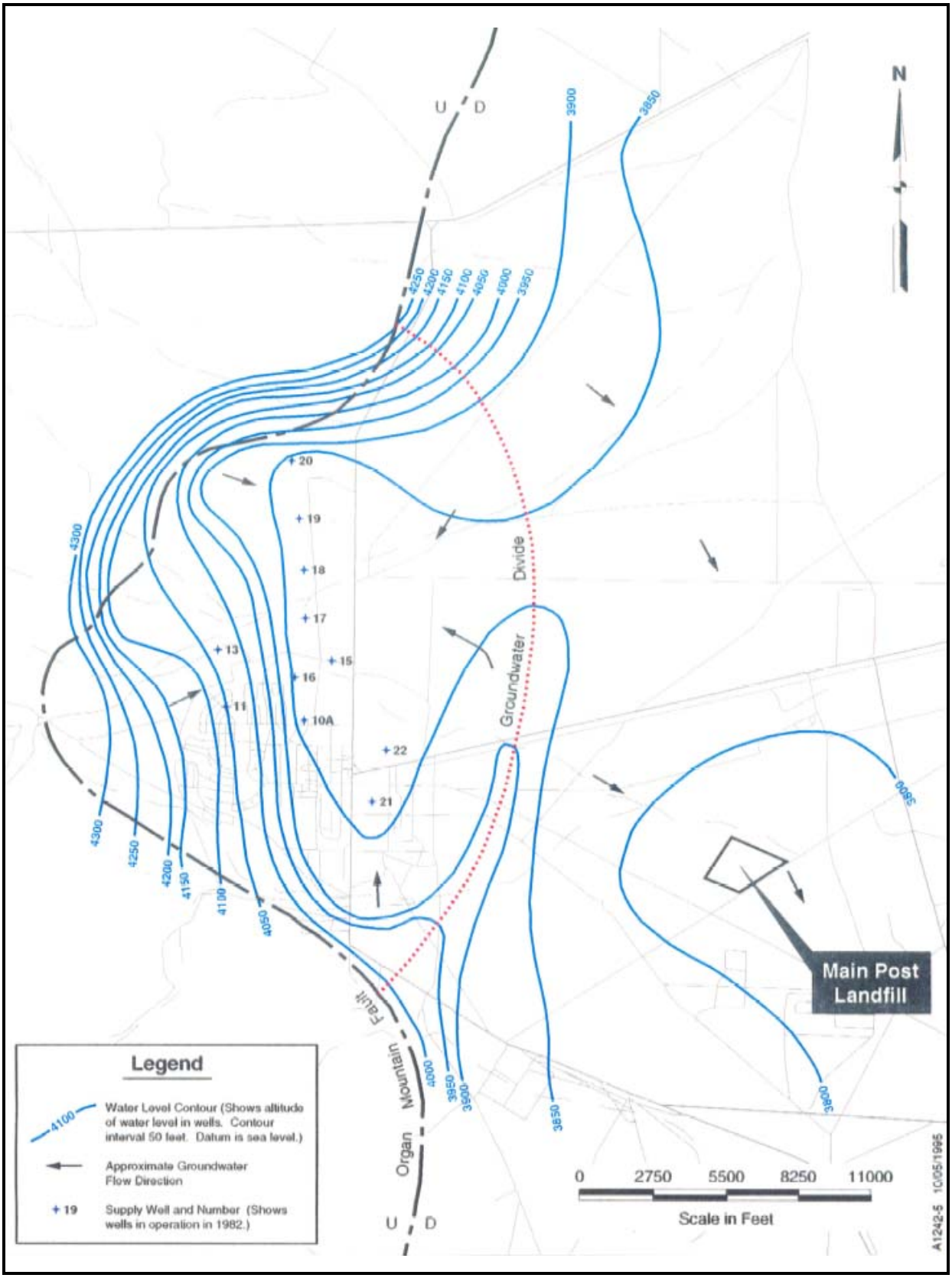


FIGURE 6: GROUNDWATER FLOW DIRECTION

Groundwater monitoring in association with the landfill has occurred since 1996. Based on recent groundwater measurements, the groundwater level has declined 3 to 4 feet over the last 11 years. This may be due to natural fluctuations based on recent drought conditions in the region as well as the continued gradual subsidence of the groundwater mound, identified by Risser (1988), which is a relict of the STP percolation ditches.

2.2.2 Groundwater Quality

Generally, groundwater quality deteriorates as it moves further east, away from the recharge area at the foot of the mountains and the alluvial fans. Approximately 5 miles east of the mountains dissolved solids content in the groundwater is greater than 1,000 milligrams per liter (mg/L) and thus, it is no longer considered potable. Groundwater at MPL has consistently demonstrated total dissolved solids readings ranging from 250 to 490 mg/L).

Initial groundwater monitoring was conducted at the MPL (wells MPL01, 02, 03, and 04, as shown in Figure 7) in 1996 and 1997. Figure 7 depicts the landfill configuration as it existed in 1996. This effort and the associated results are detailed in *Groundwater Monitoring at the Main Post Landfill White Sands Missile Range* (MEVATEC, 1997). The five independent samples were collected in June, August, October, November 1996, and February 1997. Sampling methods consisted of purging three well volumes and then collecting samples. Concentrations of aluminum, barium, boron, calcium, iron, magnesium, manganese, potassium, and sodium were detected. The presence of these metals was attributed to natural sources. Nitrate and the hazardous constituent, cyanide were also detected. These two contaminants were shown to be the result of historic discharges (1958 to 1986) of treated effluent from the STP.

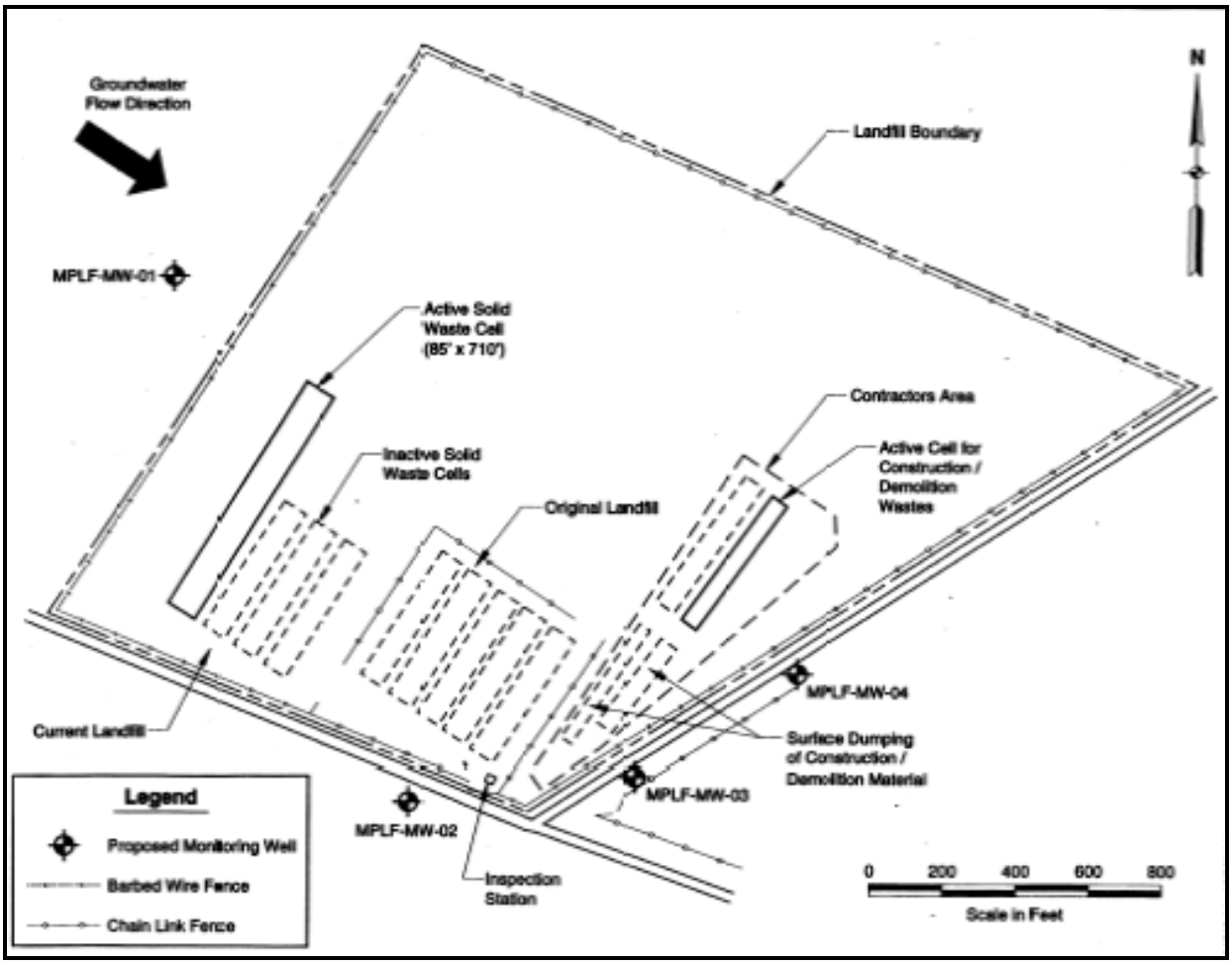


FIGURE 7: MONITORING WELL LOCATION

Groundwater monitoring activities continue in conjunction with ongoing surveillance of SWMU 82, which falls under the purview of the Hazardous Waste Bureau. Results pertaining to the MPL are reported in the Annual Solid Waste Questionnaire. Since 2005, MPL monitor wells have been sampled via low-flow methods following guidance from ASTM *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (D 6771-02)* and NMED's *Use of Low-flow and Other Non-Traditional Sampling Techniques for RCRA Compliant Groundwater Monitoring* (1 October 2001). A copy of the most recent groundwater monitoring report is presented at Appendix B.

Detected analytes did not exceed their respective groundwater protection standards. Detections were in the range of prior sampling events. The total iron sample (0.660 mgL) from MPL01 did exceed 50 percent of the groundwater protection standard (1.0 mg/L) in the February 2007 sampling. High iron detections are typical. This constituent has previously been shown to be naturally occurring.

2.3 Landfill Description & Operational History

Based on prior documentation, the trench method of landfilling was utilized for most disposal within the MPL. Some of the early C&D disposal may have been dumped on the surface, but has since been buried (Radian, 1995). According to records, MPL consisted of three disposal pits when operations began in 1983 — residential refuse or MSW, dead animals, and C&D debris. MPL ceased receiving MSW in 1996.

Measurement of areas noted in this section relied on historical documents, the topographical survey performed by Robert Pounds in 1999, and the geophysical survey performed by Blackhawk Geometrics, Inc. in 1999. Depths of cells are reported to be 25 to 35 feet (Radian, 1995). Current cover thickness varies. Hand auger tests were conducted in 1999 to confirm cover thickness at five locations. A map showing the results of a current (2008) topographic survey is included in the pocket.

2.3.1 Construction and Demolition Area to be Closed

C&D debris has been disposed in multiple areas as noted in Figures 2 and 7. The total area is approximately 9.9 acres. These cells were to be covered with at least 2 feet of soil. Three hand auger tests reached depths of 1.5, 3, and 5 feet before encountering waste. Current topography does not provide adequate slope to promote positive drainage. Landfill final grades will be sloped to prevent the ponding of water and erosion of the cover material. Additional details are noted in the Cover Plan (section 3.0) and construction drawings (Appendix C).

2.3.2 Municipal Waste Area to be Closed

The municipal waste area consists of approximately 13.9 acres of covered cells. This area received waste from 1983 to 1996. These cells were to be covered with at least 2 feet of soil. Two hand auger tests reached depths of 5 and 9 feet before encountering waste. Current topography does not provide adequate slope on portions of the area to promote positive drainage. Landfill final grades will be sloped to prevent the ponding of water and erosion of the cover material. Additional details are noted in the Cover Plan (Section 3.0) and construction drawings (Appendix C).

2.3.3 Asbestos Landfill (AL)

The AL, directly east of MPL, is near capacity on the 4.7 acres originally permitted. When WSMR applied for a new permit in 2001, an additional 5-acre expansion area was proposed. Because the application was administratively denied in 2005 this area was never utilized to dispose of asbestos material. However, there are multiple sources which incorrectly reference the AL as consisting of 10 acres. Additional details are noted in the Cover Plan (section 3.0) and construction drawings (Appendix C).

2.3.4 Types of Waste Accepted

Municipal solid waste from WSMR activities (office and base housing) was deposited in MPL from 1982 through 1996. Material accepted included household waste from approximately 850 residences, office waste, and green waste. According to the prior closure plan, MSW was placed in 12 cells along the southern portion of MPL. C&D debris has been placed in trenches north and west of the MSW area. Material accepted is typical of C&D waste—concrete, brick, wood, stone, and soil.

Debris deposited in the AL included material from remodeling/renovation projects, facilities maintenance and repair actions, building demolition projects, and missile parts (gaskets, seals, and coatings).

2.3.5 Estimated Volume of Waste On-site

The acreage and volumes of waste currently on site are shown in Table 3. Since the current C&D cell is open and receiving wastes, the volume at closure is an estimated quantity. Future C&D waste disposal is not addressed in this plan.

TABLE 3: ESTIMATED VOLUME OF WASTE

Disposed Material	Area (acres)	Estimated Volume (cubic yards)
Municipal Solid Waste	13.9	378,400
Asbestos	4.7	128,000
C&D (ready for closure)	9.9	269,500
C&D (current open trench)	1.5	30,000
C&D (future use)	44	NA
Volume calculations assume cover thickness of 2.5 feet and 25 percent volume occupied by daily cover.		

3.0 COVER PLAN

WSMR proposes to continue use of the landfill site to dispose of C&D debris generated within WSMR. Approximately 44 acres remain within the landfill fence that have not been utilized for waste disposal. New cells will be opened to receive future C&D waste; all existing cells will be closed in accordance with this closure plan.

The final cover design employs lined drainage channels which limit precipitation infiltration and minimize fill needed to reach the required slope. The shallow drainage channel will be lined with high-density polyethylene and filled with gravel to protect the liner while allowing adequate storm-water flow. The design sheets give additional construction details and are included as Appendix C. This alternative cover has been evaluated using the Army Corps of Engineers modeling software, Hydrologic Evaluation of Landfill Performance (HELP). Modeling with HELP has shown the native soil available at the site, when compacted to a thickness of 30 inches, provides protection of public health, welfare, and the environment equivalent to the cover details noted in 20.9.6.9.A NMAC. This modeling is further discussed in section 3.2.

3.1 Thickness of Existing Cover Material

Based on operating records, each of the cells was capped with a native soil cover when capacity was reached. Hand auger tests of cover thickness conducted in 1999 noted measurements of 1.5 to 9 feet. Prior to closure a systematic survey will be performed using a hand auger to measure thickness of existing cover, where data is missing. These measurements will be utilized to verify that cover requirements are met based on the alternative cover design detailed within this closure plan. Previous sample points are shown in Figure 8. Depths of existing cover are noted in Table 4.

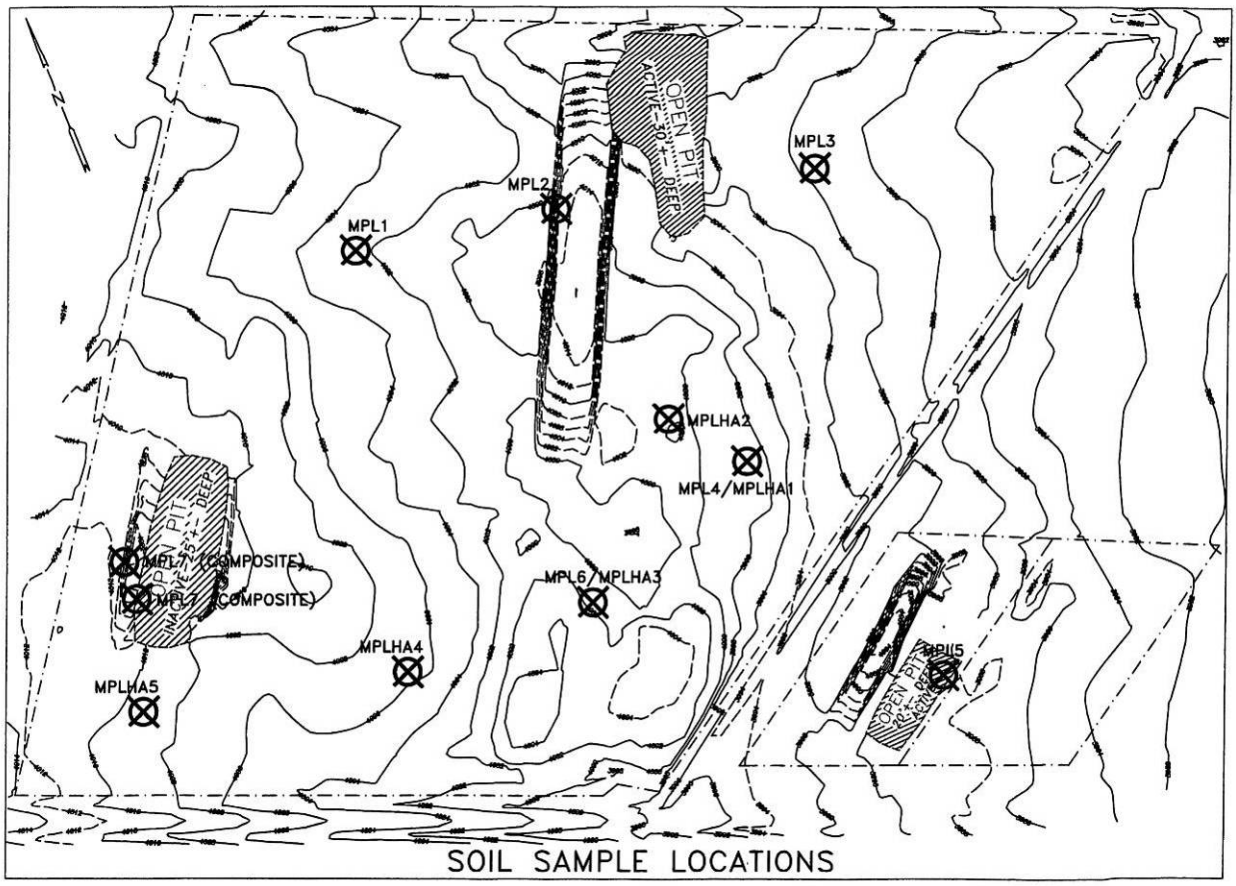


FIGURE 8: APPROXIMATE LOCATIONS OF AUGER POINTS ON EXISTING CELLS

TABLE 4: HAND AUGER RESULTS		
Sample	**Cover thickness at sample location (ft)**	**Type of waste encountered**
MPLHA 1	5	nylon mesh, wood
MPLHA 2	1.5	clay pipe, wood
MPLHA 3	5	plastic, Styrofoam, insulation
MPLHA 4	9	Styrofoam
MPLHA 5	3	aluminum, plastic, Styrofoam

3.2 HELP Model

According to 20.9.6.9.A NMAC, the cover requirement for municipal and special waste landfills is 18 inches of earthen material having a saturated hydraulic conductivity no greater than $1x10^{-5}$ centimeters per second. This is applicable to landfills like MPL which are unlined and did not receive more than 20 tons of waste per day annual average. An erosion layer consisting of 6 inches of earthen material capable of sustaining native plant growth is required over the cover. This cover is considered prescriptive cover design. WSMR proposes to use an alternative cover consisting of native soils which provides equivalent protection as the prescriptive cover.

Samples from the existing intermediate cover were collected in 1999. These samples demonstrated a range of hydraulic conductivities as noted in Table 5. Locations of these samples are noted in Figure 8.

TABLE 5: EXISTING COVER SOIL PROPERTIES

Sample	Soil Type	Cover sample location	Hydraulic conductivity (cm/sec)
MPL 1	Silty sand	surface	$2.8x10^{-5}$
MPL 2	Silty sand	stockpile	$2.4x10^{-5}$
MPL 3	Silty sand	surface	$2.6x10^{-6}$
MPL 4	Silty sand	co-located with MPLHA 1	$4.2x10^{-6}$
MPL 5	Silty sand	open pit (asbestos landfill)	$4.0x10^{-4}$
MPL 6	Silty sand	co-located with MPLHA 3	$5.8x10^{-6}$
MPL 7	Silty sand	stockpile	$1.1x10^{-4}$

3.3 MSW Area to be Closed

The existing municipal waste disposal area occupies approximately 13.9 acres. The current soil surface has a gradual slope (1 percent) to the east. According to the regulations governing closure of landfills (including MSW, asbestos, and C&D) slopes of finished grades shall not exceed 25 percent and not be less than 5 percent for landfills permitted after the effective date of the current regulations (20.9.6 NMAC). Landfills permitted prior to the effective date (2 August 2007) can be approved with minimum slope of 2 percent. However, WSMR has designed to the 5 percent standard. WSMR will verify slope and correct any areas of ponding once the final cover is complete.

Based on these requirements, WSMR proposes a native soil cover of 30 inches thickness. An additional 6 inches of soil material which is resistant to wind and water erosion will be placed over the native soil cover. The cover material will be excavated from future C&D landfill cells or from designated borrow pits on WSMR. The erosion layer will be transported from borrow pits located along the eastern slopes of the San Andres Mountains, approximately 9 miles from the site.

3.4 C&D Area to be Closed

Regulations for closure of cells containing C&D (20.9.6.10 NMAC) require a cover consisting of a minimum 18 inches of compacted soil with an additional 6 inches of soil material capable of supporting native plant life. Required slope must be less than 25 percent and more than 5 percent for landfills permitted after the effective date (2 August 2007). Landfills permitted prior to the effective date may have slopes as flat as 2 percent. As mentioned previously, WSMR is using the 5 percent standard. WSMR will verify slope and correct any areas of ponding once the final cover is complete. WSMR proposes to utilize native soil from the immediate area for construction of the cover. Additional details of proposed cover material are discussed in section 3.6.

The final cover will consist of a compacted layer of not less than 30 inches of clean soil and a minimum of 6 inches of erosion layer capable of supporting native vegetation.

3.5 Asbestos Landfill

Regulations for closure of cells containing only regulated asbestos [20.9.6.9.A.(1).(h) NMAC] require a cover with 30 inches of compacted native soil and an additional 6 inches of topsoil. The cover material can finish at original grade with measures taken to control erosion and rodent intrusion. Final elevation of the cover will be based on depth to landfilled material. If deemed necessary test borings may be used to verify the depth of cover. Any test borings made at the AL will require appropriate precautions to protect personnel performing the work. Only individuals who have been trained on the hazards

associated with asbestos containing materials will be allowed to perform direct measurements using hand auger equipment. If measured depths are not sufficient to meet the requirements noted above, adjustments to final cover grade will be made so cover thickness is met and the potential for ponding or erosion is minimized.

3.6 Cover material

Cover material will be principally derived from the existing material on site or from designated, nearby borrow pits. The cover is designed in such a way to make use of the existing soil properties and still meet the closure requirements (20.9.6.9 NMAC). The existing soil does not have a significant "topsoil" component. The lack of available topsoil should not materially effect growth of a protective vegetative layer. Native vegetation is well adapted at surviving in the alkaline sandy surface soil. The 6-inch thick erosion layer will be composed of material with a larger percentage of gravel sized particles making it more resistant to wind erosion typical of this region. This material is not available in the immediate area and will need to be transported from other locations on WSMR.

One such source of borrow material is located 9 miles north of MPL along the east slope of the San Andres Mountains. This borrow pit contains abundant coarse material. A recent sample was classified as "slightly silty sand with gravels (SM-SP)." Assuming a 6 inch thick erosion layer, approximately 20,100 cubic yards of material will be required to complete the cap for all existing MSW and C&D areas at MPL. If available, WSMR will locate a closer source for the erosion layer.

3.7 Construction Quality Assurance / Construction Quality Control (CQA/CQC)

Construction work practice will follow the guidance noted or referenced in this section. The requirements for CQA/CQC plans are taken from 20.9.4.14 NMAC.

3.7.1 Equipment, method of compaction, proctor density

Compaction will be to no less than 75 percent and no more than 85 percent of the standard proctor density [20.9.6.9.A.(1).(g) NMAC].

According to 20.9.4.14 NMAC, quality control plans will:

- Define procedures for obtaining samples and testing and reporting the test results for the installation of the final cover;
- Describe and illustrate all necessary procedures for maintaining the integrity of the final cover;
- Prescribe the minimum frequency of testing for the soil component of all final covers as follows:
    - Borrow soil will have grain size tested once every 1,000 cubic yards;
    - Atterberg limits tested once every 5,000 cubic yards;
    - Proctor compaction moisture density curve conformance tested one every 5,000 cubic yards;
    - Laboratory permeability will be tested once every 5,000 cubic yards;
    - During construction of the cover the soil will be tested as follows:
        - Density and moisture content tested by nuclear densiometer four times per acre per lift;
        - Laboratory or in-situ permeability will be tested once per 2 acres; laboratory samples will be undisturbed or recompacted to the site-specific field conditions;
        - Total thickness, by survey, will be tested once per acre (on grid)

WSMR will adhere to these requirements during construction.

3.7.2 Thickness of cover material

Thickness of the current cover will be verified using auger equipment to bore until encountering waste. Proposed locations for boreholes are noted in Figure 8.

3.7.3 Geomembrane

According to 20.9.4.14 NMAC, quality control plans will address the following:

- The geomembrane component of all liners and final covers as defined in section A of 20.9.4.13 NMAC and subsection A of 20.9.6.9 NMAC, testing both shop and field will be as recommended by the manufacturer. Minimum frequency for destructive seam sample testing will be one per 500 feet of seam length. A portion of each test sample tested in the field and another in the laboratory. Seam samples will be tested for peel adhesion and bonded seam strength. Non-destructive testing will be performed for all seams, seam repairs, and liner repairs.

The sole use of geomembranes in the planned cover is to line drainage swales. Such elements of the NMED requirements as are applicable will be followed.

3.7.4 Topographical map showing final contours and grade

WSMR will produce a topographical map noting final contours, grade, remaining structures, and drainage controls. The holding ponds, berms, and lined swale will be constructed to promote positive drainage over the entire facility. NMED recommends minimum of 5 percent on top and side slopes less than 25 percent. The top portion of the cover will have no less than a two percent slope and side slopes will not exceed 25 percent.

4.0 FINAL USE

MPL is completely located on land owned by DoD. DoD does not propose any other use of the closed MPL. There is no anticipation of base closure or other land transfer actions in the foreseeable future. Documentation will be filed with the appropriate land use agencies noting the location, contents, and closure of MPL.

4.1 Vegetation Plan

Once the protective vegetation layer has been installed and graded to design specifications, the landfill cover will be seeded with native vegetation. The seed mix and application rate is given in Table 6. Application of the seeds will be timed with the summer monsoon season to increase the probability of successful germination and establishment. Seeds will be covered with straw and rolled. An alternative form of application, such as hydroseeding, may be utilized, depending on then-current weather and climate.

TABLE 6: PROPOSED SEED MIXTURE

Name	Pounds per acre (pure live seed)
Alkali sacaton	1.0 – 1.25
Green sprangletop	2.5
Scarlet globemallow	0.75
Sand dropseed	1.0
Plains bristlegrass (Setaria)	3.0

4.2 Final Usage Plan for Site

Once closure is complete, WSMR will continue to monitor the site through the post-closure care period. WSMR is a federal testing facility that will continue to see usage and occupation by the DoD for the foreseeable future. No plans are currently proposed for usage of the site for any other purpose. The site is registered with WSMR Master Planning as a closed waste disposal site. Any future usage will take into

account the existence of the landfill and potential hazards to public health, welfare, and the environment. WSMR asserts that the area is not a threat to human health due to its limited access; access is controlled coming onto the missile range, the landfill is away from the most populated area (the Main Post), and the landfill is surrounded by a fence with a locked gate.

4.3 Methane Monitoring Plan

Prior methane monitoring consisted of quarterly sampling at 27 discrete points around the perimeter of the current landfill fence at approximately 300-foot intervals and sampling near the two on-site structures. MPL does not have methane monitor wells and relied on a soil probe to obtain samples from below the ground surface. Sampling is carried out at approximate depth of 3 feet using a soil probe and a portable gas detection meter. Reports were included in the annual Solid Waste Questionnaire delivered to NMED. No methane was detected for any events in calendar years 2004 – 2007.

The decomposition of organic material typically found in MSW landfills produces methane gas which can collect in nearby structures and pose an explosion hazard. However, the lack of significant structures near the landfill, its age and its nature, limit the potential for methane formation and impact. Further, no methane has been detected for a number of years. Therefore, WSMR proposes to conduct no additional methane sampling at the MPL.

4.4 Post Closure Submittals

Upon closure, WSMR will provide NMED with a detailed description of the site, including a plat. This will also be filed with the WSMR planning office and WSMR Real Property Division. Submittals are further discussed in section 5.4 of this plan.

5.0 POST-CLOSURE CARE PLAN

The following sections describe the actions that WSMR will take to insure the continued safety and integrity of the landfill site. WSMR asserts that the area is not a threat to human health due to its limited access; access is controlled coming onto the missile range, the landfill is away from the most populated area (the Main Post), and the landfill is secured by a fence with a locked gate. Therefore, no additional security measures are contemplated.

5.1 Monitoring and Repair Plan

This closure plan notes methods and structures, which will be put in place and serve to protect human health and the environment from potential contaminants located within the solid waste cells of MPL.

- Semi-annual inspections will occur during the groundwater sampling events (see Section 5.3) to examine the site for integrity of the cover relating to settlement, ponding, water and wind erosion, drainage, and vegetation maintenance over the 30-year post-closure care period. These inspections will also verify the fence, drainage structures, and monitor wells are free from damage and operating as intended.
- The cover is designed in such a way to limit the potential for wind and water erosion. The construction assurance plan notes methods to limit settlement which leads to ponding. Despite these efforts, issues with erosion, settlement, or other problems may occur.
- As inspections reveal these problems, WSMR will take steps to repair and remedy any noted issues. Remedies may include filling and regrading areas of settlement or erosion; replacing cover cap material (milled asphalt or gravel); repair of fences, gates, or well covers; and repair of lined drainage structures.
- Any minor problems noted will be addressed and corrected within 60 days of inspection. If major deficiencies are found, WSMR will contact NMED in writing to discuss correction procedure and schedule.

5.2 Methane Monitoring Plan

As discussed in Section 4.3, WSMR plans no additional monitoring for methane.

5.3 Groundwater Monitoring System Plan

Based on the dates of operation, WSMR was required to submit and obtain approval of a groundwater monitoring system plan (20.9.9.8 NMAC). The initial groundwater monitoring plan for MPL was approved in correspondence from NMED dated 8 November 1995. Groundwater monitoring, conducted in conjunction with surveillance of SWMU 62, has taken place since 2000. This program has been more extensive than that designated by the Monitoring Plan. Beginning in 2005, groundwater monitoring has been carried out via approved low-flow methods. Specific monitor well details and historic detections are discussed in section 2.2 of this report.

In a continuing effort to consolidate and conserve effort, monitoring of the landfill site will continue in conjunction with surveillance of SWMU 82. The current monitoring program for SWMU 82 is provided as Appendix E. For purposes of this closure plan, the applicability of the monitoring plan is limited to monitor wells MPL01 through 04.

5.3.1 Frequency

Groundwater monitoring will continue on a semi-annual basis as currently carried out, unless analytical results demonstrate more frequent sampling is necessary. Sampling events generally occur in January and June of a given year. If continued sampling demonstrates limited variation in constituent concentrations, WSMR will propose reducing sampling frequency to an annual basis. Unless approved by NMED, WSMR will continue to perform groundwater monitoring activities and reporting throughout the 30 year post-closure care period. Inspections of the landfill will occur during groundwater monitoring events.

5.3.2 Sampling Method

Monitor wells were sampled via low-flow methods following guidance from ASTM *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (D 6771-02)* and NMED's *Use of Low-flow and Other Non-Traditional Sampling Techniques for RCRA Compliant Groundwater Monitoring* (30 October 2001). Samples will be collected when temperature and conductivity, as measured during pumping, have stabilized.

5.4 Security and Signage

5.4.1 Security Plan

WSMR asserts that the area is not a threat to human health due to its limited access; access is controlled coming onto the missile range, the landfill is away from the most populated area (the Main Post), and the landfill is secured by a fence with a locked gate. The Main Post Landfill is gated and continually staffed to control access to the site. Therefore, no additional security measures are contemplated. The asbestos landfill is fenced with two locked gates and access will be required thru the environmental office.

5.4.2 Signage and Physical Barriers

The portions of the landfill to be closed are inside a larger compound that also contains future C&D landfill operations. Signage will be emplaced to warn current and future operators of the presence of buried waste. Signs will be posted around the perimeter of the closed cells, in English and Spanish, as follows:

WARNING
ENTRY IS PROHIBITED
CLOSED LANDFILL
No Dumping or Digging Allowed

and

AVISO
ENTRAR ES PROHIBIDO
RELLENO SANITARIO CLAUSURADO.
Prohibido descargar basura o escombro.
Prohibido excavar.

In addition, boulders or concrete barriers will be spaced around the edges of the closed cells to delineate the boundaries.

5.5 Schedule for Completion of Closure Activities

The closure of the facility will be based on the following schedule as noted in NMAC regulations. The following schedule may be modified or amended by NMED. Changes will be noted in official correspondence, which will be made part of the operating record. References to the secretary indicate the secretary of NMED or official designee.

1. Once NMED deems the plan is complete, notice of the closure plan will be posted in local newspapers in Doña Ana and Otero counties. If sufficient public response is received, NMED may hold a non-adjudicatory hearing (20.9.6.8G NMAC).
2. WSMR will not begin closure activities until approval of the Closure and Post-Closure Care Plan (20.9.6.8.F NMAC). Closure activities will begin within 30 days of receiving plan approval or 30 days after the landfill receives the final receipt of waste, whichever is later (20.9.6.9 NMAC).
3. WSMR will notify the secretary in writing of intent to close at least 90 days before closure occurs. Notice in writing will also be given within 14 days of becoming a locked facility (20.9.6.8.D NMAC). These notices will be placed in the operating record.
4. White Sands Missile Range will complete closure activities in accordance with the approved closure plan within 180 days of beginning such activities (20.9.6.9. NMAC).
5. Following closure, WSMR will file a plat with WSMR Real Property noting the property was used as a landfill facility and further use is restricted as described in the Post-Closure Care Plan (20.9.6.9.A.6 NMAC).
6. WSMR will submit a closure report to NMED within 60 days of closure completion. This report will contain a summary of closure activities and be certified by a New Mexico registered professional engineer (20.9.6.8.L NMAC). This certification will state that closure of the solid waste facility has been completed and all conditions of the approved closure plan have been satisfied.
7. Once the post-closure care period expires, WSMR will submit a post-closure report which includes a summary of post-closure activities and is certified by a New Mexico registered professional engineer that post-closure requirements and any applicable corrective actions have been completed and all conditions of the Post-Closure Care Plan have been satisfied (20.9.6.8.N NMAC). Post-closure care is not terminated until the secretary provides written verification that the requirements of the approved post-closure care plan have been satisfied (20.9.6.8.O NMAC).

6.0 FINANCIAL ASSURANCE

WSMR is a Federal facility and is therefore exempt from financial assurance requirements as noted in 20.9.10.8.A NMAC.

REFERENCES

ASTM, 2002. *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (D 6771-02)*, February 2002.

Department of Army, 1976. *US Army White Sands Missile Range, Installation Environmental Impact Assessment, White Sands Missile Range, New Mexico*.

MEVATEC, 1997. *Groundwater Monitoring at the Main Post Landfill, White Sands Missile Range, Draft Final Report*, MEVATEC Corporation, as published in *Exhibit Y, Appendix III, Main Post Landfill Solid Waste Permit Application,* January 2001, WS-ES-EC-0102.

MEVATEC, 1999. *Site Characterization Report for the Former Sewage Treatment Plant (STP) Percolation Ditches, Final, White Sands Missile Range*, MEVATEC Corporation, WSNRES-ES-9912.

MEVATEC, 2000. *Summary Report of Geology and Hydrogeology at the Main Post Landfill*, MEVATEC Corporation, as published in *Exhibit Y, Appendix I, Main Post Landfill Solid Waste Permit Application,* January 2001, WS-ES-EC-0102.

NMED-HWB, 2001. *Use of Low-flow and Other Non-Traditional Sampling Techniques for RCRA Compliant Groundwater Monitoring* (30 October 2001).

Radian, 1995. *Main Post Landfill Background Groundwater Monitoring Plan, Draft Final Sampling and Analysis Plan*. Radian Corporation. Contract No. DACA 56-94-D-0015.

Risser, D.W., 1988. *Simulated water-level and water-quality changes in the bolson-fill aquifer, Post Headquarters area, White Sands Missile Range, New Mexico*: U.S. Geological Survey Water- Resources Investigations Report 87-4152.

Schroeder, P. R., Aziz, N. M. Lloyd, C. M. and Zappi, P. A. (1994). *The Hydrologic Evaluation of Landfill Performance (HELP) Model: User's Guide for Version 3,* EPA/600/R-94/168a, September 1994, U.S. Environmental Protection Agency Office of Research and Development, Washington, DC.

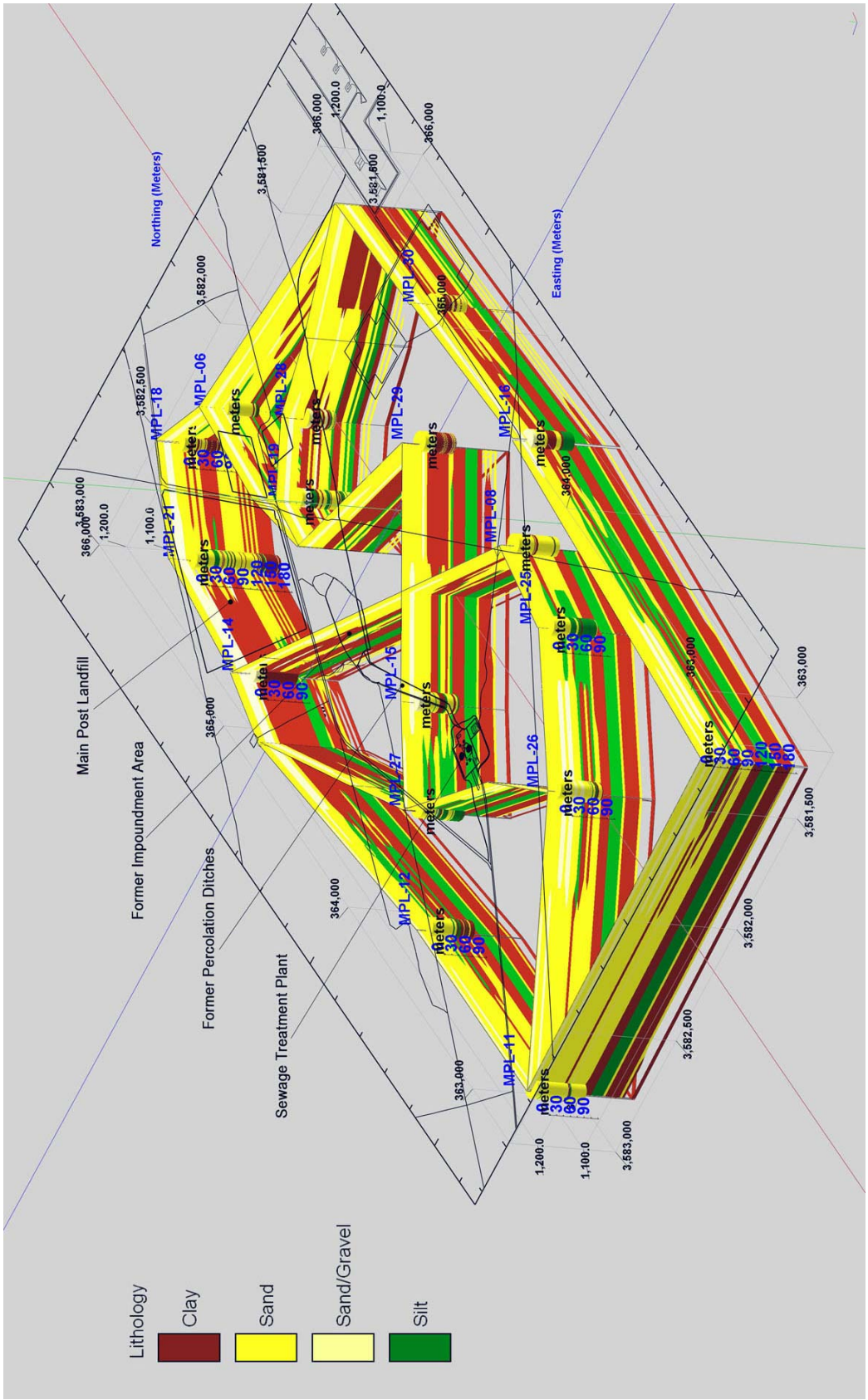
WSMR, 2006. *2005 Annual Report Questionnaire for NMED Solid Waste Bureau.* February 2006.

WSMR, 2007. *2006 Annual Report Questionnaire for NMED Solid Waste Bureau.* February 2007.

WSMR, 2008. *2007 Solid Waste Annual Report for NMED Solid Waste Bureau and supporting documents.* February 2008.

APPENDIX A

Fence Diagram



FENCE DIAGRAM FOR MAIN POST LANDFILL VICINIT

APPENDIX B

Analytical Results of 2007 Groundwater Sampling for the Main Post Landfill

I. 2007 General Information Form

Facility Information January 1-December 31, 2007

Permit/Registration #

County: Dona Ana Check One: ☑ Open Facility ☐ Closed Facility

Facility Name WSMR Main Post Landfill Phone 575-678-1007

Contact Person Javier Mendoza E-Mail Address javier.mendoza@us.army.mil

Facility Mailing Address 100 Headquarters Ave. ATTN: IMSW-WSM-PW

City: White Sands Missile Range (WSMR) State: NM Zip Code: 88002

Physical Location of Facility (City/County Road) WSMR, Dona Ana County, three miles east of Main Post on Farewell Blvd.

Facility Operator US Army WSMR Phone 575-678-8966

Contact Person Thomas A. Ladd E-mail Address ta.ladd@us.army.mil

Street Address 100 Headquarters Ave. ATTN: IMSW-WSM-PW

City WSMR State: NM Zip Code: 88002

Facility Owner Same Phone

Contact Person E-mail Address

Street Address

City State: Zip Code:

Land Owner US Army WSMR Phone 575-678-2220

Contact Person Gary D. Giebel E-mail Address gary.giebel@us.army.mil

Street Address 100 Headquarters Ave. ATTN: IMSW-WSM-ZA

City WSMR State: NM Zip Code: 88002

Financial Assurance

☑ Check One Box

☐ Updated Financial Assurance Attached

☐ Financial Assurance required but not Attached (Explain on Comment Sheet)

☑ Financial Assurance not required (Explain on Comment Sheet)

Questions?
Call 505-827-0197,
or 505-476-3561

Landfills Only

Check One: ☑ Open Landfill ☐ Closed Landfill

Capacity Information for Open Landfills ***(If not provided explain on Comment Sheet)***

Provide Landfill Capacity **Used** during 2006 5003.7 (Cubic Yards)

Provide **Remaining** Landfill Capacity 530673 (Cubic Yards) (See *V. Capacity Worksheet*.)

Provide **Remaining** Landfill Life 106.1 (Years) (See *V. Capacity Worksheet*.)

Number of acres at current site, not permitted, that could be used for diposal in the future

Were there any changes in operations that reduced the active life of the landfill by 25% or more?

☑ No ☐ Yes (Attach Notification)

Monitoring Results for Open Landfills (and Closed Landfill in Post-Closure Care)

☐ **No** ☑ **Yes** Summary of Landfill Gas Monitoring Results Enclosed (if not explain on Comment Sheet)

☐ **No** ☑ **Yes** Summary of Landfill Ground Water Monitoring Results Enclosed (if not explain on Comment Sheet)

☑ **No** ☐ **Yes** Summary of Leachate Generated & Treated or Disposed Enclosed (if not explain on Comment Sheet)

Closure and Post-Closure Activity Date of Closure

Total Acreage Used for Disposal (as of 12/31/06) (Acres)

Intermediate Cover (Acres) Area Seeded (Acres)

Total Acreage with Final Cover Installed (per Closure Plan) (Acres)

II. 2007 Material and Solid Waste Management Form

Facility Name: WSMR Main Post Landfill	**PRINT** Name, Title and Telephone # of the Person Completing Form: James Thompson, Task Coordinator, 575-678-1941
County: Dona Ana — Permit or Registration #	Facility Type: ☑ Landfill ☐ Recycling ☐ Composting ☐ Transfer/Convenience Center

	Material Type (See Instructions)	Method ☒ Mark One: Weighed	Method: Estimated	Waste Origin: Amount of In-State Material Received in **Tons** (a)	Waste Origin: Amount Out-of State Materials Received in **Tons** (b)	Managed On-Site: Landfilled or Treated (c)	Managed On-Site: Composted or Mulched (d)	Managed On-Site: Beneficially Used (e)	Sent Off-Site to be: Treated, Disposed, Incinerated (f)	Sent Off-Site to be: Recycled, Mulched, Composted (g)	Sent Off-Site to be: Beneficially Used (h)	Sent to: Provide Facility Name, City and State (i)
1	MSW	X							1247.01			Otero-Lincoln County Regional Landfill, Alamogordo, NM
2	C & D		X			1667.90						WSMR C&D Landfill, WSMR, NM
3	Clean Fill											
Special Wastes:												
4	Industrial Waste											
5	Regulated Asbestos		X			92.20						WSMR Asbestos Landfill, WSMR, NM
6	Infectious Waste											
7	Ash											
8	PCS											
9	Offal											
10	Bio-Solids (Treated Sewage Sludge)											
11	Other Sludges											
12	Other Special Waste											
Other Materials:												
13	Brush/Green Waste											
14	Scrap Tires	X								47.93		DRMO, Holloman AFB, Alamogordo, NM
15	Motor Oil		x							77.40		Thermofluids, Inc., El Paso, TX
16	Antifreeze		x							3.72		Thermofluids, Inc., El Paso, TX
17	Lead Acid Batteries	x								57.94		DRMO, Holloman AFB, Alamogordo, NM
18	HHW											
19	Other Wastes											
20	**TOTAL**					1760.10			1247.01	186.99		

Please refer to the enclosed tables *Volume to Weight Conversion Factors* to convert cubic yards and gallons to TONS.

Questions?
Call 505-827-0197
or 505-476-3561

III. 2007 Recyclable Materials Form

Facility Name: WSMR Main Post Landfill	**PRINT** Name, Title & Telephone # of Person Completing Form: James Thompson, Task Coordinator, 575-678-1941
County: Dona Ana; Permit or Registration #	Facility Type: ☑ Landfill ☐ Recycling ☐ Composting ☐ Transfer/Convenience Center

	Type of Recyclable	Method ☒ Mark One: Weighed	Method: Estimated	Material Origin: Amount of In-State Materials Received in **Tons** (a)	Material Origin: Amount of Out-of-State Materials Received in **Tons** (b)	Managed On-Site: (c) Beneficially Used or Re-used	Sent Off-Site to be: (d) Recycled or Processed	Sent Off-Site to be: (e) Beneficially Used	Facility sent to: (f) Provide Facility Name and City/State
Paper:									
1	Mixed Paper								
2	Cardboard (OCC)		X				24.00		Durango-McKinley Paper, Albuquerque, NM
3	Newspaper (ONP)								
4	Office Paper								
5	Phone Books								
6	Chip Board								
Containers:									
7	Plastics								
8	Aluminum								
9	Steel Cans								
10	Glass								
11	Mixed Containers								
Other Materials:									
12	Scrap Metals/ White Goods	X					835.16		MPI, B&B Recycling, El Paso, TX
13	Carpet Padding								
14	Pallets								
15	Electronic Scrap								
16	Plastic Films								
17	Other Plastics								
18	Household Items								
19	Textiles/Clothing								
20	Other								
21	**TOTAL**						859.16		

Please refer to the enclosed tables *Volume to Weight Conversion Factors* to convert cubic yards and gallons to TONS.

Questions?
Call 505-827-0197
or 505-476-3561

IV. 2007 Comment Sheet

Name of Facility:	WSMR Main Post Landfill
Name of Person completing form:	James Thompson, White Sands Technical Services, LLC

Financial Assurance not enclosed because:

Not necessary since WSMR is a Federal government facility and is exempt from this requirement.

Gas Monitoring Results not enclosed because:

One quarter of gas monitoring results are enclosed. The other three quarters were not available at the time of submittal due to communication difficulties within WSMR. These remaining three quarters will be provided to NMED-SWB as soon as this problem can be resolved. WSMR appreciates NMED-SWB's patience in this matter.

Ground Water Monitoring Results not enclosed because:

Leachate Generation Report not enclosed because:

No leachate collection system exists due to age of landfill.

C&D landfills do not require a leachate generation report.

Capacity Information not provided because:

Questons?
Call 505-827-0197or 505-476-3561

Revised 12/13/07

V. Capacity Worksheet

Landfill Capacity Calculation Worksheet for__ WSMR Main Post Landfill

All owners operators are required to provide information regarding landfill capacity. To calculate your landfill's remaining capacity you may use this Excel worksheet, a terrain computer model program such as "TerraModel ToolPak", or hire an engineering firm to complete the calculations. If you use the worksheet it will calculate the values K, L and M for you, all you need to do is input the information as requested for Items A through J. A completed SAMPLE is also provided for your reference and to understand the process. Once completed include this form as part of your Annual Report.

There are threesheets in this data base. Click on the labeled tabs below to acess sheets

Enter your data here

Landfill information

(A)	Total landfill area	26.0	Acres
(B)	Total permitted volume (gross capacity)	871,200	Cubic yards
(C)	Thickness of liner protective soil layer	0.0	Feet
(D)	Thickness of final cover	2.5	Feet
(E)	Estimated percentage of gross capacity taken by daily and intermediate covers (if unknown, use default value of 25%)	25.0	%

Waste Information

Note: The worksheet allows you to enter the amount of received waste based on combination of two different types of records: tonnage and gate-yards. Combined, these records should represent the total received waste. Mark appropriate boxes if values are actual or estimated .

				Actual	Estimated
(F)	Waste received through 2006 based on tonnage (if no tonnage receipts, enter 0)	4,285.4	Tons	☐	X
(G)	Waste received through 2006 based on gate-yards (if no gate-yard receipts, enter 0)		Cubic yards	☐	☐
(H)	Waste received in 2007 based on tonnage (if no tonnage receipts, enter 0)	1,667.9	Tons	☐	X
(I)	Waste received in 2007 based on gate-yards (if no gate-yard receipts, enter 0)		Cubic yards	☐	☐
(J)	Compaction rate of emplaced waste (for example, enter 3 for 3 to 1 compaction). If wastes are being compacted but compaction rate is unknown, enter default value of 2 for a conservative result. If no compaction, enter 1.	2.0			

Calculations

Note: If the calculations are not performed automatically by the worksheet, complete them manually using the provided formulas.

Do not add values for K, L, and M

(K)	**Net waste capacity** K=B - A*(C+D)*4840/3 - B*E/100	548,533	Cubic yards
(L)	**Remaining permitted waste capacity** L=K - (F+H)*6/J - (G+I)/J	530,673	Cubic yards
(M)	**Estimated remaining site life** M=L/(H*6/J + I/J)	106.1	Years

Notes:

K: 4,840 = square yards in acre

L: 6 = number of uncompacted cubic yards in 1 ton

Form Completed by:___James Thompson_____

Telephone number:_____575-678-1941_____

LETTER REPORT

The following letter report was prepared under Contract W9124Q-04-D-0012, TO No. 052.

1. TITLE

Analytical results of 2007 Groundwater Sampling for the Main Post Landfill

2. DATE

February 2008

3. INTRODUCTION

White Sands Missile Range (WSMR) has the requirement to monitor groundwater at the Main Post Landfill (MPL) on a semi-annual basis. This monitoring is performed in conjunction with the groundwater sampling for the former Sewage Treatment Plant (STP) Percolation Ditches. This letter report conveys the results of the groundwater monitoring for calendar year 2007.

4. BACKGROUND

The WSMR Main Post Landfill was registered with NMED in April 1982 and has been in operation since 1983. MPL covers an area of approximately 92.7 acres. Initially utilized as a municipal and construction and demolition (C&D) waste landfill, the MPL now only accepts C&D waste. The landfill received municipal waste until 1996. A section of the landfill is designated for asbestos containing wastes. The asbestos area is approximately 10 acres. All waste cells at MPL are unlined and a leachate collection system was not installed. Groundwater monitoring activities began in 1996 with installation of the monitoring wells and five quarters of sampling to establish background concentrations. Groundwater monitoring, as designated by the Monitoring Plan, has been taking place since 2000. Groundwater in the area of MPL exists at approximately 180 to 200 feet below ground surface. Methane monitoring takes place at MPL on a quarterly basis. Results of this monitoring are reported to NMED separately.

5. DISCUSSION

Monitor wells were sampled via low-flow methods following guidance from ASTM Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations (D 6771-02) and NMED's Use of Low-flow and Other Non-Traditional Sampling Techniques for RCRA Compliant Groundwater Monitoring (1 October 2001). The average production rate for the four wells sampled was 120 milliliters per minute. Samples were collected when temperature and conductivity stabilized. Sampling was conducted on 8, 9, and 12 February as well as 6, 7, and 11 June 2007. The analytical schedule is shown on Table 1.

6. ANALYSIS

The observations made at the time of sampling are shown in Table 2 and 3. Detected analytes are noted in Table 3 and 4. The associated laboratory reports are attached as an appendix. Prior reports compared observed values to concentrations presented in the New Mexico Solid Waste Regulations (20.9.1.1100 A. Table 1 NMAC). The NMED Solid Waste Bureau has updated 20.9.9 NMAC as of 2 August 2007, which included a repeal of 20.9.1. This updated code contains reference to constituents and parameters (20.9.9.20 NMAC) which are to be evaluated, but at the time of this report's preparation no new standards or practical quantitation limits (PQLs) were available. Thus, WSMR refers to the most recent standards, PQLs, and assessment monitoring levels (AMLs) agreed to by WSMR and NMED HWB. Concentrations above those standards are **bolded.** The data shown are consistent with previous events.

TABLE 1: MAIN POST LANDFILL ANALYTICAL SCHEDULE

Parameter		Reference Method	Method Type
Field Parameters			
pH		SM 4500-H^+ B	Field / Probe
Conductivity		SM 2510 B	
Turbidity		SM 2130 B	
Dissolved Oxygen		SM 4500-O G	
Temperature		SM 2550 B	
Oxidation/Reduction Potential		SM 2580 B	
Total Metals			
Aluminum Arsenic Barium Boron Cadmium Chromium Cobalt Copper Iron Lead	Magnesium Manganese Molybdenum Nickel Potassium Selenium Silver Sodium Uranium Zinc	SW846 6010A	Inductively Coupled Plasma Emission Spectroscopy

TABLE 2: PARAMETERS AT THE TIME OF SAMPLING – FEBRUARY 2007

Field Sample ID	Date Collected	Well Name	Depth to Water (ft bgs)	Well Elevation (ft MSL)	Water Table Elevation (ft MSL)	Temperature °C	Conductivity (µmho/cm)	Dissolved Oxygen (mg/L)	pH	ORP (mV)	Turbidity (NTU)
MNPL-MPL-MPL-001-0207	02/08/07	MPL01	202.53	4012.56	3810.03	25.42	0.396	4.94	7.68	170.8	9.79
MNPL-MPL-MPL-002-0207	02/09/07	MPL02	195.96	4004.55	3808.59	20.56	0.539	5.29	7.33	235.2	2.24
MNPL-MPL-MPL-003-0207	02/12/07	MPL03	189.90	3997.75	3807.85	21.29	0.677	4.95	7.34	237.7	5.72
MNPL-MPL-MPL-004-0207	02/12/07	MPL04	185.69	3993.50	3807.81	20.56	0.777	5.32	7.21	248.7	4.00

TABLE 3: PARAMETERS AT THE TIME OF SAMPLING – JUNE 2007

Field Sample ID	Date Collected	Well Name	Depth to Water (ft bgs)	Well Elevation (ft MSL)	Water Table Elevation (ft MSL)	Temperature °C	Conductivity (µmho/cm)	Dissolved Oxygen (mg/L)	pH	ORP (mV)	Turbidity (NTU)
MNPL-MPL-MPL-001-0607	06/06/07	MPL01	202.37	4012.56	3810.19	25.25	0.375	5.34	7.56	117.9	1.61
MNPL-MPL-MPL-002-0607	06/07/07	MPL02	187.81	4004.55	***3816.74***	23.20	0.512	5.05	7.13	206.1	3.07
MNPL-MPL-MPL-003-0607	06/07/07	MPL03	189.75	3997.75	3808.00	23.27	0.640	4.95	7.18	217.0	2.11
MNPL-MPL-MPL-004-0607	06/11/07	MPL04	185.51	3993.50	3807.99	23.74	0.738	5.16	6.99	221.6	3.39

The water table measurement from June 2007 at MPL-02 is outside of the normal range. This is apparently a measurement error. This error does not materially affect the sampling conducted in June. All other parameters are within the expected ranges. Care will be taken during the next sampling event to determine the accurate measurement of MPL-02.

TABLE 4: ANALYTES DETECTED (FEBRUARY 2007)

Field Sample ID	Well Name	Date Collected	Analyte Name	Detection Limit	Reporting Limit	Result	Standard*
MNPL-MPL-MPL-001-0207	MPL01	2/08/2007	Total Aluminum	0.00228	0.00500	0.693	5.0 List C PQL = 3.0
MNPL-MPL-MPL-002-0207	MPL02	2/09/2007		0.00228	0.00500	0.063	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.00228	0.00500	0.080	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.00228	0.00500	0.103	
MNPL-MPL-MPL-001-0207	MPL01	2/08/2007	Total Barium	0.0017	0.0100	0.1180	1.0 PQL = 0.02
MNPL-MPL-MPL-002-0207	MPL02	2/09/2007		0.0017	0.0100	0.0770	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.0017	0.0100	0.0550	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.0017	0.0100	0.0700	
MNPL-MPL-MPL-001-0207	MPL01	2/08/2007	Total Boron	0.0044	0.00500	0.0250	0.75 List C PQL = 0.5
MNPL-MPL-MPL-002-0207	MPL02	2/09/2007		0.0044	0.00500	0.0290	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.0044	0.00500	0.0305	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.0044	0.00500	0.0420	
MNPL-MPL-MPL-001-0207	MPL01	2/8/2007	Total Calcium	0.517	1.00	49.4	None given PQL = 1
MNPL-MPL-MPL-002-0207	MPL02	2/9/2007		0.517	1.00	70.5	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.517	1.00	89.4	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.517	1.00	109.0	
MNPL-MPL-MPL-001-0207	MPL01	2/8/2007	Total Chromium	0.0009	0.00500	0.0160	0.05 PQL = 0.01
MNPL-MPL-MPL-002-0207	MPL02	2/9/2007		0.0009	0.00500	0.0120	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.0009	0.00500	0.0085	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.0009	0.00500	0.0050	
MNPL-MPL-MPL-001-0207	MPL01	2/8/2007	Total Iron	0.0069	0.0100	***0.660***	1.0 List B PQL = 0.1
MNPL-MPL-MPL-002-0207	MPL02	2/9/2007		0.0069	0.0100	0.239	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.0069	0.0100	0.2535	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.0069	0.0100	0.281	
MNPL-MPL-MPL-001-0207	MPL01	2/8/2007	Total Magnesium	0.203	1.00	8.34	None given PQL = 1
MNPL-MPL-MPL-002-0207	MPL02	2/9/2007		0.203	1.00	12.1	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.203	1.00	15.55	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.203	1.00	19.2	
MNPL-MPL-MPL-001-0207	MPL01	2/8/2007	Total Potassium	0.866	1.00	3.14	None given PQL = 1
MNPL-MPL-MPL-002-0207	MPL02	2/9/2007		0.866	1.00	3.59	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.866	1.00	4.15	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.866	1.00	4.58	
MNPL-MPL-MPL-001-0207	MPL01	2/8/2007	Total Sodium	0.668	1.00	26.3	None given PQL = 1
MNPL-MPL-MPL-002-0207	MPL02	2/9/2007		0.668	1.00	32.1	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.668	1.00	36.05	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.668	1.00	36.5	
MNPL-MPL-MPL-001-0207	MPL01	2/8/2007	Total Vanadium	0.0015	0.00500	0.00600	None given PQL = 0.08
MNPL-MPL-MPL-002-0207	MPL02	2/9/2007		0.0015	0.00500	<0.00500	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.0015	0.00500	<0.00500	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.0015	0.00500	<0.00500	
MNPL-MPL-MPL-001-0207	MPL01	2/8/2007	Total Zinc	0.0071	0.00500	0.0110	10.0 List B PQL = 0.05
MNPL-MPL-MPL-002-0207	MPL02	2/9/2007		0.0071	0.00500	0.0200	
MNPL-MPL-MPL-003-0207*	MPL03	2/12/2007		0.0071	0.00500	0.0050	
MNPL-MPL-MPL-004-0207	MPL04	2/12/2007		0.0071	0.00500	0.0120	

Notes: Analytical values and standards given in milligrams per liter (mg/L).
* Analytical results from MPL03 are a mean of duplicate analyses.
** Standards are as noted in NMAC 20.6.2.3103. Unless otherwise noted, standards are from List A "Human Health Standards." List B includes "Other Standards for Domestic Water Supply" and List C includes "Standards for Irrigation Use." Practical quantitation limits (PQL) noted are from NMAC 20.9.1.1100 Table A.

The Standards noted in Tables 5 and 6 have been updated based on the most recent (August 2007) publication of NMAC 20.9. Previous reports had relied on the Standards in NMAC 20.9.1.1100 Table A. This table is no longer included in NMAC 20.9. The solid waste regulations (NMAC 20.9) now reference NMAC 20.6.2.3103 and other sources for groundwater protection standards. Since WSMR is a RCRA regulated facility and NMED-HWB relies on the standards noted in NMAC 20.6.2.3103, those standards are now relied on for comparison to analytical detections from 2007 sampling events at MPL.

TABLE 5: ANALYTES DETECTED (JUNE 2007)

Field Sample ID	Well Name	Date Collected	Analyte Name	Detection Limit	Reporting Limit	Result	Standard*
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Aluminum	0.00228	0.00500	0.120	5.0 List C PQL = 3.0
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.00228	0.00500	0.0710	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.00228	0.00500	0.0965	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.00228	0.00500	0.137	
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Barium	0.0017	0.0100	0.1180	1.0 PQL = 0.02
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.0017	0.0100	0.0780	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.0017	0.0100	0.0570	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.0017	0.0100	0.0760	
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Boron	0.0044	0.00500	0.0310	0.75 List C PQL = 0.5
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.0044	0.00500	0.0240	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.0044	0.00500	0.0425	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.0044	0.00500	0.0440	
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Calcium	0.517	1.00	50	None given PQL = 1
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.517	1.00	69.6	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.517	1.00	87.05	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.517	1.00	98.2	
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Chromium	0.0009	0.00500	0.0170	0.05 PQL = 0.01
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.0009	0.00500	0.0150	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.0009	0.00500	0.0135	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.0009	0.00500	0.0140	
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Iron	0.0069	0.0100	0.204	1.0 List B PQL = 0.1
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.0069	0.0100	0.248	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.0069	0.0100	0.266	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.0069	0.0100	0.321	
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Magnesium	0.203	1.00	8.24	None given PQL = 1
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.203	1.00	12.0	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.203	1.00	15.05	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.203	1.00	18.2	
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Potassium	0.866	1.00	3.03	None given PQL = 1
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.866	1.00	3.37	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.866	1.00	3.855	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.866	1.00	4.00	
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Sodium	0.668	1.00	26.5	None given PQL = 1
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.668	1.00	31.6	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.668	1.00	35.25	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.668	1.00	34.9	
MNPL-MPL-MPL-001-0207	MPL01	6/6/2007	Total Vanadium	0.0015	0.00500	0.00600	None given PQL = 0.08
MNPL-MPL-MPL-002-0207	MPL02	6/7/2007		0.0015	0.00500	<0.00500	
MNPL-MPL-MPL-003-0207*	MPL03	6/7/2007		0.0015	0.00500	<0.00500	
MNPL-MPL-MPL-004-0207	MPL04	6/11/2007		0.0015	0.00500	<0.00500	

Notes: Analytical values and standards given in milligrams per liter (mg/L).
* Analytical results from MPL03 are a mean of duplicate analyses.
** Standards are as noted in NMAC 20.6.2.3103. Unless otherwise noted, standards are from List A "Human Health Standards." List B includes "Other Standards for Domestic Water Supply" and List C includes "Standards for Irrigation Use." Practical quantitation limits (PQL) noted are from NMAC 20.9.1.1100 Table A.

7. CONCLUSIONS

None of the detected analytes exceeded their respective groundwater protection standards. Detections were in the range of prior sampling events. The total iron sample (0.660 milligrams per liter) from MPL-01 did exceed 50 percent of the groundwater protection standard (1.0 milligrams per liter) in the February 2007 sampling. High iron detections are typical. This constituent has previously been shown to be naturally occurring.

8. RECOMMENDATIONS

Semi-annual groundwater monitoring is recommended to continue as planned. Additional care will be taken during water level measurements to maintain accuracy. This report will be incorporated in the NMED 2007 Annual Solid Waste Questionnaire scheduled for submittal in early 2008.

9. WTS TASK MANAGER AND TASK COORDINATOR / PHONE NO.:

Task Manager: Fred Bourger, Phone (575) 678-3426
Task Coordinator: James J. Thompson, P.E., Phone (575) 678-1941

APPENDIX
Analytical Data

Analytical and Quality Control Report

William Little
WTS
P.O. Box 363
Building 126 3RD Floor
WSMR, NM, 88002

Report Date: June 29, 2007

Work Order: 7061301

Project Name: Main Post Landfill Well MPL-01-TO MPL-04
Project Number: 15

Enclosed are the Analytical Report and Quality Control Report for the following sample(s) submitted to TraceAnalysis, Inc.

Sample	Description	Matrix	Date Taken	Time Taken	Date Received
127179	MNPL-MPL-MPL-103-0207	water	2007-02-12	10:07	2007-06-11
127184	MNPL-MPL-MPL-003-0207	water	2007-02-12	10:07	2007-06-11
127185	MNPL-MPL-MPL-002-0207	water	2007-02-09	10:45	2007-06-11
127186	MNPL-MPL-MPL-001-0207	water	2007-02-08	14:55	2007-06-11
127187	MNPL-MPL-MPL-001-0607	water	2007-06-06	13:50	2007-06-04
127188	MNPL-MPL-MPL-002-0607	water	2007-06-07	10:15	2007-06-04
127189	MNPL-MPL-MPL-003-0607	water	2007-06-07	13:31	2007-06-04
127190	MNPL-MPL-MPL-103-0607	water	2007-06-07	13:31	2007-06-04
127191	MNPL-MPL-MPL-004-0607	water	2007-06-11	10:21	2007-06-04
127196	MNPL-MPL-MPL-004-0207	water	2007-02-12	14:15	2007-06-11

These results represent only the samples received in the laboratory. The Quality Control Report is generated on a batch basis. All information contained in this report is for the analytical batch(es) in which your sample(s) were analyzed.

This report consists of a total of 26 pages and shall not be reproduced except in its entirety, without written approval of TraceAnalysis, Inc.

Dr. Blair Leftwich, Director

Standard Flags

B - The sample contains less than ten times the concentration found in the method blank.

Case Narrative

Samples for project Main Post Landfill Well MPL-01-TO MPL-04, Main Post Landfill Well MPL-01-TO MPL-04, Main Post Landfill Well MPL-01-TO MPL-04, Main Post Landfill Well MPL-01-TO MPL-04, MPL Total Metals and Main Post Landfill Well MPL-01-TO MPL-04 were received by TraceAnalysis, Inc. on 2007-06-11, 2007-06-11, 2007-06-11, 2007-06-11, 2007-06-04 and 2007-06-11 and assigned to work orders 7061301, 7061303, 7061304, 7061305, 7061306 and 7061309 respecively. Samples for work order 7061301 were received intact at a temperature of 4.0 deg.C.Samples for work order 7061303 were received intact at a temperature of 4.0 deg.C.Samples for work order 7061304 were received intact at a temperature of 4.0 deg.C.Samples for work order 7061305 were received intact at a temperature of 4.0 deg.C.Samples for work order 7061306 were received intact at a temperature of 4.0 deg.C.Samples for work order 7061309 were received intact at a temperature of 4.0 deg.C.

Samples were analyzed for the following tests using their respective methods.

Results for these samples are reported on a wet weight basis unless data package indicates otherwise.

A matrix spike (MS) and matrix spike duplicate (MSD) sample is chosen at random from each preparation batch. The MS and MSD will indicate if a site specific matrix problem is occurring, however, it may not pertain to the samples for work orders 7061301, 7061303, 7061304, 7061305, 7061306 and 7061309 since the sample was chosen at random. Therefore, the validity of the analytical data reported has been determined by the laboratory control sample (LCS) and the method blank (MB). These quality control measures are performed with each preparation batch to ensure data integrity.

All other exceptions associated with this report have been footnoted on the appropriate analytical page to assist in general data comprehension. Please contact the laboratory directly if there are any questions regarding this project.

Analytical Report

Sample: 127179 - MNPL-MPL-MPL-103-0207

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**90.6**	mg/L	1	1.00
Total Magnesium		**16.1**	mg/L	1	1.00
Total Potassium		**4.09**	mg/L	1	1.00
Total Sodium		**37.1**	mg/L	1	1.00

Sample: 127179 - MNPL-MPL-MPL-103-0207

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200
Total Aluminum		**0.0720**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0450**	mg/L	1	0.00500
Total Barium		**0.0550**	mg/L	1	0.0100
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		**0.0120**	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.246**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Uranium		<0.0200	mg/L	1	0.0200
Total Vanadium		<0.00500	mg/L	1	0.00500
Total Zinc		<0.00500	mg/L	1	0.00500

Sample: 127184 - MNPL-MPL-MPL-003-0207

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38634	Date Analyzed:	2007-06-28	Analyzed By:	TP
Prep Batch:	33401	Sample Preparation:	2007-06-28	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**88.2**	mg/L	1	1.00
Total Magnesium		**15.0**	mg/L	1	1.00
Total Potassium		**4.20**	mg/L	1	1.00
Total Sodium		**35.0**	mg/L	1	1.00

Sample: 127184 - MNPL-MPL-MPL-003-0207

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38621	Date Analyzed:	2007-06-28	Analyzed By:	RR
Prep Batch:	33401	Sample Preparation:	2007-06-28	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200
Total Aluminum		**0.0880**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0160**	mg/L	1	0.00500
Total Barium		**0.0550**	mg/L	1	0.0100
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		<0.00500	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.261**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Vanadium		<0.00500	mg/L	1	0.00500
Total Zinc		<0.00500	mg/L	1	0.00500

Sample: 127184 - MNPL-MPL-MPL-003-0207

Analysis:	U, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38621	Date Analyzed:	2007-06-28	Analyzed By:	RR
Prep Batch:	33401	Sample Preparation:	2007-06-28	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Uranium		<0.0200	mg/L	1	0.0200

Sample: 127185 - MNPL-MPL-MPL-002-0207

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**70.5**	mg/L	1	1.00
Total Magnesium		**12.1**	mg/L	1	1.00
Total Potassium		**3.59**	mg/L	1	1.00
Total Sodium		**32.1**	mg/L	1	1.00

Sample: 127185 - MNPL-MPL-MPL-002-0207

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200
Total Aluminum		**0.0630**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0290**	mg/L	1	0.00500
Total Barium		**0.0770**	mg/L	1	0.0100
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		**0.0120**	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.239**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Vanadium		<0.00500	mg/L	1	0.00500
Total Zinc		**0.0200**	mg/L	1	0.00500

Sample: 127185 - MNPL-MPL-MPL-002-0207

Analysis:	U, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Uranium		<0.0200	mg/L	1	0.0200

Sample: 127186 - MNPL-MPL-MPL-001-0207

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**49.4**	mg/L	1	1.00
Total Magnesium		**8.34**	mg/L	1	1.00
Total Potassium		**3.14**	mg/L	1	1.00
Total Sodium		**26.3**	mg/L	1	1.00

Sample: 127186 - MNPL-MPL-MPL-001-0207

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200
Total Aluminum		**0.693**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0250**	mg/L	1	0.00500
Total Barium		**0.118**	mg/L	1	0.0100
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		**0.0160**	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.660**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Uranium		<0.0200	mg/L	1	0.0200
Total Vanadium		**0.00600**	mg/L	1	0.00500
Total Zinc		**0.0110**	mg/L	1	0.00500

Sample: 127187 - MNPL-MPL-MPL-001-0607

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

continued . . .

sample 127187 continued . . .

Parameter	Flag	RL Result	Units	Dilution	RL

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**50.0**	mg/L	1	1.00
Total Magnesium		**8.24**	mg/L	1	1.00
Total Potassium		**3.03**	mg/L	1	1.00
Total Sodium		**26.5**	mg/L	1	1.00

Sample: 127187 - MNPL-MPL-MPL-001-0607

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200
Total Aluminum		**0.120**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0310**	mg/L	1	0.00500
Total Barium		**0.118**	mg/L	1	0.0100
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		**0.0170**	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.204**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Uranium		<0.0200	mg/L	1	0.0200
Total Vanadium		**0.00600**	mg/L	1	0.00500
Total Zinc		<0.00500	mg/L	1	0.00500

Sample: 127188 - MNPL-MPL-MPL-002-0607

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**69.6**	mg/L	1	1.00

continued . . .

sample 127188 continued . . .

Parameter	Flag	RL Result	Units	Dilution	RL
Total Magnesium		**12.0**	mg/L	1	1.00
Total Potassium		**3.37**	mg/L	1	1.00
Total Sodium		**31.6**	mg/L	1	1.00

Sample: 127188 - MNPL-MPL-MPL-002-0607

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200
Total Aluminum		**0.0710**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0240**	mg/L	1	0.00500
Total Barium		**0.0780**	mg/L	1	0.0100
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		**0.0150**	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.248**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Uranium		<0.0200	mg/L	1	0.0200
Total Vanadium		<0.00500	mg/L	1	0.00500
Total Zinc		<0.00500	mg/L	1	0.00500

Sample: 127189 - MNPL-MPL-MPL-003-0607

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**87.2**	mg/L	1	1.00
Total Magnesium		**14.9**	mg/L	1	1.00
Total Potassium		**3.88**	mg/L	1	1.00
Total Sodium		**35.5**	mg/L	1	1.00

Sample: 127189 - MNPL-MPL-MPL-003-0607

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200
Total Aluminum		**0.0300**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0420**	mg/L	1	0.00500
Total Barium		**0.0560**	mg/L	1	0.0100
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		**0.0140**	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.206**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Uranium		<0.0200	mg/L	1	0.0200
Total Vanadium		<0.00500	mg/L	1	0.00500
Total Zinc		<0.00500	mg/L	1	0.00500

Sample: 127190 - MNPL-MPL-MPL-103-0607

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**86.9**	mg/L	1	1.00
Total Magnesium		**15.2**	mg/L	1	1.00
Total Potassium		**3.83**	mg/L	1	1.00
Total Sodium		**35.0**	mg/L	1	1.00

Sample: 127190 - MNPL-MPL-MPL-103-0607

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

continued . . .

sample 127190 continued . . .

Parameter	Flag	RL Result	Units	Dilution	RL

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200
Total Aluminum		**0.163**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0430**	mg/L	1	0.00500
Total Barium		**0.0580**	mg/L	1	0.0100
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		**0.0130**	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.326**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Uranium		<0.0200	mg/L	1	0.0200
Total Vanadium		<0.00500	mg/L	1	0.00500
Total Zinc		<0.00500	mg/L	1	0.00500

Sample: 127191 - MNPL-MPL-MPL-004-0607

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**98.2**	mg/L	2	1.00
Total Magnesium		**18.2**	mg/L	1	1.00
Total Potassium		**4.00**	mg/L	1	1.00
Total Sodium		**34.9**	mg/L	1	1.00

Sample: 127191 - MNPL-MPL-MPL-004-0607

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200

continued . . .

sample 127191 continued . . .

Parameter	Flag	RL Result	Units	Dilution	RL
Total Aluminum		**0.137**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0440**	mg/L	1	0.00500
Total Barium		**0.0760**	mg/L	1	0.0100
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		**0.0140**	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.321**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Uranium		<0.0200	mg/L	1	0.0200
Total Vanadium		<0.00500	mg/L	1	0.00500
Total Zinc		<0.00500	mg/L	1	0.00500

Sample: 127196 - MNPL-MPL-MPL-004-0207

Analysis:	Salts, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Calcium		**109**	mg/L	10	1.00
Total Magnesium		**19.2**	mg/L	1	1.00
Total Potassium		**4.58**	mg/L	1	1.00
Total Sodium		**36.5**	mg/L	1	1.00

Sample: 127196 - MNPL-MPL-MPL-004-0207

Analysis:	Total Metals	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Silver		<0.00200	mg/L	1	0.00200
Total Aluminum		**0.103**	mg/L	1	0.00500
Total Arsenic		<0.0100	mg/L	1	0.0100
Total Boron		**0.0420**	mg/L	1	0.00500
Total Barium		**0.0700**	mg/L	1	0.0100

continued . . .

sample 127196 continued . . .

Parameter	Flag	RL Result	Units	Dilution	RL
Total Beryllium		<0.00250	mg/L	1	0.00250
Total Cadmium		<0.00100	mg/L	1	0.00100
Total Cobalt		<0.00500	mg/L	1	0.00500
Total Chromium		<0.00500	mg/L	1	0.00500
Total Copper		<0.00500	mg/L	1	0.00500
Total Iron		**0.281**	mg/L	1	0.0100
Total Manganese		<0.0250	mg/L	1	0.0250
Total Molybdenum		<0.0500	mg/L	1	0.0500
Total Nickel		<0.00500	mg/L	1	0.00500
Total Lead		<0.00500	mg/L	1	0.00500
Total Antimony		<0.0500	mg/L	1	0.0500
Total Selenium		<0.0100	mg/L	1	0.0100
Total Thallium		<0.0500	mg/L	1	0.0500
Total Vanadium		<0.00500	mg/L	1	0.00500
Total Zinc		**0.0120**	mg/L	1	0.00500

Sample: 127196 - MNPL-MPL-MPL-004-0207

Analysis:	U, Total	Analytical Method:	S 6010B	Prep Method:	S 3010A
QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	Sample Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	RL Result	Units	Dilution	RL
Total Uranium		<0.0200	mg/L	1	0.0200

Method Blank (1) QC Batch: 38315

QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	QC Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	MDL Result	Units	RL
Total Uranium		<0.0545	mg/L	0.02

Method Blank (1) QC Batch: 38315

QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	QC Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	MDL Result	Units	RL
Total Silver		<0.00210	mg/L	0.002

continued . . .

method blank continued . . .

Parameter	Flag	MDL Result	Units	RL
Total Aluminum		<0.00228	mg/L	0.005
Total Arsenic		<0.00430	mg/L	0.01
Total Boron		<0.00440	mg/L	0.005
Total Barium		<0.00170	mg/L	0.01
Total Beryllium		<0.00220	mg/L	0.0025
Total Cadmium		<0.00140	mg/L	0.001
Total Cobalt		<0.00220	mg/L	0.005
Total Chromium		<0.000900	mg/L	0.005
Total Copper		<0.00140	mg/L	0.005
Total Iron		<0.00690	mg/L	0.01
Total Manganese		<0.000600	mg/L	0.025
Total Molybdenum		<0.00790	mg/L	0.05
Total Nickel		<0.00190	mg/L	0.005
Total Lead		<0.00740	mg/L	0.005
Total Antimony		<0.0166	mg/L	0.05
Total Selenium		<0.0131	mg/L	0.01
Total Thallium		<0.0189	mg/L	0.05
Total Uranium		<0.0545	mg/L	0.02
Total Vanadium		<0.00150	mg/L	0.005
Total Zinc		<0.00710	mg/L	0.005

Method Blank (1) QC Batch: 38431

QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	QC Preparation:	2007-06-19	Prepared By:	TS

Parameter	Flag	MDL Result	Units	RL
Total Calcium		<0.517	mg/L	1
Total Magnesium		<0.203	mg/L	1
Total Potassium		<0.866	mg/L	1
Total Sodium		<0.668	mg/L	1

Method Blank (1) QC Batch: 38621

QC Batch:	38621	Date Analyzed:	2007-06-28	Analyzed By:	RR
Prep Batch:	33401	QC Preparation:	2007-06-28	Prepared By:	TS

Parameter	Flag	MDL Result	Units	RL
Total Uranium		<0.0545	mg/L	0.02

Method Blank (1) QC Batch: 38621

QC Batch:	38621	Date Analyzed:	2007-06-28	Analyzed By:	RR
Prep Batch:	33401	QC Preparation:	2007-06-28	Prepared By:	TS

Parameter	Flag	MDL Result	Units	RL
Total Silver		<0.00210	mg/L	0.002
Total Aluminum		<0.00228	mg/L	0.005
Total Arsenic		<0.00430	mg/L	0.01
Total Boron		<0.00440	mg/L	0.005
Total Barium		<0.00170	mg/L	0.01
Total Beryllium		<0.00220	mg/L	0.0025
Total Cadmium		<0.00140	mg/L	0.001
Total Cobalt		<0.00220	mg/L	0.005
Total Chromium		<0.000900	mg/L	0.005
Total Copper		<0.00140	mg/L	0.005
Total Iron		<0.00690	mg/L	0.01
Total Manganese		<0.000600	mg/L	0.025
Total Molybdenum		<0.00790	mg/L	0.05
Total Nickel		<0.00190	mg/L	0.005
Total Lead		<0.00740	mg/L	0.005
Total Antimony		<0.0166	mg/L	0.05
Total Selenium		<0.0131	mg/L	0.01
Total Thallium		<0.0189	mg/L	0.05
Total Vanadium		<0.00150	mg/L	0.005
Total Zinc		<0.00710	mg/L	0.005

Method Blank (1) QC Batch: 38634

QC Batch:	38634	Date Analyzed:	2007-06-28	Analyzed By:	TP
Prep Batch:	33401	QC Preparation:	2007-06-28	Prepared By:	TS

Parameter	Flag	MDL Result	Units	RL
Total Calcium		<0.517	mg/L	1
Total Magnesium		<0.203	mg/L	1
Total Potassium		1.28	mg/L	1
Total Sodium		<0.668	mg/L	1

Laboratory Control Spike (LCS-1)

QC Batch:	38315	Date Analyzed:	2007-06-19	Analyzed By:	RR
Prep Batch:	33164	QC Preparation:	2007-06-19	Prepared By:	TS

Param	LCS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Uranium	0.487	mg/L	1	0.500	<0.0545	97	85 - 115

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Uranium	0.486	mg/L	1	0.500	<0.0545	97	85 - 115	0	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Laboratory Control Spike (LCS-1)

QC Batch: 38315 Date Analyzed: 2007-06-19 Analyzed By: RR
Prep Batch: 33164 QC Preparation: 2007-06-19 Prepared By: TS

Param	LCS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Silver	0.127	mg/L	1	0.125	<0.00210	102	87.2 - 108
Total Aluminum	0.965	mg/L	1	1.00	<0.00228	96	76.4 - 107
Total Arsenic	0.509	mg/L	1	0.500	<0.00430	102	81.9 - 110
Total Boron	0.0545	mg/L	1	0.0500	<0.00440	109	75.7 - 124
Total Barium	1.02	mg/L	1	1.00	<0.00170	102	88.7 - 111
Total Beryllium	0.0232	mg/L	1	0.0250	<0.00220	93	78.1 - 117
Total Cadmium	0.256	mg/L	1	0.250	<0.00140	102	83.4 - 111
Total Cobalt	0.243	mg/L	1	0.250	<0.00220	97	91 - 108
Total Chromium	0.104	mg/L	1	0.100	<0.000900	104	86.5 - 115
Total Copper	0.131	mg/L	1	0.125	<0.00140	105	91.2 - 109
Total Iron	0.522	mg/L	1	0.500	<0.00690	104	89.4 - 113
Total Manganese	0.250	mg/L	1	0.250	<0.000600	100	85 - 113
Total Molybdenum	0.546	mg/L	1	0.500	<0.00790	109	80 - 114
Total Nickel	0.254	mg/L	1	0.250	<0.00190	102	86.1 - 111
Total Lead	0.518	mg/L	1	0.500	<0.00740	104	88 - 108
Total Antimony	0.227	mg/L	1	0.250	<0.0166	91	79.4 - 114
Total Selenium	0.425	mg/L	1	0.500	<0.0131	85	70.2 - 111
Total Thallium	0.468	mg/L	1	0.500	<0.0189	94	81.8 - 115
Total Uranium	0.487	mg/L	1	0.500	<0.0545	97	85 - 115
Total Vanadium	0.265	mg/L	1	0.250	<0.00150	106	85.9 - 110
Total Zinc	0.244	mg/L	1	0.250	<0.00710	98	82.9 - 109

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Silver	0.126	mg/L	1	0.125	<0.00210	101	87.2 - 108	1	20
Total Aluminum	0.977	mg/L	1	1.00	<0.00228	98	76.4 - 107	1	20
Total Arsenic	0.493	mg/L	1	0.500	<0.00430	99	81.9 - 110	3	20
Total Boron	0.0524	mg/L	1	0.0500	<0.00440	105	75.7 - 124	4	20
Total Barium	1.02	mg/L	1	1.00	<0.00170	102	88.7 - 111	0	20
Total Beryllium	0.0237	mg/L	1	0.0250	<0.00220	95	78.1 - 117	2	20
Total Cadmium	0.257	mg/L	1	0.250	<0.00140	103	83.4 - 111	0	20
Total Cobalt	0.242	mg/L	1	0.250	<0.00220	97	91 - 108	0	20
Total Chromium	0.105	mg/L	1	0.100	<0.000900	105	86.5 - 115	1	20
Total Copper	0.131	mg/L	1	0.125	<0.00140	105	91.2 - 109	0	20
Total Iron	0.528	mg/L	1	0.500	<0.00690	106	89.4 - 113	1	20
Total Manganese	0.253	mg/L	1	0.250	<0.000600	101	85 - 113	1	20
Total Molybdenum	0.544	mg/L	1	0.500	<0.00790	109	80 - 114	0	20
Total Nickel	0.254	mg/L	1	0.250	<0.00190	102	86.1 - 111	0	20

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control spikes continued . . .

Param	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Lead	0.523	mg/L	1	0.500	<0.00740	105	88 - 108	1	20
Total Antimony	0.237	mg/L	1	0.250	<0.0166	95	79.4 - 114	4	20
Total Selenium	0.424	mg/L	1	0.500	<0.0131	85	70.2 - 111	0	20
Total Thallium	0.468	mg/L	1	0.500	<0.0189	94	81.8 - 115	0	20
Total Uranium	0.486	mg/L	1	0.500	<0.0545	97	85 - 115	0	20
Total Vanadium	0.267	mg/L	1	0.250	<0.00150	107	85.9 - 110	1	20
Total Zinc	0.248	mg/L	1	0.250	<0.00710	99	82.9 - 109	2	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Laboratory Control Spike (LCS-1)

QC Batch: 38431 Date Analyzed: 2007-06-22 Analyzed By: TP
Prep Batch: 33164 QC Preparation: 2007-06-19 Prepared By: TS

Param	LCS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Calcium	51.2	mg/L	1	50.0	<0.517	102	85 - 115
Total Magnesium	50.1	mg/L	1	50.0	<0.203	100	85 - 115
Total Potassium	50.6	mg/L	1	50.0	<0.866	101	85 - 115
Total Sodium	51.6	mg/L	1	50.0	<0.668	103	87.3 - 124

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Calcium	51.4	mg/L	1	50.0	<0.517	103	85 - 115	0	20
Total Magnesium	50.3	mg/L	1	50.0	<0.203	101	85 - 115	0	20
Total Potassium	50.8	mg/L	1	50.0	<0.866	102	85 - 115	0	20
Total Sodium	51.3	mg/L	1	50.0	<0.668	103	87.3 - 124	1	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Laboratory Control Spike (LCS-1)

QC Batch: 38621 Date Analyzed: 2007-06-28 Analyzed By: RR
Prep Batch: 33401 QC Preparation: 2007-06-28 Prepared By: TS

Param	LCS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Uranium	0.553	mg/L	1	0.500	<0.0545	111	85 - 115

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Uranium	0.558	mg/L	1	0.500	<0.0545	112	85 - 115	1	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Laboratory Control Spike (LCS-1)

QC Batch: 38621 Date Analyzed: 2007-06-28 Analyzed By: RR
Prep Batch: 33401 QC Preparation: 2007-06-28 Prepared By: TS

Param	LCS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Silver	0.126	mg/L	1	0.125	<0.00210	101	87.2 - 108
Total Aluminum	0.966	mg/L	1	1.00	<0.00228	97	76.4 - 107
Total Arsenic	0.509	mg/L	1	0.500	<0.00430	102	81.9 - 110
Total Boron	0.0470	mg/L	1	0.0500	<0.00440	94	75.7 - 124
Total Barium	1.02	mg/L	1	1.00	<0.00170	102	88.7 - 111
Total Beryllium	0.0260	mg/L	1	0.0250	<0.00220	104	78.1 - 117
Total Cadmium	0.248	mg/L	1	0.250	<0.00140	99	83.4 - 111
Total Cobalt	0.252	mg/L	1	0.250	<0.00220	101	91 - 108
Total Chromium	0.107	mg/L	1	0.100	<0.000900	107	86.5 - 115
Total Copper	0.131	mg/L	1	0.125	<0.00140	105	91.2 - 109
Total Iron	0.513	mg/L	1	0.500	<0.00690	103	89.4 - 113
Total Manganese	0.258	mg/L	1	0.250	<0.000600	103	85 - 113
Total Molybdenum	0.507	mg/L	1	0.500	<0.00790	101	80 - 114
Total Nickel	0.261	mg/L	1	0.250	<0.00190	104	86.1 - 111
Total Lead	0.503	mg/L	1	0.500	<0.00740	101	88 - 108
Total Antimony	0.225	mg/L	1	0.250	<0.0166	90	79.4 - 114
Total Selenium	0.484	mg/L	1	0.500	<0.0131	97	70.2 - 111
Total Thallium	0.467	mg/L	1	0.500	<0.0189	93	81.8 - 115
Total Vanadium	0.260	mg/L	1	0.250	<0.00150	104	85.9 - 110
Total Zinc	0.253	mg/L	1	0.250	<0.00710	101	82.9 - 109

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Silver	0.126	mg/L	1	0.125	<0.00210	101	87.2 - 108	0	20
Total Aluminum	0.953	mg/L	1	1.00	<0.00228	95	76.4 - 107	1	20
Total Arsenic	0.475	mg/L	1	0.500	<0.00430	95	81.9 - 110	7	20
Total Boron	0.0480	mg/L	1	0.0500	<0.00440	96	75.7 - 124	2	20
Total Barium	1.03	mg/L	1	1.00	<0.00170	103	88.7 - 111	1	20
Total Beryllium	0.0260	mg/L	1	0.0250	<0.00220	104	78.1 - 117	0	20
Total Cadmium	0.246	mg/L	1	0.250	<0.00140	98	83.4 - 111	1	20
Total Cobalt	0.251	mg/L	1	0.250	<0.00220	100	91 - 108	0	20
Total Chromium	0.106	mg/L	1	0.100	<0.000900	106	86.5 - 115	1	20
Total Copper	0.132	mg/L	1	0.125	<0.00140	106	91.2 - 109	1	20
Total Iron	0.512	mg/L	1	0.500	<0.00690	102	89.4 - 113	0	20
Total Manganese	0.256	mg/L	1	0.250	<0.000600	102	85 - 113	1	20
Total Molybdenum	0.512	mg/L	1	0.500	<0.00790	102	80 - 114	1	20
Total Nickel	0.258	mg/L	1	0.250	<0.00190	103	86.1 - 111	1	20
Total Lead	0.511	mg/L	1	0.500	<0.00740	102	88 - 108	2	20
Total Antimony	0.226	mg/L	1	0.250	<0.0166	90	79.4 - 114	0	20
Total Selenium	0.466	mg/L	1	0.500	<0.0131	93	70.2 - 111	4	20
Total Thallium	0.523	mg/L	1	0.500	<0.0189	105	81.8 - 115	11	20
Total Vanadium	0.261	mg/L	1	0.250	<0.00150	104	85.9 - 110	0	20
Total Zinc	0.260	mg/L	1	0.250	<0.00710	104	82.9 - 109	3	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Laboratory Control Spike (LCS-1)

QC Batch: 38634 Date Analyzed: 2007-06-28 Analyzed By: TP
Prep Batch: 33401 QC Preparation: 2007-06-28 Prepared By: TS

Param	LCS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Calcium	50.3	mg/L	1	50.0	<0.517	101	85 - 115
Total Magnesium	49.2	mg/L	1	50.0	<0.203	98	85 - 115
Total Potassium	48.5	mg/L	1	50.0	<0.866	97	85 - 115
Total Sodium	50.1	mg/L	1	50.0	<0.668	100	87.3 - 124

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	LCSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Calcium	47.8	mg/L	1	50.0	<0.517	96	85 - 115	5	20
Total Magnesium	46.6	mg/L	1	50.0	<0.203	93	85 - 115	5	20
Total Potassium	45.9	mg/L	1	50.0	<0.866	92	85 - 115	6	20
Total Sodium	47.7	mg/L	1	50.0	<0.668	95	87.3 - 124	5	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) Spiked Sample: 127196

QC Batch: 38315 Date Analyzed: 2007-06-19 Analyzed By: RR
Prep Batch: 33164 QC Preparation: 2007-06-19 Prepared By: TS

Param	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Uranium	0.463	mg/L	1	0.500	<0.0545	93	75 - 125

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Uranium	0.453	mg/L	1	0.500	<0.0545	91	75 - 125	2	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) Spiked Sample: 127196

QC Batch: 38315 Date Analyzed: 2007-06-19 Analyzed By: RR
Prep Batch: 33164 QC Preparation: 2007-06-19 Prepared By: TS

Param	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Silver	0.124	mg/L	1	0.125	<0.00210	99	80.5 - 104
Total Aluminum	1.01	mg/L	1	1.00	0.103	91	62.2 - 133
Total Arsenic	0.558	mg/L	1	0.500	<0.00440	112	67.6 - 116
Total Boron	0.0950	mg/L	1	0.0500	0.042	106	10 - 168
Total Barium	1.06	mg/L	1	1.00	0.07	99	61.9 - 120
Total Beryllium	0.0260	mg/L	1	0.0250	<0.00220	104	76.5 - 118

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matrix spikes continued . . .

Param	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Cadmium	0.249	mg/L	1	0.250	<0.00140	100	72.9 - 109
Total Cobalt	0.232	mg/L	1	0.250	<0.00220	93	71 - 112
Total Chromium	0.108	mg/L	1	0.100	<0.000900	108	66.2 - 121
Total Copper	0.128	mg/L	1	0.125	<0.00140	102	84.1 - 108
Total Iron	0.787	mg/L	1	0.500	0.281	101	61 - 122
Total Manganese	0.240	mg/L	1	0.250	<0.000600	96	61.2 - 120
Total Molybdenum	0.550	mg/L	1	0.500	<0.00790	110	60.1 - 125
Total Nickel	0.245	mg/L	1	0.250	<0.00190	98	56.1 - 119
Total Lead	0.512	mg/L	1	0.500	<0.00740	102	74.1 - 111
Total Antimony	0.242	mg/L	1	0.250	<0.0166	97	71.3 - 118
Total Selenium	0.458	mg/L	1	0.500	<0.0131	92	64.3 - 111
Total Thallium	0.459	mg/L	1	0.500	<0.0189	92	66 - 121
Total Uranium	0.463	mg/L	1	0.500	<0.0545	93	75 - 125
Total Vanadium	0.261	mg/L	1	0.250	<0.00150	104	74.1 - 110
Total Zinc	0.258	mg/L	1	0.250	0.012	98	75.5 - 113

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Silver	0.125	mg/L	1	0.125	<0.00210	100	80.5 - 104	1	20
Total Aluminum	1.03	mg/L	1	1.00	0.103	93	62.2 - 133	2	20
Total Arsenic	0.545	mg/L	1	0.500	<0.00440	109	67.6 - 116	2	20
Total Boron	0.100	mg/L	1	0.0500	0.042	116	10 - 168	5	20
Total Barium	1.08	mg/L	1	1.00	0.07	101	61.9 - 120	2	20
Total Beryllium	0.0250	mg/L	1	0.0250	<0.00220	100	76.5 - 118	4	20
Total Cadmium	0.254	mg/L	1	0.250	<0.00140	102	72.9 - 109	2	20
Total Cobalt	0.236	mg/L	1	0.250	<0.00220	94	71 - 112	2	20
Total Chromium	0.104	mg/L	1	0.100	<0.000900	104	66.2 - 121	4	20
Total Copper	0.130	mg/L	1	0.125	<0.00140	104	84.1 - 108	2	20
Total Iron	0.813	mg/L	1	0.500	0.281	106	61 - 122	3	20
Total Manganese	0.245	mg/L	1	0.250	<0.000600	98	61.2 - 120	2	20
Total Molybdenum	0.564	mg/L	1	0.500	<0.00790	113	60.1 - 125	2	20
Total Nickel	0.245	mg/L	1	0.250	<0.00190	98	56.1 - 119	0	20
Total Lead	0.520	mg/L	1	0.500	<0.00740	104	74.1 - 111	2	20
Total Antimony	0.234	mg/L	1	0.250	<0.0166	94	71.3 - 118	3	20
Total Selenium	0.445	mg/L	1	0.500	<0.0131	89	64.3 - 111	3	20
Total Thallium	0.442	mg/L	1	0.500	<0.0189	88	66 - 121	4	20
Total Uranium	0.453	mg/L	1	0.500	<0.0545	91	75 - 125	2	20
Total Vanadium	0.271	mg/L	1	0.250	<0.00150	108	74.1 - 110	4	20
Total Zinc	0.262	mg/L	1	0.250	0.012	100	75.5 - 113	2	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) Spiked Sample: 127196

QC Batch:	38431	Date Analyzed:	2007-06-22	Analyzed By:	TP
Prep Batch:	33164	QC Preparation:	2007-06-19	Prepared By:	TS

Param	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Calcium	162	mg/L	1	50.0	109	106	75 - 125
Total Magnesium	68.3	mg/L	1	50.0	19.2	98	75 - 125
Total Potassium	53.8	mg/L	1	50.0	4.58	98	75 - 125
Total Sodium	87.7	mg/L	1	50.0	36.5	102	75 - 125

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Calcium	168	mg/L	1	50.0	109	118	75 - 125	4	20
Total Magnesium	70.1	mg/L	1	50.0	19.2	102	75 - 125	3	20
Total Potassium	55.8	mg/L	1	50.0	4.58	102	75 - 125	4	20
Total Sodium	89.9	mg/L	1	50.0	36.5	107	75 - 125	2	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) Spiked Sample: 127184

QC Batch: 38621 Date Analyzed: 2007-06-28 Analyzed By: RR
Prep Batch: 33401 QC Preparation: 2007-06-28 Prepared By: TS

Param	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Uranium	0.521	mg/L	1	0.500	<0.0545	104	75 - 125

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Uranium	0.499	mg/L	1	0.500	<0.0545	100	75 - 125	4	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) Spiked Sample: 127184

QC Batch: 38621 Date Analyzed: 2007-06-28 Analyzed By: RR
Prep Batch: 33401 QC Preparation: 2007-06-28 Prepared By: TS

Param	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Silver	0.126	mg/L	1	0.125	<0.00210	101	80.5 - 104
Total Aluminum	1.14	mg/L	1	1.00	0.088	105	62.2 - 133
Total Arsenic	0.482	mg/L	1	0.500	<0.00440	96	67.6 - 116
Total Boron	0.0720	mg/L	1	0.0500	0.016	112	10 - 168
Total Barium	1.14	mg/L	1	1.00	0.055	108	61.9 - 120
Total Beryllium	0.0270	mg/L	1	0.0250	<0.00220	108	76.5 - 118
Total Cadmium	0.267	mg/L	1	0.250	<0.00140	107	72.9 - 109
Total Cobalt	0.269	mg/L	1	0.250	<0.00220	108	71 - 112
Total Chromium	0.111	mg/L	1	0.100	<0.000900	111	66.2 - 121
Total Copper	0.132	mg/L	1	0.125	<0.00140	106	84.1 - 108
Total Iron	0.790	mg/L	1	0.500	0.261	106	61 - 122
Total Manganese	0.259	mg/L	1	0.250	<0.000600	104	61.2 - 120

continued . . .

matrix spikes continued . . .

Param	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Molybdenum	0.550	mg/L	1	0.500	<0.00790	110	60.1 - 125
Total Nickel	0.261	mg/L	1	0.250	<0.00190	104	56.1 - 119
Total Lead	0.544	mg/L	1	0.500	<0.00740	109	74.1 - 111
Total Antimony	0.255	mg/L	1	0.250	<0.0166	102	71.3 - 118
Total Selenium	0.450	mg/L	1	0.500	<0.0131	90	64.3 - 111
Total Thallium	0.524	mg/L	1	0.500	<0.0189	105	66 - 121
Total Vanadium	0.247	mg/L	1	0.250	<0.00150	99	74.1 - 110
Total Zinc	0.248	mg/L	1	0.250	<0.00710	99	75.5 - 113

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Silver	0.125	mg/L	1	0.125	<0.00210	100	80.5 - 104	1	20
Total Aluminum	1.12	mg/L	1	1.00	0.088	103	62.2 - 133	2	20
Total Arsenic	0.501	mg/L	1	0.500	<0.00440	100	67.6 - 116	4	20
Total Boron	0.0610	mg/L	1	0.0500	0.016	90	10 - 168	16	20
Total Barium	1.14	mg/L	1	1.00	0.055	108	61.9 - 120	0	20
Total Beryllium	0.0260	mg/L	1	0.0250	<0.00220	104	76.5 - 118	4	20
Total Cadmium	0.265	mg/L	1	0.250	<0.00140	106	72.9 - 109	1	20
Total Cobalt	0.263	mg/L	1	0.250	<0.00220	105	71 - 112	2	20
Total Chromium	0.108	mg/L	1	0.100	<0.000900	108	66.2 - 121	3	20
Total Copper	0.132	mg/L	1	0.125	<0.00140	106	84.1 - 108	0	20
Total Iron	0.812	mg/L	1	0.500	0.261	110	61 - 122	3	20
Total Manganese	0.257	mg/L	1	0.250	<0.000600	103	61.2 - 120	1	20
Total Molybdenum	0.559	mg/L	1	0.500	<0.00790	112	60.1 - 125	2	20
Total Nickel	0.269	mg/L	1	0.250	<0.00190	108	56.1 - 119	3	20
Total Lead	0.541	mg/L	1	0.500	<0.00740	108	74.1 - 111	1	20
Total Antimony	0.245	mg/L	1	0.250	<0.0166	98	71.3 - 118	4	20
Total Selenium	0.489	mg/L	1	0.500	<0.0131	98	64.3 - 111	8	20
Total Thallium	0.523	mg/L	1	0.500	<0.0189	105	66 - 121	0	20
Total Vanadium	0.246	mg/L	1	0.250	<0.00150	98	74.1 - 110	0	20
Total Zinc	0.249	mg/L	1	0.250	<0.00710	100	75.5 - 113	0	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Matrix Spike (MS-1) Spiked Sample: 127184

QC Batch:	38634	Date Analyzed:	2007-06-28	Analyzed By:	TP
Prep Batch:	33401	QC Preparation:	2007-06-28	Prepared By:	TS

Param	MS Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit
Total Calcium	136	mg/L	1	50.0	88.2	96	75 - 125
Total Magnesium	62.1	mg/L	1	50.0	15	94	75 - 125
Total Potassium	52.5	mg/L	1	50.0	4.2	97	75 - 125
Total Sodium	83.1	mg/L	1	50.0	35	96	75 - 125

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Param	MSD Result	Units	Dil.	Spike Amount	Matrix Result	Rec.	Rec. Limit	RPD	RPD Limit
Total Calcium	140	mg/L	1	50.0	88.2	104	75 - 125	3	20
Total Magnesium	63.0	mg/L	1	50.0	15	96	75 - 125	1	20
Total Potassium	52.9	mg/L	1	50.0	4.2	97	75 - 125	1	20
Total Sodium	83.7	mg/L	1	50.0	35	97	75 - 125	1	20

Percent recovery is based on the spike result. RPD is based on the spike and spike duplicate result.

Standard (ICV-1)

QC Batch: 38315 Date Analyzed: 2007-06-19 Analyzed By: RR

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Uranium		mg/L	1.00	0.988	99	90 - 110	2007-06-19

Standard (ICV-1)

QC Batch: 38315 Date Analyzed: 2007-06-19 Analyzed By: RR

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Silver		mg/L	0.125	0.126	101	90 - 110	2007-06-19
Total Aluminum		mg/L	1.00	0.998	100	90 - 110	2007-06-19
Total Arsenic		mg/L	1.00	0.975	98	90 - 110	2007-06-19
Total Boron		mg/L	1.00	1.01	101	90 - 110	2007-06-19
Total Barium		mg/L	1.00	1.01	101	90 - 110	2007-06-19
Total Beryllium		mg/L	1.00	1.01	101	90 - 110	2007-06-19
Total Cadmium		mg/L	1.00	1.06	106	90 - 110	2007-06-19
Total Cobalt		mg/L	1.00	1.01	101	90 - 110	2007-06-19
Total Chromium		mg/L	1.00	1.04	104	90 - 110	2007-06-19
Total Copper		mg/L	1.00	1.00	100	90 - 110	2007-06-19
Total Iron		mg/L	1.00	1.05	105	90 - 110	2007-06-19
Total Manganese		mg/L	1.00	1.00	100	90 - 110	2007-06-19
Total Molybdenum		mg/L	1.00	1.08	108	90 - 110	2007-06-19
Total Nickel		mg/L	1.00	1.01	101	90 - 110	2007-06-19
Total Lead		mg/L	1.00	1.02	102	90 - 110	2007-06-19
Total Antimony		mg/L	1.00	1.02	102	90 - 110	2007-06-19
Total Selenium		mg/L	1.00	1.04	104	90 - 110	2007-06-19
Total Thallium		mg/L	1.00	0.944	94	90 - 110	2007-06-19
Total Uranium		mg/L	1.00	0.988	99	90 - 110	2007-06-19
Total Vanadium		mg/L	1.00	0.983	98	90 - 110	2007-06-19
Total Zinc		mg/L	1.00	0.998	100	90 - 110	2007-06-19

Standard (CCV-1)

QC Batch: 38315 Date Analyzed: 2007-06-19 Analyzed By: RR

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Uranium		mg/L	1.00	1.07	107	90 - 110	2007-06-19

Standard (CCV-1)

QC Batch: 38315 Date Analyzed: 2007-06-19 Analyzed By: RR

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Silver		mg/L	0.125	0.136	109	90 - 110	2007-06-19
Total Aluminum		mg/L	1.00	1.07	107	90 - 110	2007-06-19
Total Arsenic		mg/L	1.00	1.08	108	90 - 110	2007-06-19
Total Boron		mg/L	1.00	1.07	107	90 - 110	2007-06-19
Total Barium		mg/L	1.00	1.07	107	90 - 110	2007-06-19
Total Beryllium		mg/L	1.00	1.07	107	90 - 110	2007-06-19
Total Cadmium		mg/L	1.00	1.04	104	90 - 110	2007-06-19
Total Cobalt		mg/L	1.00	1.07	107	90 - 110	2007-06-19
Total Chromium		mg/L	1.00	1.07	107	90 - 110	2007-06-19
Total Copper		mg/L	1.00	1.07	107	90 - 110	2007-06-19
Total Iron		mg/L	1.00	1.04	104	90 - 110	2007-06-19
Total Manganese		mg/L	1.00	1.07	107	90 - 110	2007-06-19
Total Molybdenum		mg/L	1.00	1.04	104	90 - 110	2007-06-19
Total Nickel		mg/L	1.00	1.08	108	90 - 110	2007-06-19
Total Lead		mg/L	1.00	1.08	108	90 - 110	2007-06-19
Total Antimony		mg/L	1.00	1.08	108	90 - 110	2007-06-19
Total Selenium		mg/L	1.00	1.06	106	90 - 110	2007-06-19
Total Thallium		mg/L	1.00	0.990	99	90 - 110	2007-06-19
Total Uranium		mg/L	1.00	1.07	107	90 - 110	2007-06-19
Total Vanadium		mg/L	1.00	1.06	106	90 - 110	2007-06-19
Total Zinc		mg/L	1.00	1.08	108	90 - 110	2007-06-19

Standard (ICV-1)

QC Batch: 38431 Date Analyzed: 2007-06-22 Analyzed By: TP

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Calcium		mg/L	50.0	50.5	101	90 - 110	2007-06-22
Total Magnesium		mg/L	50.0	50.5	101	90 - 110	2007-06-22
Total Potassium		mg/L	50.0	50.1	100	90 - 110	2007-06-22
Total Sodium		mg/L	50.0	50.3	101	90 - 110	2007-06-22

Standard (CCV-1)

QC Batch: 38431 Date Analyzed: 2007-06-22 Analyzed By: TP

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Calcium		mg/L	50.0	48.8	98	90 - 110	2007-06-22
Total Magnesium		mg/L	50.0	48.3	97	90 - 110	2007-06-22
Total Potassium		mg/L	50.0	48.1	96	90 - 110	2007-06-22
Total Sodium		mg/L	50.0	48.3	97	90 - 110	2007-06-22

Standard (ICV-1)

QC Batch: 38621 Date Analyzed: 2007-06-28 Analyzed By: RR

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Uranium		mg/L	1.00	1.00	100	90 - 110	2007-06-28

Standard (ICV-1)

QC Batch: 38621 Date Analyzed: 2007-06-28 Analyzed By: RR

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Silver		mg/L	0.125	0.128	102	90 - 110	2007-06-28
Total Aluminum		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Arsenic		mg/L	1.00	1.08	108	90 - 110	2007-06-28
Total Boron		mg/L	1.00	1.02	102	90 - 110	2007-06-28
Total Barium		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Beryllium		mg/L	1.00	1.00	100	90 - 110	2007-06-28
Total Cadmium		mg/L	1.00	1.04	104	90 - 110	2007-06-28
Total Cobalt		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Chromium		mg/L	1.00	1.04	104	90 - 110	2007-06-28
Total Copper		mg/L	1.00	1.02	102	90 - 110	2007-06-28
Total Iron		mg/L	1.00	1.03	103	90 - 110	2007-06-28
Total Manganese		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Molybdenum		mg/L	1.00	1.02	102	90 - 110	2007-06-28
Total Nickel		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Lead		mg/L	1.00	1.04	104	90 - 110	2007-06-28
Total Antimony		mg/L	1.00	0.974	97	90 - 110	2007-06-28
Total Selenium		mg/L	1.00	0.979	98	90 - 110	2007-06-28
Total Thallium		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Vanadium		mg/L	1.00	1.03	103	90 - 110	2007-06-28
Total Zinc		mg/L	1.00	0.993	99	90 - 110	2007-06-28

Standard (CCV-1)

QC Batch: 38621 Date Analyzed: 2007-06-28 Analyzed By: RR

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Uranium		mg/L	1.00	1.04	104	90 - 110	2007-06-28

Standard (CCV-1)

QC Batch: 38621 Date Analyzed: 2007-06-28 Analyzed By: RR

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Silver		mg/L	0.125	0.127	102	90 - 110	2007-06-28
Total Aluminum		mg/L	1.00	1.00	100	90 - 110	2007-06-28
Total Arsenic		mg/L	1.00	0.963	96	90 - 110	2007-06-28
Total Boron		mg/L	1.00	0.929	93	90 - 110	2007-06-28
Total Barium		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Beryllium		mg/L	1.00	0.995	100	90 - 110	2007-06-28
Total Cadmium		mg/L	1.00	1.04	104	90 - 110	2007-06-28
Total Cobalt		mg/L	1.00	0.994	99	90 - 110	2007-06-28
Total Chromium		mg/L	1.00	1.03	103	90 - 110	2007-06-28
Total Copper		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Iron		mg/L	1.00	1.02	102	90 - 110	2007-06-28
Total Manganese		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Molybdenum		mg/L	1.00	1.03	103	90 - 110	2007-06-28
Total Nickel		mg/L	1.00	0.998	100	90 - 110	2007-06-28
Total Lead		mg/L	1.00	1.03	103	90 - 110	2007-06-28
Total Antimony		mg/L	1.00	1.05	105	90 - 110	2007-06-28
Total Selenium		mg/L	1.00	0.959	96	90 - 110	2007-06-28
Total Thallium		mg/L	1.00	0.968	97	90 - 110	2007-06-28
Total Vanadium		mg/L	1.00	1.01	101	90 - 110	2007-06-28
Total Zinc		mg/L	1.00	0.987	99	90 - 110	2007-06-28

Standard (ICV-1)

QC Batch: 38634 Date Analyzed: 2007-06-28 Analyzed By: TP

Param	Flag	Units	ICVs True Conc.	ICVs Found Conc.	ICVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Calcium		mg/L	50.0	51.5	103	90 - 110	2007-06-28
Total Magnesium		mg/L	50.0	51.6	103	90 - 110	2007-06-28
Total Potassium		mg/L	50.0	51.4	103	90 - 110	2007-06-28
Total Sodium		mg/L	50.0	50.7	101	90 - 110	2007-06-28

Standard (CCV-1)

QC Batch: 38634 Date Analyzed: 2007-06-28 Analyzed By: TP

Param	Flag	Units	CCVs True Conc.	CCVs Found Conc.	CCVs Percent Recovery	Percent Recovery Limits	Date Analyzed
Total Calcium		mg/L	50.0	51.7	103	90 - 110	2007-06-28
Total Magnesium		mg/L	50.0	51.6	103	90 - 110	2007-06-28
Total Potassium		mg/L	50.0	50.6	101	90 - 110	2007-06-28
Total Sodium		mg/L	50.0	49.8	100	90 - 110	2007-06-28

QUARTERLY
LANDFILL METHANE MONITORING
FIRST QUARTER 2007
WHITE SANDS MISSILE RANGE

Submitted to:

Joe Talamantes

U.S. Army
White Sands Missile Range
National Range Support Directorate
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CH_4 Gas survey completed and prepared by:

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03/21/07
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QUARTERLY LANDFILL GAS MONITORING
FIRST QUARTER 2007
THE MAIN POST CONSTRUCTION AND DEMOLITION LANDFILL
WHITE SANDS MISSILE RANGE

Executive Summary

The following report pertains to the ongoing quarterly landfill gas monitoring for the landfill located at the Main Post Construction and Demolition Landfill, White Sands Missile Range, New Mexico. At the request of White Sands Missile Range, SafeNet Services, LLC (SafeNet) conducted the gas monitoring on March 21, 2007, for the 1st quarter of 2007.

Findings:

> **Methane Gas-** Results indicate that no methane gas was detected at any of the sampling points.

This facility has a fence line of 2420.58 meters or 7941.54 feet enclosed by chain-linked and barbed wire fence. The reported site lithology is a sandy soil with some silt to thirty feet. This quarterly monitoring was conducted in accordance with, and to comply in part with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities.

The requirements are to ensure the concentration of explosive gases generated by this facility or practice comply with 20 NMAC 9.1, Subpart IV 403 C, and shall not exceed:

1.) Twenty-five percent (25%) of the lower explosive limit for the gases in facility structures (excluding gas control or recovery system components); and
2.) The lower explosive limit for gases at the property boundary.

On March 21, 2007, SafeNet personnel conducted monitoring operations for the possible migration of methane (CH_4) as directed by the Regulatory Compliance Office, White Sands Missile Range (WSMR) and in compliance with New Mexico Environmental Department, Solid Waste Bureau. Landfill gas monitoring points were selected within the landfill area at the property boundary at approximately 300-foot intervals. Each sampling point was taken at a total depth of three (3) feet below ground surface (bgs.) utilizing soil gas sampling technology. Monitoring points are presented in the Methane Sampling Location Map located in the Appendix. This monitoring event also encompassed all buildings within the permitted facility. All gas-monitoring points were conducted by constructing monitoring probes using the soil gas vapor impact probe system, and a Landtec GEM2000 portable gas detection meter. The GEM2000 meter was properly calibrated as to the manufactures specifications and utilized within the instrument's manufactures criteria for monitoring landfill gas. Identical methodology was utilized throughout the gas-monitoring event.

A total of twenty-seven (27) gas-monitoring points were conducted, within the landfill permitted area. Results from our on-site field analyses are presented as Landfill Gas Monitoring Results, downloaded from the Landtec GEM2000.

Introduction and Scope

The Main Post Construction and Demolition Landfill (landfill facility) is located at White Sands Missile Range, New Mexico. The facility has a fence line of 2420.58 meters or 7941.54 feet enclosed by chain-linked and barbed wire fence with two buildings. One building is currently utilized as a guardhouse and the other is a vacant guardhouse within the property boundary and is represented in this report as "Methane Sampling Location Map" located in the Appendix. The stratigraphy beneath the site is a sandy soil with some silt to thirty feet, as reported by WSMR. Examination of the retained soil retrieved from around the soil vapor probes during the sampling process verified this to a depth of three feet.

To comply in part with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities, quarterly landfill gas monitoring must be conducted for explosive gases. The requirements are to ensure the concentration of explosive gases generated by this facility or practice comply with 20 NMAC 9.1, Subpart IV 403 C, and shall not exceed:

1.) Twenty-five percent (25%) of the lower explosive limit for the gases in facility structures (excluding gas control or recovery system components); and
2.) The lower explosive limit for gases at the property boundary.

The sampling probe used in this monitoring event is a patented, re-usable; AMS Retract-A-Tip designed as a survey tool for collection of discrete soil gas samples. It is constructed of hardened stainless steel and is designed to open when the drive extensions are retracted by 2 inches. The sampling probe was driven into the soil using a heavy duty Bosch 11245 rotary hammer drill with a 5/8-inch diameter x 3-foot long extension drive rod. Once installed, the drive extension was retracted 2 inches. In this open position, a gas sample was collected utilizing a Landtec GEM2000 meter. Teflon tubing was used in conjunction with the GEM2000 for soil gas transference media.

To comply with the Main Post Landfill Operating Plan application permit, the quarterly landfill methane gas monitoring will be conducted in the following manner.

1.) Request and receive utility clearance from White Sands Missile Range.

2.) Non-discrete monitoring points will be installed along the facility perimeter at 300-foot intervals (27 collection points were identified).

3.) Monitoring points will include the inside of all facility structures; a Photo Ionization Detector (intrinsically safe) will be utilized before entering closed structures.

4.) Bar-hole or soil gas vapor probes will be installed for monitoring points to a depth of three feet.

5.) A Landtec GEM2000 Gas Analyzer or other combustible gas indicator (GEM2000) that utilizes the catalytic oxidation method or thermal conductivity will be used to detect and record combustible gas levels. Notify Regulatory Compliance Office, WSMR immediately if methane concentrations are detected at or near the limiting concentrations.

6.) Report all procedures used and the results in a quality that can be submitted to the State of New Mexico, Environment Department.

Sampling Plan

On March 21, 2007 SafeNet conducted monitoring operations for the possible migration of methane (CH_4) as directed by the WSMR Regulatory Compliance Office, in compliance with New Mexico Environmental Department, Solid Waste Bureau. A permit was obtained from WSMR as to the location of any buried utility lines (gas, water, electrical) at, near, or crossing the property boundary. The only utility identified was a phone line located in front of the guardhouse area. This area was avoided during the sampling event. Landfill gas monitoring points were then selected within the landfill area at the property boundary at approximately 300-foot intervals utilizing a Trumeter measuring wheel. A soil gas vapor probe was installed at each monitoring point utilizing the following procedures:

(1) Typical Soil Gas Vapor Probe Installation (27 each at 300' intervals):

- A pilot hole was first installed utilizing a heavy-duty hammer drill and soil probe, a 5/8-inch diameter rod with a stainless steel tip, which was driven approximately 2 ½ feet into the soil. Soils showed to be sandy with little silt.

- The soil probe was withdrawn to allow for the placement of the sampling tip (AMS Retract-A-Tip).

- Place the sampling tip onto the 5/8-inch hollow rod and a probe adapter that allowed for a ¼" ID Teflon sample tube to be attached. The heavy-duty hammer drill was used to drive the sample to a total depth of 3 feet below ground surface.

- The Landtec- GEM2000 was then attached to the Teflon tubing and a sample was collected. (See: GEM2000 *Infrared Gas Analyzer*).

- The probe was withdrawn from the hole and the screen checked for plugging or damage, when necessary probe screens were replaced as to insure appropriate consecutive readings and functionality of the probe.

- Each location was identified by a round marker attached with tin-plated wire onto the chain-linked or barbwire fence that surrounded the property, thus allowing for future sampling reference points.

Note: Operators measured and recorded the depth of each probe to insure standardization with each probe placement.

(2) On-site structures

There are two on-site structures, one is a small concrete building used as a landfill office and the other is a vacant guardhouse. The monitoring measurement was taken 6 feet from the north wall of the vacant structure. Landscaping gravel has been placed around the landfill office; therefore the sample by the office was moved to approximately 30 feet north of the building. All results were data logged and downloaded to computer (See: *Results and Findings*).

(3) GEM2000 **Infrared Gas Analyzer**

The Landtec GEM2000 is a compact field instrument that can and was configured to analyze the methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) levels in landfill gas (LFG). It is an approved instrument in monitoring migration gases, active and passive gas extraction systems and measuring LFG at flares or other approved control systems. This instrument uses computer technology that displays on-screen menus to provide a simplified user interface for accurate data analysis and recording. All information collected was dated and time stamped and readings were stored in memory. The data was later downloaded via a serial connection to a computer, then inserted into our table template and submitted into our report as Landfill Gas Monitoring Results.

This unit works with a vacuum sample pump that draws a quantity of gas through the sample hose, in-line water trap and the user replaceable particulate filter, into a sample chamber. An infrared beam is projected, via sapphire windows, through the gas sample. On the other side of the chamber, methane and carbon dioxide detectors sense the beam. A microprocessor calculates the amount of infrared light absorbed at different wavelengths and determines the various gas concentrations.

When a sufficient amount of gas has entered the sample chamber, gas concentration levels were shown on the display as it stabilizes (approximately 60 seconds). The SafeNet technician, with a few keystrokes, stores the measurement data in memory utilizing a unique I.D. code, as well as the date and time.

(4) Combustible Gas Instrument Field Calibration

The Landtec GEM2000 Gas Analyzer utilizes an internal pump to pull air into the calibration map that is accessed by its microprocessor for baseline reference data. This reference data, as stated by the manufacture, was programmed into the GEM2000 during the factory calibration using various gas mixtures in an environmental chamber. The GEM2000 can be cleared of user calibration settings and restored to “factory settings” as needed. The factory calibration has been designed to give the best possible results over a wide range of conditions. However, SafeNet technicians performed “field calibrations” to improve the instrument’s accuracy for this monitoring event. Each field calibration on-site was performed at stabilized working temperature. Whenever temperature changes occurred during the operation, the GEM2000 was re-calibrated (example: the cool of the morning to the hottest part of the day). Field calibration was performed using the manufacturer’s recommended gas mixture for low concentrations which are 15/15 (15% methane, 15% carbon dioxide), 4 % oxygen and balance nitrogen, 15/15% and 4.0% oxygen/nitrogen. (See Landtec GEM2000 Operation Manual for procedures)

(5) Probe Purging:

The probe condition was checked for structural integrity and suitability for monitoring before each use. After the probe had been driven to the desired sampling depth (3 feet), it was purged (evacuated) to remove ambient air. Typically purging can be accomplished using either a hand pump, peristaltic pump, or pump attached to the top of the probe via PVC or polyethylene tubing. The GEM2000 used in this event (see GEM2000 *Infrared Gas Analyzer*) was designed with an internal pump that did actively draw the vapor sample into the instrument for continual analysis.

The GEM2000 was used alone, due to the shallow depth of each probe in this monitoring event, for the purging of each probe point via the internal pump. Purge time was based on the volume of the probe sampling system, and purging done long enough to remove 1 to 5 casing volumes of air from the system. Purge volumes and times were recorded within the GEM2000, which are presented as Landfill Gas Monitoring Results, and also on field forms. A particulate-moisture trap was placed between the probe and the GEM2000 to prevent damage to the instrument. This trap was checked before each use or sampling point due to the soil make up (sand and silt) with the possible vacuum pickup of particulate from the probe. The GEM2000 was directly connected to the vapor probe with ¼" Teflon tubing.

Results and Findings

SAMPLE NUMBER SES-	CH_4%	CO_2 %	O_2%	ATMOSPHERIC PRESSURE "HG"	Temp. DegF	DEPTH FEET
1	0	0	20.5	25.92	73	3ft
2	0	0	20.7	25.92	73	3ft
3	0	0	20.7	25.92	73	3ft
4	0	0	20.9	25.91	73	3ft
5	0	0	20.8	25.91	73	3ft
6	0	0	20.8	25.91	73	3ft
7	0	0	20.9	25.92	73	3ft
8	0	0	21.0	25.92	73	3ft
9	0	0	21.2	25.91	73	3ft
10	0	0	20.8	25.93	73	3ft
11	0	0	20.7	25.92	73	3ft
12	0	0	20.7	25.92	73	3ft
13	0	0	21.3	25.92	73	3ft
14	0	0	21.0	25.93	73	3ft
15	0.1	0	21.1	25.93	73	3ft
16	0.1	0	21.1	25.94	73	3ft
17	0	0	21.1	25.94	73	3ft
18	0.1	0	21.0	25.94	73	3ft
19	0.1	0	20.9	25.95	73	3ft
20	0.1	0	21.1	25.95	73	3ft
21	0	0	21.2	25.95	73	3ft
22	0	0	21.0	25.96	73	3ft
23	0	0	21.0	25.96	73	3ft
24	0	0	21.0	25.96	73	3ft
25	0	0	21.1	25.97	73	3ft
26	0	0	21.2	25.97	73	3ft
27	0	0	20.8	25.97	73	3ft

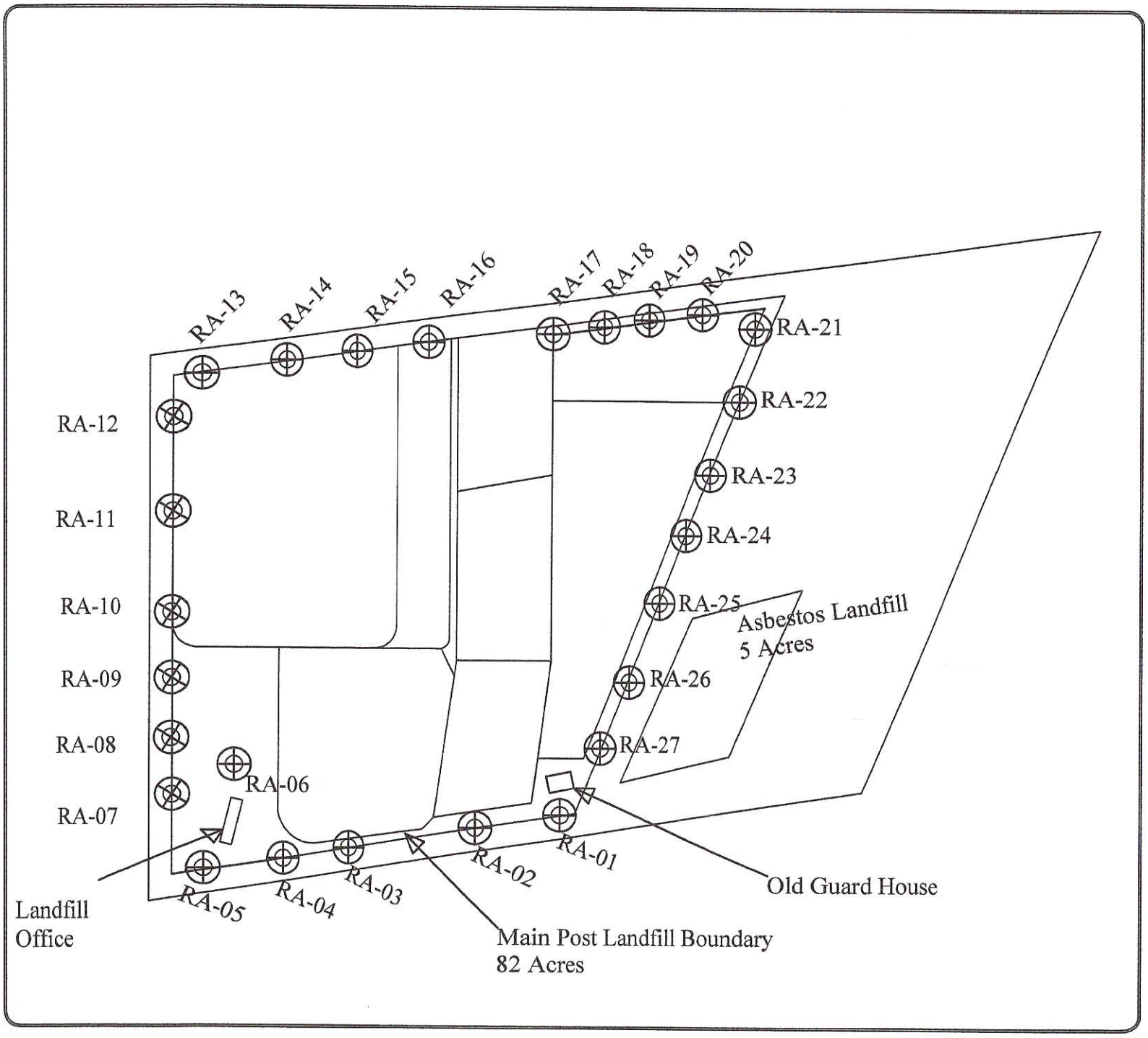
Discussion

This quarterly monitoring was conducted in accordance with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities. This field investigation as shown in the results, verified non-detectable levels of methane at the facility's property boundary and within all facility's structures.

Sincerely,

Oscar E. Ayala
SafeNet Services, LLC
cc: file

Appendix A



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FAX (915) 779-6689

WHITE SANDS MISSILE RANGE

METHANE MONITORING

LOCATION
White Sands Missile Range Landfill

LEGEND
Samples Location

REVISIONS

INSPECTED BY: O.E. AYALA
DRAWN BY: J.E. AYALA
DATE: 03/21/07
PROJECT#:
SHEET #:

QUARTERLY
LANDFILL METHANE MONITORING
SECOND QUARTER 2007
WHITE SANDS MISSILE RANGE

Submitted to:

Joe Talamantes

U.S. Army
White Sands Missile Range
National Range Support Directorate
Engineering Division
White Sands Missile Range, New Mexico 88002

Submitted by:

SafeNet Environmental Services, LLC
6500 Boeing Suite T-1
El Paso, Texas 79925

CH_4 Gas survey completed and prepared by:

Concurrence:

06/18/07
Oscar E. Ayala

06/18/07
Juan E. Ayala

QUARTERLY LANDFILL GAS MONITORING
SECOND QUARTER 2007
THE MAIN POST CONSTRUCTION AND DEMOLITION LANDFILL
WHITE SANDS MISSILE RANGE

Executive Summary

The following report pertains to the ongoing quarterly landfill gas monitoring for the landfill located at the Main Post Construction and Demolition Landfill, White Sands Missile Range, New Mexico. At the request of White Sands Missile Range, SafeNet Services, LLC (SafeNet) conducted the gas monitoring on June 18, 2007, for the second quarter of 2007.

Findings:

> **Methane Gas-** Results indicate that no methane gas was detected at any of the sampling points.

This facility has a fence line of 2420.58 meters or 7941.54 feet enclosed by chain-linked and barbed wire fence. The reported site lithology is a sandy soil with some silt to thirty feet. This quarterly monitoring was conducted in accordance with, and to comply in part with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities.

The requirements are to ensure the concentration of explosive gases generated by this facility or practice comply with 20 NMAC 9.1, Subpart IV 403 C, and shall not exceed:

1.) Twenty-five percent (25%) of the lower explosive limit for the gases in facility structures (excluding gas control or recovery system components); and
2.) The lower explosive limit for gases at the property boundary.

On June 18, 2007, SafeNet personnel conducted monitoring operations for the possible migration of methane (CH_4) as directed by the Regulatory Compliance Office, White Sands Missile Range (WSMR) and in compliance with New Mexico Environmental Department, Solid Waste Bureau. Landfill gas monitoring points were selected within the landfill area at the property boundary at approximately 300-foot intervals. Each sampling point was taken at a total depth of three (3) feet below ground surface (bgs.) utilizing soil gas sampling technology. Monitoring points are presented in the Methane Sampling Location Map located in the Appendix. This monitoring event also encompassed all buildings within the permitted facility. All gas-monitoring points were conducted by constructing monitoring probes using the soil gas vapor impact probe system, and a Landtec GEM2000 portable gas detection meter. The GEM2000 meter was properly calibrated as to the manufactures specifications and utilized within the instrument's manufactures criteria for monitoring landfill gas. Identical methodology was utilized throughout the gas-monitoring event.

A total of twenty-seven (27) gas-monitoring points were conducted, within the landfill permitted area. Results from our on-site field analyses are presented as Landfill Gas Monitoring Results, downloaded from the Landtec GEM2000.

Introduction and Scope

The Main Post Construction and Demolition Landfill (landfill facility) is located at White Sands Missile Range, New Mexico. The facility has a fence line of 2420.58 meters or 7941.54 feet enclosed by chain-linked and barbed wire fence with two buildings. One building is currently utilized as a guardhouse and the other is a vacant guardhouse within the property boundary and is represented in this report as "Methane Sampling Location Map" located in the Appendix. The stratigraphy beneath the site is a sandy soil with some silt to thirty feet, as reported by WSMR. Examination of the retained soil retrieved from around the soil vapor probes during the sampling process verified this to a depth of three feet.

To comply in part with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities, quarterly landfill gas monitoring must be conducted for explosive gases. The requirements are to ensure the concentration of explosive gases generated by this facility or practice comply with 20 NMAC 9.1, Subpart IV 403 C, and shall not exceed:

1.) Twenty-five percent (25%) of the lower explosive limit for the gases in facility structures (excluding gas control or recovery system components); and
2.) The lower explosive limit for gases at the property boundary.

The sampling probe used in this monitoring event is a patented, re-usable; AMS Retract-A-Tip designed as a survey tool for collection of discrete soil gas samples. It is constructed of hardened stainless steel and is designed to open when the drive extensions are retracted by 2 inches. The sampling probe was driven into the soil using a heavy duty Bosch 11245 rotary hammer drill with a 5/8-inch diameter x 3-foot long extension drive rod. Once installed, the drive extension was retracted 2 inches. In this open position, a gas sample was collected utilizing a Landtec GEM2000 meter. Teflon tubing was used in conjunction with the GEM2000 for soil gas transference media.

To comply with the Main Post Landfill Operating Plan application permit, the quarterly landfill methane gas monitoring will be conducted in the following manner.

1.) Request and receive utility clearance from White Sands Missile Range.

2.) Non-discrete monitoring points will be installed along the facility perimeter at 300-foot intervals (27 collection points were identified).

3.) Monitoring points will include the inside of all facility structures; a Photo Ionization Detector (intrinsically safe) will be utilized before entering closed structures.

4.) Bar-hole or soil gas vapor probes will be installed for monitoring points to a depth of three feet.

5.) A Landtec GEM2000 Gas Analyzer or other combustible gas indicator (GEM2000) that utilizes the catalytic oxidation method or thermal conductivity will be used to detect and record combustible gas levels. Notify Regulatory Compliance Office, WSMR immediately if methane concentrations are detected at or near the limiting concentrations.

6.) Report all procedures used and the results in a quality that can be submitted to the State of New Mexico, Environment Department.

Sampling Plan

On June 18, 2007 SafeNet conducted monitoring operations for the possible migration of methane (CH_4) as directed by the WSMR Regulatory Compliance Office, in compliance with New Mexico Environmental Department, Solid Waste Bureau. A permit was obtained from WSMR as to the location of any buried utility lines (gas, water, electrical) at, near, or crossing the property boundary. The only utility identified was a phone line located in front of the guardhouse area. This area was avoided during the sampling event. Landfill gas monitoring points were then selected within the landfill area at the property boundary at approximately 300-foot intervals utilizing a Trumeter measuring wheel. A soil gas vapor probe was installed at each monitoring point utilizing the following procedures:

(1) Typical Soil Gas Vapor Probe Installation (27 each at 300' intervals):

- A pilot hole was first installed utilizing a heavy-duty hammer drill and soil probe, a 5/8-inch diameter rod with a stainless steel tip, which was driven approximately 2 ½ feet into the soil. Soils showed to be sandy with little silt.

- The soil probe was withdrawn to allow for the placement of the sampling tip (AMS Retract-A-Tip).

- Place the sampling tip onto the 5/8-inch hollow rod and a probe adapter that allowed for a ¼" ID Teflon sample tube to be attached. The heavy-duty hammer drill was used to drive the sample to a total depth of 3 feet below ground surface.

- The Landtec- GEM2000 was then attached to the Teflon tubing and a sample was collected. (See: GEM2000 *Infrared Gas Analyzer*).

- The probe was withdrawn from the hole and the screen checked for plugging or damage, when necessary probe screens were replaced as to insure appropriate consecutive readings and functionality of the probe.

- Each location was identified by a round marker attached with tin-plated wire onto the chain-linked or barbwire fence that surrounded the property, thus allowing for future sampling reference points.

Note: Operators measured and recorded the depth of each probe to insure standardization with each probe placement.

(2) On-site structures

There are two on-site structures, one is a small concrete building used as a landfill office and the other is a vacant guardhouse. The monitoring measurement was taken 6 feet from the north wall of the vacant structure. Landscaping gravel has been placed around the landfill office; therefore the sample by the office was moved to approximately 30 feet north of the building. All results were data logged and downloaded to computer (See: *Results and Findings*).

(3) GEM2000 **Infrared Gas Analyzer**

The Landtec GEM2000 is a compact field instrument that can and was configured to analyze the methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) levels in landfill gas (LFG). It is an approved instrument in monitoring migration gases, active and passive gas extraction systems and measuring LFG at flares or other approved control systems. This instrument uses computer technology that displays on-screen menus to provide a simplified user interface for accurate data analysis and recording. All information collected was dated and time stamped and readings were stored in memory. The data was later downloaded via a serial connection to a computer, then inserted into our table template and submitted into our report as Landfill Gas Monitoring Results.

This unit works with a vacuum sample pump that draws a quantity of gas through the sample hose, in-line water trap and the user replaceable particulate filter, into a sample chamber. An infrared beam is projected, via sapphire windows, through the gas sample. On the other side of the chamber, methane and carbon dioxide detectors sense the beam. A microprocessor calculates the amount of infrared light absorbed at different wavelengths and determines the various gas concentrations.

When a sufficient amount of gas has entered the sample chamber, gas concentration levels were shown on the display as it stabilizes (approximately 60 seconds). The SafeNet technician, with a few keystrokes, stores the measurement data in memory utilizing a unique I.D. code, as well as the date and time.

(4) Combustible Gas Instrument Field Calibration

The Landtec GEM2000 Gas Analyzer utilizes an internal pump to pull air into the calibration map that is accessed by its microprocessor for baseline reference data. This reference data, as stated by the manufacture, was programmed into the GEM2000 during the factory calibration using various gas mixtures in an environmental chamber. The GEM2000 can be cleared of user calibration settings and restored to "factory settings" as needed. The factory calibration has been designed to give the best possible results over a wide range of conditions. However, SafeNet technicians performed "field calibrations" to improve the instrument's accuracy for this monitoring event. Each field calibration on-site was performed at stabilized working temperature. Whenever temperature changes occurred during the operation, the GEM2000 was re-calibrated (example: the cool of the morning to the hottest part of the day). Field calibration was performed using the manufacturer's recommended gas mixture for low concentrations which are 15/15 (15% methane, 15% carbon dioxide), 4 % oxygen and balance nitrogen, 15/15% and 4.0% oxygen/nitrogen. (See Landtec GEM2000 Operation Manual for procedures)

(5) Probe Purging:

The probe condition was checked for structural integrity and suitability for monitoring before each use. After the probe had been driven to the desired sampling depth (3 feet), it was purged (evacuated) to remove ambient air. Typically purging can be accomplished using either a hand pump, peristaltic pump, or pump attached to the top of the probe via PVC or polyethylene tubing. The GEM2000 used in this event (see GEM2000 *Infrared Gas Analyzer*) was designed with an internal pump that did actively draw the vapor sample into the instrument for continual analysis.

The GEM2000 was used alone, due to the shallow depth of each probe in this monitoring event, for the purging of each probe point via the internal pump. Purge time was based on the volume of the probe sampling system, and purging done long enough to remove 1 to 5 casing volumes of air from the system. Purge volumes and times were recorded within the GEM2000, which are presented as Landfill Gas Monitoring Results, and also on field forms. A particulate-moisture trap was placed between the probe and the GEM2000 to prevent damage to the instrument. This trap was checked before each use or sampling point due to the soil make up (sand and silt) with the possible vacuum pickup of particulate from the probe. The GEM2000 was directly connected to the vapor probe with ¼" Teflon tubing.

Results and Findings

SAMPLE NUMBER SES-	CH_4%	Co_2 %	O_2%	ATMOSPHERIC PRESSURE "HG"	Temp. DegF	DEPTH FEET
1	0.1	0	20.5	30.06	98	3ft
2	0	0	20.7	30.06	98	3ft
3	0	0	20.7	30.05	98	3ft
4	0.1	0	20.9	30.06	98	3ft
5	0.1	0	20.8	30.06	98	3ft
6	0.1	0	20.8	30.05	98	3ft
7	0.1	0	20.9	30.05	98	3ft
8	0.1	0	21.0	30.04	98	3ft
9	0.1	0	21.2	30.05	98	3ft
10	0.1	0	20.8	30.05	98	3ft
11	0.1	0	20.7	30.05	98	3ft
12	0.1	0	20.7	30.04	98	3ft
13	0.2	0	21.3	30.04	98	3ft
14	0.1	0	21.0	30.05	98	3ft
15	0.2	0	21.1	30.05	98	3ft
16	0.2	0	21.1	30.04	98	3ft
17	0.2	0	21.1	30.04	98	3ft
18	0.3	0	21.0	30.05	98	3ft
19	0	0	20.9	30.04	98	3ft
20	0.1	0	21.1	30.03	98	3ft
21	0.1	0	21.2	30.03	98	3ft
22	0.2	0	21.0	30.02	98	3ft
23	0.2	0	21.0	30.01	98	3ft
24	0.2	0	21.0	30.02	98	3ft
25	0.2	0	21.1	30.01	98	3ft
26	0.2	0	21.2	30.01	98	3ft
27	0.2	0	20.8	30.01	98	3ft

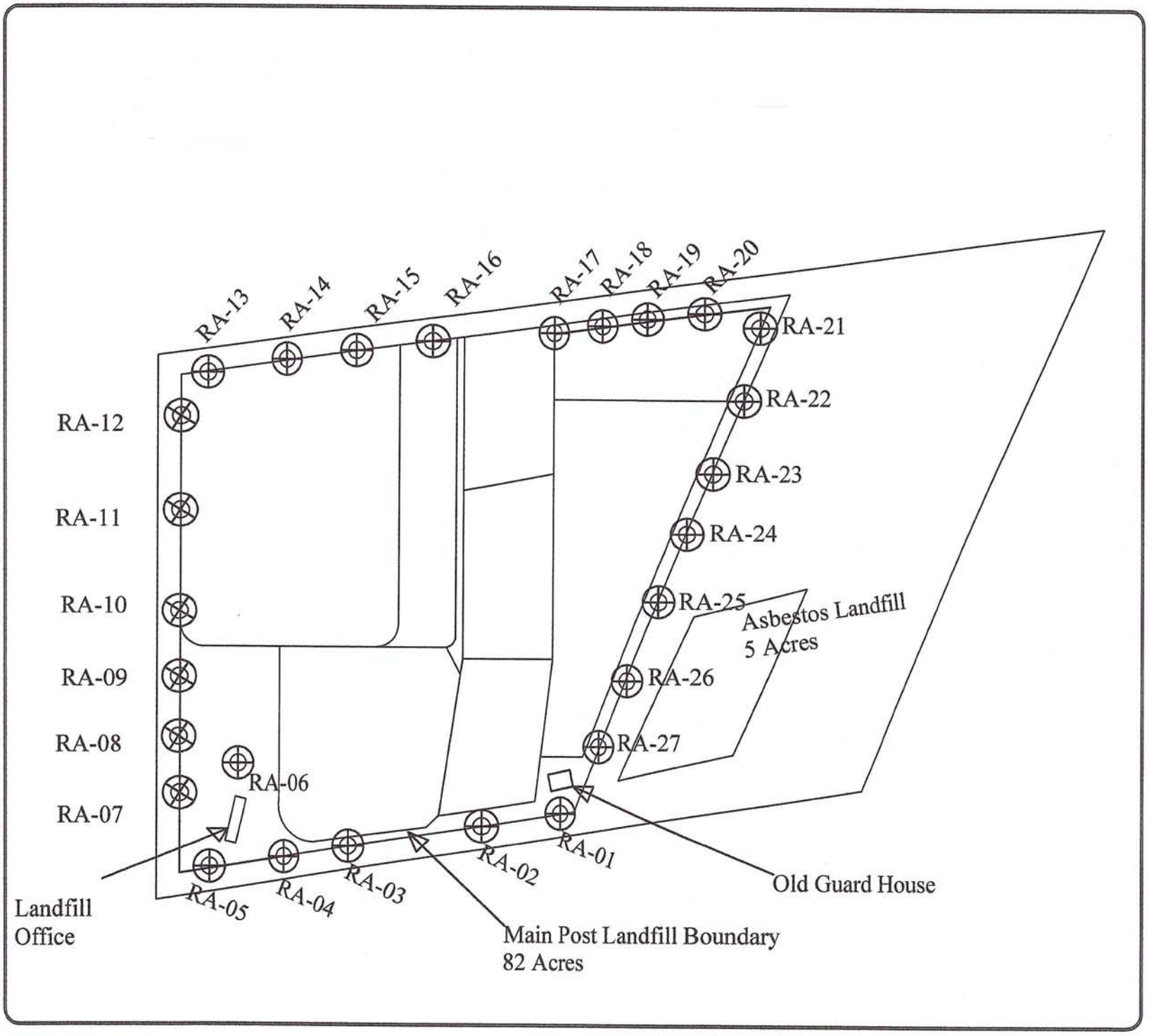
Discussion

This quarterly monitoring was conducted in accordance with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities. This field investigation as shown in the results, verified non-detectable levels of methane at the facility's property boundary and within all facility's structures.

Sincerely,

Oscar E. Ayala
SafeNet Services, LLC
cc: file

Appendix A



SafeNet
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(915) 587-6900

WHITE SANDS
MISSILE RANGE

METHANE
MONITORING

LOCATION
White Sands
Missile Range
Landfill

LEGEND

Samples
Location

REVISIONS

INSPECTED BY:
O.E. AYALA
DRAWN BY:
J.E. AYALA
DATE:
06/18/07
PROJECT#:

SHEET #:

QUARTERLY
LANDFILL METHANE MONITORING
THIRD QUARTER 2007
WHITE SANDS MISSILE RANGE

Submitted to:

Joe Talamantes

U.S. Army
White Sands Missile Range
National Range Support Directorate
Engineering Division
White Sands Missile Range, New Mexico 88002

Submitted by:

SafeNet Environmental Services, LLC
6500 Boeing Suite T-1
El Paso, Texas 79925

CH_4 Gas survey completed and prepared by:

Concurrence:

09/16/2007
Oscar E. Ayala

09/18/2007
Juan E. Ayala

QUARTERLY LANDFILL GAS MONITORING
THIRD QUARTER 2007
THE MAIN POST CONSTRUCTION AND DEMOLITION LANDFILL
WHITE SANDS MISSILE RANGE

Executive Summary

The following report pertains to the ongoing quarterly landfill gas monitoring for the landfill located at the Main Post Construction and Demolition Landfill, White Sands Missile Range, New Mexico. At the request of White Sands Missile Range, SafeNet Services, LLC (SafeNet) conducted the gas monitoring on September 18, 2007, for the Third quarter of 2007.

Findings:

Methane Gas- Results indicate that no methane gas was detected at any of the sampling points.

This facility has a fence line of 2420.58 meters or 7941.54 feet enclosed by chain-linked and barbed wire fence. The reported site lithology is a sandy soil with some silt to thirty feet. This quarterly monitoring was conducted in accordance with, and to comply in part with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities.

The requirements are to ensure the concentration of explosive gases generated by this facility or practice comply with 20 NMAC 9.1, Subpart IV 403 C, and shall not exceed:

1.) Twenty-five percent (25%) of the lower explosive limit for the gases in facility structures (excluding gas control or recovery system components); and
2.) The lower explosive limit for gases at the property boundary.

On September 18, 2007, SafeNet personnel conducted monitoring operations for the possible migration of methane (CH_4) as directed by the Regulatory Compliance Office, White Sands Missile Range (WSMR) and in compliance with New Mexico Environmental Department, Solid Waste Bureau. Landfill gas monitoring points were selected within the landfill area at the property boundary at approximately 300-foot intervals. Each sampling point was taken at a total depth of three (3) feet below ground surface (bgs.) utilizing soil gas sampling technology. Monitoring points are presented in the Methane Sampling Location Map located in the Appendix. This monitoring event also encompassed all buildings within the permitted facility. All gas-monitoring points were conducted by constructing monitoring probes using the soil gas vapor impact probe system, and a Landtec GEM2000 portable gas detection meter. The GEM2000 meter was properly calibrated as to the manufactures specifications and utilized within the instrument's manufactures criteria for monitoring landfill gas. Identical methodology was utilized throughout the gas-monitoring event.

A total of twenty-seven (27) gas-monitoring points were conducted, within the landfill permitted area. Results from our on-site field analyses are presented as Landfill Gas Monitoring Results, downloaded from the Landtec GEM2000.

Introduction and Scope

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To comply with the Main Post Landfill Operating Plan application permit, the quarterly landfill methane gas monitoring will be conducted in the following manner.

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6.) Report all procedures used and the results in a quality that can be submitted to the State of New Mexico, Environment Department.

Sampling Plan

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- The soil probe was withdrawn to allow for the placement of the sampling tip (AMS Retract-A-Tip).
- Place the sampling tip onto the 5/8-inch hollow rod and a probe adapter that allowed for a ¼" ID Teflon sample tube to be attached. The heavy-duty hammer drill was used to drive the sample to a total depth of 3 feet below ground surface.
- The Landtec- GEM2000 was then attached to the Teflon tubing and a sample was collected. (See: GEM2000 *Infrared Gas Analyzer*).
- The probe was withdrawn from the hole and the screen checked for plugging or damage, when necessary probe screens were replaced as to insure appropriate consecutive readings and functionality of the probe.
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2	0	0	20.3	29.90	79	3ft
3	0.1	0	20.9	29.90	79	3ft
4	0	0	21.3	29.90	79	3ft
5	0.1	0	21.1	29.90	79	3ft
6	0.1	0	20.9	29.90	79	3ft
7	0.1	0	20.9	29.90	79	3ft
8	0	0	21.1	29.90	79	3ft
9	0.2	0	20.8	29.90	79	3ft
10	0.1	0	20.7	29.90	79	3ft
11	0.1	0	20.9	29.90	79	3ft
12	0.3	0	20.9	29.90	79	3ft
13	0.1	0	21.1	29.90	79	3ft
14	0.1	0	21.1	29.90	79	3ft
15	0.1	0	21.0	29.90	79	3ft
16	0.0	0	20.8	29.90	79	3ft
17	0.1	0	20.9	29.90	79	3ft
18	0.1	0	21.1	29.90	79	3ft
19	0.2	0	21.2	29.90	79	3ft
20	0.1	0	21.0	29.90	79	3ft
21	0.1	0	20.9	29.90	79	3ft
22	0.1	0	21.2	29.90	79	3ft
23	0	0	21.1	29.90	79	3ft
24	0.2	0	20.9	29.90	79	3ft
25	0.1	0	21.1	29.90	79	3ft
26	0.1	0	21.1	29.90	79	3ft
27	0.0	0	20.1	29.90	79	3ft

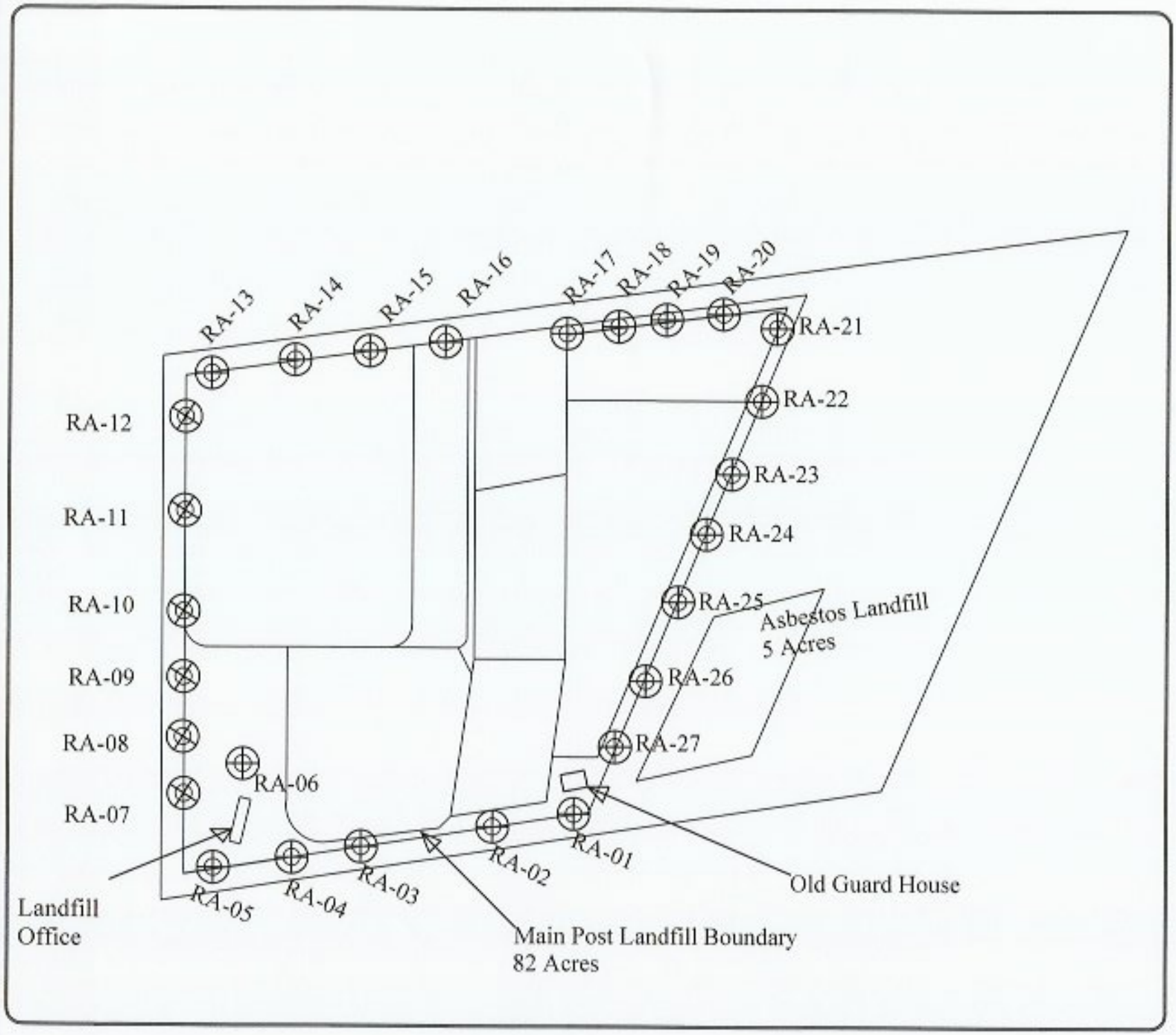
Discussion

This quarterly monitoring was conducted in accordance with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities. This field investigation as shown in the results, verified non-detectable levels of methane at the facility's property boundary and within all facility's structures.

Sincerely,

Oscar E. Ayala
SafeNet Services, LLC
cc: file

Appendix A



SafeNet

Environmental Services LLC
6500 Boeing Suite T-1
El Paso, Texas 79925
(915) 587-6900

WHITE SANDS MISSILE RANGE

METHANE MONITORING

LOCATION
White Sands Missile Range Landfill

LEGEND

Samples Location

REVISIONS

INSPECTED BY: O.E. AYALA
DRAWN BY: J.E. AYALA
DATE: 09/18/07
PROJECT #:
SHEET #:

QUARTERLY
LANDFILL METHANE MONITORING
FOURTH QUARTER 2007
WHITE SANDS MISSILE RANGE

Submitted to:

Joe Talamantes

U.S. Army
White Sands Missile Range
National Range Support Directorate
Engineering Division
White Sands Missile Range, New Mexico 88002

Submitted by:

SafeNet Environmental Services, LLC
6500 Boeing Suite T-1
El Paso, Texas 79925

CH_4 Gas survey completed and prepared by:

Concurrence:

12/04/2007
Oscar E. Ayala

12/04/2007
Juan E. Ayala

QUARTERLY LANDFILL GAS MONITORING
FOURTH QUARTER 2007
THE MAIN POST CONSTRUCTION AND DEMOLITION LANDFILL
WHITE SANDS MISSILE RANGE

Executive Summary

The following report pertains to the ongoing quarterly landfill gas monitoring for the landfill located at the Main Post Construction and Demolition Landfill, White Sands Missile Range, New Mexico. At the request of White Sands Missile Range, SafeNet Services, LLC (SafeNet) conducted the gas monitoring on December 4, 2007, for the Fourth quarter of 2007.

Findings:

Methane Gas- Results indicate that no methane gas was detected at any of the sampling points.

This facility has a fence line of 2420.58 meters or 7941.54 feet enclosed by chain-linked and barbed wire fence. The reported site lithology is a sandy soil with some silt to thirty feet. This quarterly monitoring was conducted in accordance with, and to comply in part with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities.

The requirements are to ensure the concentration of explosive gases generated by this facility or practice comply with 20 NMAC 9.1, Subpart IV 403 C, and shall not exceed:

1.) Twenty-five percent (25%) of the lower explosive limit for the gases in facility structures (excluding gas control or recovery system components); and
2.) The lower explosive limit for gases at the property boundary.

On December 4, 2007, SafeNet personnel conducted monitoring operations for the possible migration of methane (CH_4) as directed by the Regulatory Compliance Office, White Sands Missile Range (WSMR) and in compliance with New Mexico Environmental Department, Solid Waste Bureau. Landfill gas monitoring points were selected within the landfill area at the property boundary at approximately 300-foot intervals. Each sampling point was taken at a total depth of three (3) feet below ground surface (bgs.) utilizing soil gas sampling technology. Monitoring points are presented in the Methane Sampling Location Map located in the Appendix. This monitoring event also encompassed all buildings within the permitted facility. All gas-monitoring points were conducted by constructing monitoring probes using the soil gas vapor impact probe system, and a Landtec GEM2000 portable gas detection meter. The GEM2000 meter was properly calibrated as to the manufactures specifications and utilized within the instrument's manufactures criteria for monitoring landfill gas. Identical methodology was utilized throughout the gas-monitoring event.

A total of twenty-seven (27) gas-monitoring points were conducted, within the landfill permitted area. Results from our on-site field analyses are presented as Landfill Gas Monitoring Results, downloaded from the Landtec GEM2000.

Introduction and Scope

The Main Post Construction and Demolition Landfill (landfill facility) is located at White Sands Missile Range, New Mexico. The facility has a fence line of 2420.58 meters or 7941.54 feet enclosed by chain-linked and barbed wire fence with two buildings. One building is currently utilized as a guardhouse and the other is a vacant guardhouse within the property boundary and is represented in this report as "Methane Sampling Location Map" located in the Appendix. The stratigraphy beneath the site is a sandy soil with some silt to thirty feet, as reported by WSMR. Examination of the retained soil retrieved from around the soil vapor probes during the sampling process verified this to a depth of three feet.

To comply in part with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities, quarterly landfill gas monitoring must be conducted for explosive gases. The requirements are to ensure the concentration of explosive gases generated by this facility or practice comply with 20 NMAC 9.1, Subpart IV 403 C, and shall not exceed:

1.) Twenty-five percent (25%) of the lower explosive limit for the gases in facility structures (excluding gas control or recovery system components); and
2.) The lower explosive limit for gases at the property boundary.

The sampling probe used in this monitoring event is a patented, re-usable; AMS Retract-A-Tip designed as a survey tool for collection of discrete soil gas samples. It is constructed of hardened stainless steel and is designed to open when the drive extensions are retracted by 2 inches. The sampling probe was driven into the soil using a heavy duty Bosch 11245 rotary hammer drill with a 5/8-inch diameter x 3-foot long extension drive rod. Once installed, the drive extension was retracted 2 inches. In this open position, a gas sample was collected utilizing a Landtec GEM2000 meter. Teflon tubing was used in conjunction with the GEM2000 for soil gas transference media.

To comply with the Main Post Landfill Operating Plan application permit, the quarterly landfill methane gas monitoring will be conducted in the following manner.

1.) Request and receive utility clearance from White Sands Missile Range.

2.) Non-discrete monitoring points will be installed along the facility perimeter at 300-foot intervals (27 collection points were identified).

3.) Monitoring points will include the inside of all facility structures; a Photo Ionization Detector (intrinsically safe) will be utilized before entering closed structures.

4.) Bar-hole or soil gas vapor probes will be installed for monitoring points to a depth of three feet.

5.) A Landtec GEM2000 Gas Analyzer or other combustible gas indicator (GEM2000) that utilizes the catalytic oxidation method or thermal conductivity will be used to detect and record combustible gas levels. Notify Regulatory Compliance Office, WSMR immediately if methane concentrations are detected at or near the limiting concentrations.

6.) Report all procedures used and the results in a quality that can be submitted to the State of New Mexico, Environment Department.

Sampling Plan

On December 4, 2007 SafeNet conducted monitoring operations for the possible migration of methane (CH_4) as directed by the WSMR Regulatory Compliance Office, in compliance with New Mexico Environmental Department, Solid Waste Bureau. A permit was obtained from WSMR as to the location of any buried utility lines (gas, water, electrical) at, near, or crossing the property boundary. The only utility identified was a phone line located in front of the guardhouse area. This area was avoided during the sampling event. Landfill gas monitoring points were then selected within the landfill area at the property boundary at approximately 300-foot intervals utilizing a Trumeter measuring wheel. A soil gas vapor probe was installed at each monitoring point utilizing the following procedures:

(1) Typical Soil Gas Vapor Probe Installation (27 each at 300' intervals):

- A pilot hole was first installed utilizing a heavy-duty hammer drill and soil probe, a 5/8-inch diameter rod with a stainless steel tip, which was driven approximately 2 ½ feet into the soil. Soils showed to be sandy with little silt.

- The soil probe was withdrawn to allow for the placement of the sampling tip (AMS Retract-A-Tip).

- Place the sampling tip onto the 5/8-inch hollow rod and a probe adapter that allowed for a ¼" ID Teflon sample tube to be attached. The heavy-duty hammer drill was used to drive the sample to a total depth of 3 feet below ground surface.

- The Landtec- GEM2000 was then attached to the Teflon tubing and a sample was collected. (See: GEM2000 *Infrared Gas Analyzer*).

- The probe was withdrawn from the hole and the screen checked for plugging or damage, when necessary probe screens were replaced as to insure appropriate consecutive readings and functionality of the probe.

- Each location was identified by a round marker attached with tin-plated wire onto the chain-linked or barbwire fence that surrounded the property, thus allowing for future sampling reference points.

Note: Operators measured and recorded the depth of each probe to insure standardization with each probe placement.

(2) On-site structures

There are two on-site structures, one is a small concrete building used as a landfill office and the other is a vacant guardhouse. The monitoring measurement was taken 6 feet from the north wall of the vacant structure. Landscaping gravel has been placed around the landfill office; therefore the sample by the office was moved to approximately 30 feet north of the building. All results were data logged and downloaded to computer (See: *Results and Findings*).

(3) GEM2000 **Infrared Gas Analyzer**

The Landtec GEM2000 is a compact field instrument that can and was configured to analyze the methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) levels in landfill gas (LFG). It is an approved instrument in monitoring migration gases, active and passive gas extraction systems and measuring LFG at flares or other approved control systems. This instrument uses computer technology that displays on-screen menus to provide a simplified user interface for accurate data analysis and recording. All information collected was dated and time stamped and readings were stored in memory. The data was later downloaded via a serial connection to a computer, then inserted into our table template and submitted into our report as Landfill Gas Monitoring Results.

This unit works with a vacuum sample pump that draws a quantity of gas through the sample hose, in-line water trap and the user replaceable particulate filter, into a sample chamber. An infrared beam is projected, via sapphire windows, through the gas sample. On the other side of the chamber, methane and carbon dioxide detectors sense the beam. A microprocessor calculates the amount of infrared light absorbed at different wavelengths and determines the various gas concentrations.

When a sufficient amount of gas has entered the sample chamber, gas concentration levels were shown on the display as it stabilizes (approximately 60 THIRDs). The SafeNet technician, with a few keystrokes, stores the measurement data in memory utilizing a unique I.D. code, as well as the date and time.

(4) Combustible Gas Instrument Field Calibration

The Landtec GEM2000 Gas Analyzer utilizes an internal pump to pull air into the calibration map that is accessed by its microprocessor for baseline reference data. This reference data, as stated by the manufacture, was programmed into the GEM2000 during the factory calibration using various gas mixtures in an environmental chamber. The GEM2000 can be cleared of user calibration settings and restored to "factory settings" as needed. The factory calibration has been designed to give the best possible results over a wide range of conditions. However, SafeNet technicians performed "field calibrations" to improve the instrument's accuracy for this monitoring event. Each field calibration on-site was performed at stabilized working temperature. Whenever temperature changes occurred during the operation, the GEM2000 was re-calibrated (example: the cool of the morning to the hottest part of the day). Field calibration was performed using the manufacturer's recommended gas mixture for low concentrations which are 15/15 (15% methane, 15% carbon dioxide), 4 % oxygen and balance nitrogen, 15/15% and 4.0% oxygen/nitrogen. (See Landtec GEM2000 Operation Manual for procedures)

(5) Probe Purging:

The probe condition was checked for structural integrity and suitability for monitoring before each use. After the probe had been driven to the desired sampling depth (3 feet), it was purged (evacuated) to remove ambient air. Typically purging can be accomplished using either a hand pump, peristaltic pump, or pump attached to the top of the probe via PVC or polyethylene tubing. The GEM2000 used in this event (see GEM2000 *Infrared Gas Analyzer*) was designed with an internal pump that did actively draw the vapor sample into the instrument for continual analysis.

The GEM2000 was used alone, due to the shallow depth of each probe in this monitoring event, for the purging of each probe point via the internal pump. Purge time was based on the volume of the probe sampling system, and purging done long enough to remove 1 to 5 casing volumes of air from the system. Purge volumes and times were recorded within the GEM2000, which are presented as Landfill Gas Monitoring Results, and also on field forms. A particulate-moisture trap was placed between the probe and the GEM2000 to prevent damage to the instrument. This trap was checked before each use or sampling point due to the soil make up (sand and silt) with the possible vacuum pickup of particulate from the probe. The GEM2000 was directly connected to the vapor probe with ¼" Teflon tubing.

Results and Findings

SAMPLE NUMBER SES-	CH_4%	CO_2 %	O_2%	ATMOSPHERIC PRESSURE "HG"	Temp. DegF	DEPTH FEET
1	0.1	0	19.6	26.07	70	3ft
2	0	0	19.5	26.07	70	3ft
3	0.1	0	19.6	26.07	70	3ft
4	0	0	19.7	26.07	70	3ft
5	0.1	0	19.7	26.07	70	3ft
6	0.1	0	19.8	26.07	70	3ft
7	0.1	0	19.8	26.07	70	3ft
8	0.1	0	19.9	26.07	70	3ft
9	0.1	0	19.9	26.07	70	3ft
10	0.1	0	19.8	26.07	70	3ft
11	0.1	0	20.0	26.07	70	3ft
12	0	0	20.2	26.07	70	3ft
13	0	0	19.9	26.07	70	3ft
14	0.1	0	19.8	26.07	70	3ft
15	0	0	19.6	26.07	70	3ft
16	0.1	0	20.0	26.07	70	3ft
17	0	0	20.0	26.07	70	3ft
18	0.2	0	20.1	26.07	70	3ft
19	0.1	0	20.1	26.07	70	3ft
20	0	0	20.3	26.07	70	3ft
21	0.1	0	20.5	26.07	70	3ft
22	0	0	20.2	26.07	70	3ft
23	0.1	0	20.1	26.07	70	3ft
24	0.2	0	20.4	26.07	70	3ft
25	0.1	0	19.6	26.07	70	3ft
26	0.1	0	19.8	26.07	70	3ft
27	0.0	0	20.2	26.07	70	3ft

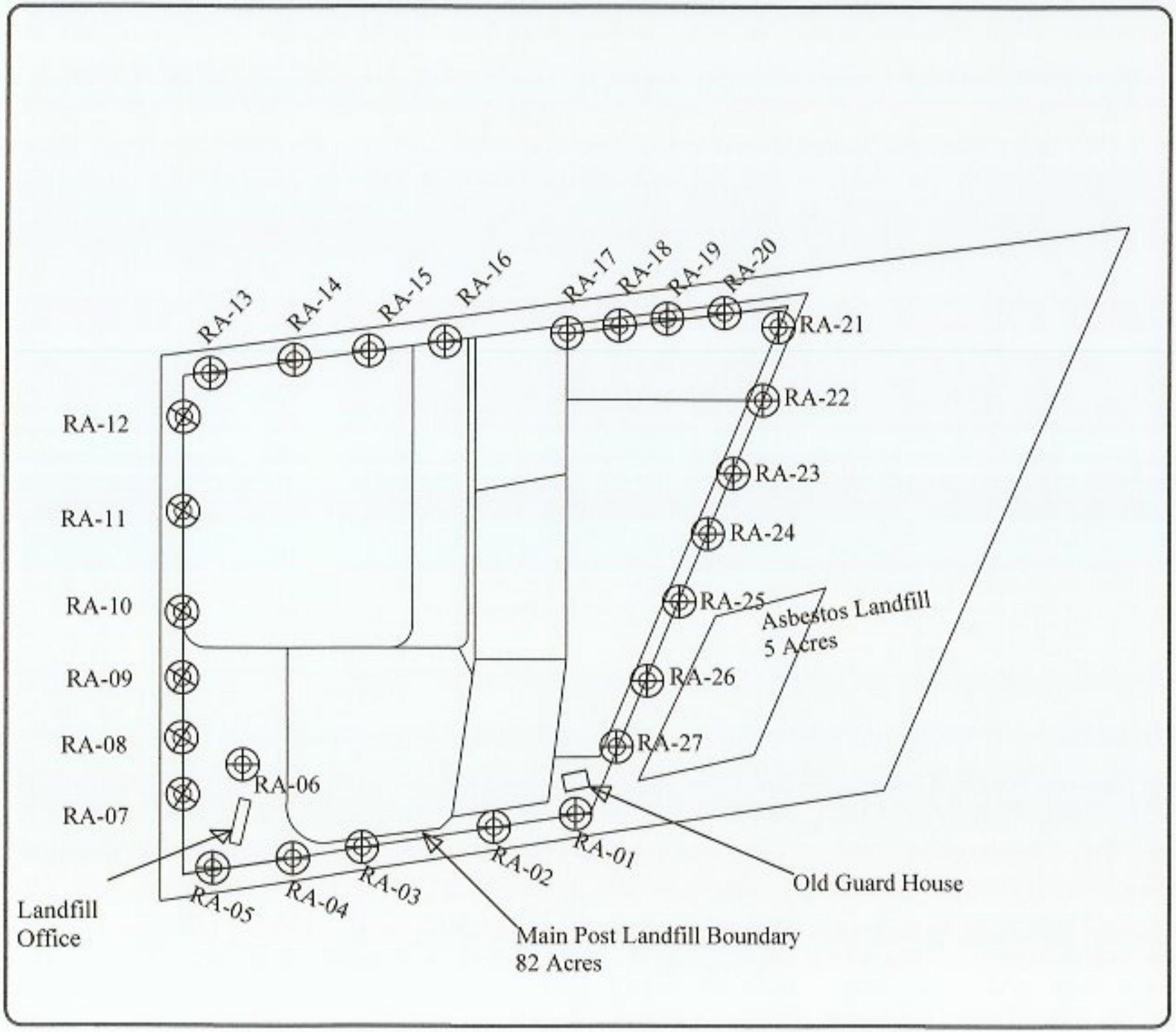
Discussion

This quarterly monitoring was conducted in accordance with the New Mexico Environmental Department, Solid Waste Bureau, 20 NMAC 9.1 permitting for solid waste facilities. This field investigation as shown in the results, verified non-detectable levels of methane at the facility's property boundary and within all facility's structures.

Sincerely,

Oscar E. Ayala
SafeNet Services, LLC
cc: file

Appendix A



SafeNet
Environmental Services LLC
6500 Boeing Suite T-1
El Paso, Texas 79925
(915) 587-6900

WHITE SANDS MISSILE RANGE

METHANE MONITORING

LOCATION
White Sands Missile Range Landfill

LEGEND
Samples Location

REVISIONS

INSPECTED BY: O.E. AYALA
DRAWN BY: J.E. AYALA
DATE: 12/04/2007
PROJECT #:
SHEET #:

I. 2007 General Information Form

Facility Information January 1-December 31, 2007

Permit/Registration #

County: Socorro Check One: ☑ Open Facility ☐ Closed Facility

Facility Name WSMR PHETS Landfill Phone 575-678-1007

Contact Person Javier Mendoza E-Mail Address javier.mendoza@us.army.mil

Facility Mailing Address 100 Headquarters Ave. ATTN: IMSW-WSM-PW

City: White Sands Missile Range (WSMR) State: NM Zip Code: 88002

Physical Location of Facility (City/County Road) Approximately 13 miles south of Stallion Range Center, between Range Roads 7 and 13, WSMR, NM. T 8 S, R 4 E, portions of Sections 13 & 14

Facility Operator US Army WSMR Phone 575-678-8966

Contact Person Thomas A. Ladd E-mail Address ta.ladd@us.army.mil

Street Address 100 Headquarters Ave. ATTN: IMSW-WSM-PW

City WSMR State: NM Zip Code: 88002

Facility Owner Same Phone

Contact Person E-mail Address

Street Address

City State: Zip Code:

Land Owner US Army WSMR Phone 575-678-2220

Contact Person Gary D. Giebel E-mail Address gary.giebel@us.army.mil

Street Address 100 Headquarters Ave. ATTN: IMSW-WSM-ZA

City WSMR State: NM Zip Code: 88002

Financial Assurance

☑ Check One Box

☐ Updated Financial Assurance Attached

☐ Financial Assurance required but not Attached (Explain on Comment Sheet)

☑ Financial Assurance not required (Explain on Comment Sheet)

Questions?
Call 505-827-0197,
or 505-476-3561

Landfills Only

Check One: ☑ Open Landfill ☐ Closed Landfill

Capacity Information for Open Landfills ***(If not provided explain on Comment Sheet)***

Provide Landfill Capacity **Used** during 2006 177 (Cubic Yards)

Provide **Remaining** Landfill Capacity 435103 (Cubic Yards) (See *V. Capacity Worksheet*.)

Provide **Remaining** Landfill Life 114 (Years) (See *V. Capacity Worksheet*.)

Number of acres at current site, not permitted, that could be used for diposal in the future

Were there any changes in operations that reduced the active life of the landfill by 25% or more?

☑ No ☐ Yes (Attach Notification)

Monitoring Results for Open Landfills (and Closed Landfill in Post-Closure Care)

☑ **No** ☐ **Yes** Summary of Landfill Gas Monitoring Results Enclosed (if not explain on Comment Sheet)

☑ **No** ☐ **Yes** Summary of Landfill Ground Water Monitoring Results Enclosed (if not explain on Comment Sheet)

☑ **No** ☐ **Yes** Summary of Leachate Generated & Treated or Disposed Enclosed (if not explain on Comment Sheet)

Closure and Post-Closure Activity Date of Closure

Total Acreage Used for Disposal (as of 12/31/06) (Acres)

Intermediate Cover (Acres) Area Seeded (Acres)

Total Acreage with Final Cover Installed (per Closure Plan) (Acres)

II. 2007 Material and Solid Waste Management Form

Facility Name: WSMR PHETS Landfill	**PRINT** Name, Title and Telephone # of the Person Completing Form: James Thompson, Task Coordinator, 575-678-1941
County: Dona Ana — Permit or Registration #	Facility Type: ☑ Landfill ☐ Recycling ☐ Composting ☐ Transfer/Convenience Center

	Material Type (See Instructions)	Method ☒ Mark One: Weighed	Method ☒ Mark One: Estimated	Waste Origin: Amount of In-State Material Received in **Tons** (a)	Waste Origin: Amount Out-of State Materials Received in **Tons** (b)	Managed On-Site: Landfilled or Treated (c)	Managed On-Site: Composted or Mulched (d)	Managed On-Site: Beneficially Used (e)	Sent Off-Site to be: Treated, Disposed, Incinerated (f)	Sent Off-Site to be: Recycled, Mulched, Composted (g)	Sent Off-Site to be: Beneficially Used (h)	Sent to: Provide Facility Name, City and State (i)
1	MSW											
2	C & D		x			96.05						WSMR PHETS Landfill, WSMR, NM
3	Clean Fill											
Special Wastes:												
4	Industrial Waste											
5	Regulated Asbestos											
6	Infectious Waste											
7	Ash											
8	PCS											
9	Offal											
10	Bio-Solids (Treated Sewage Sludge)											
11	Other Sludges											
12	Other Special Waste											
Other Materials:												
13	Brush/Green Waste											
14	Scrap Tires											
15	Motor Oil											
16	Antifreeze											
17	Lead Acid Batteries											
18	HHW											
19	Other Wastes											
20	**TOTAL**					96.05						

Please refer to the enclosed tables *Volume to Weight Conversion Factors* to convert cubic yards and gallons to TONS.

Questions?
Call 505-827-0197
or 505-476-3561

III. 2007 Recyclable Materials Form

Facility Name: WSMR PHETS Landfill	**PRINT** Name, Title & Telephone # of Person Completing Form: James Thompson, Task Coordinator, 575-678-1941
County: Socorro / Permit or Registration #	Facility Type: ☑ Landfill ☐ Recycling ☐ Composting ☐ Transfer/Convenience Center

	Type of Recyclable	Method ☒ Mark One: Weighed	Method: Estimated	Material Origin: Amount of In-State Materials Received in **Tons** (a)	Material Origin: Amount of Out-of-State Materials Received in **Tons** (b)	Managed On-Site: (c) Beneficially Used or Re-used	Sent Off-Site to be: (d) Recycled or Processed	Sent Off-Site to be: (e) Beneficially Used	Facility sent to: (f) Provide Facility Name and City/State
Paper:									
1	Mixed Paper								
2	Cardboard (OCC)								
3	Newspaper (ONP)								
4	Office Paper								
5	Phone Books								
6	Chip Board								
Containers:									
7	Plastics								
8	Aluminum								
9	Steel Cans								
10	Glass								
11	Mixed Containers								
Other Materials:									
12	Scrap Metals/ White Goods								
13	Carpet Padding								
14	Pallets								
15	Electronic Scrap								
16	Plastic Films								
17	Other Plastics								
18	Household Items								
19	Textiles/Clothing								
20	Other								
21	**TOTAL**								

Please refer to the enclosed tables *Volume to Weight Conversion Factors* to convert cubic yards and gallons to TONS.

Questions?
Call 505-827-0197
or 505-476-3561

IV. 2007 Comment Sheet

Name of Facility:	WSMR PHETS Landfill
Name of Person completing form:	James Thompson, White Sands Technical Services, LLC

Financial Assurance not enclosed because:

Not necessary since WSMR is a Federal government facility and is exempt from this requirement.

Gas Monitoring Results not enclosed because:

C&D Landfills are exempt from gas monitoring.

Ground Water Monitoring Results not enclosed because:

C&D Landfills are exempt from groundwater monitoring.

Leachate Generation Report not enclosed because:

C&D Landfills are exempt from leachate generation reporting.

No leachate collection system exists.

Capacity Information not provided because:

Calculations from the capacity worksheet showed greater than 1000 years life. Thus, WSMR maintained the 114 years calculated in 2006.

Questons?
Call 505-827-0197or 505-476-3561

Revised 12/13/07

V. Capacity Worksheet

Landfill Capacity Calculation Worksheet for__ WSMR PHETS Landfill

All owners operators are required to provide information regarding landfill capacity. To calculate your landfill's remaining capacity you may use this Excel worksheet, a terrain computer model program such as "TerraModel ToolPak", or hire an engineering firm to complete the calculations. If you use the worksheet it will calculate the values K, L and M for you, all you need to do is input the information as requested for Items A through J. A completed SAMPLE is also provided for your reference and to understand the process. Once completed include this form as part of your Annual Report.

There are threesheets in this data base. Click on the labeled tabs below to acess sheets

Enter your data here

Landfill information

(A)	Total landfill area	32.8	Acres
(B)	Total permitted volume (gross capacity)	952,512	Cubic yards
(C)	Thickness of liner protective soil layer	0.0	Feet
(D)	Thickness of final cover	2.5	Feet
(E)	Estimated percentage of gross capacity taken by daily and intermediate covers (if unknown, use default value of 25%)	25.0	%

Waste Information

Note: The worksheet allows you to enter the amount of received waste based on combination of two different types of records: tonnage and gate-yards. Combined, these records should represent the total received waste. Mark appropriate boxes if values are actual or estimated .

				Actual	Estimated
(F)	Waste received through 2006 based on tonnage (if no tonnage receipts, enter 0)	0.0	Tons	☐	☐
(G)	Waste received through 2006 based on gate-yards (if no gate-yard receipts, enter 0)	293,394	Cubic yards	☐	X
(H)	Waste received in 2007 based on tonnage (if no tonnage receipts, enter 0)	97.1	Tons	☐	X
(I)	Waste received in 2007 based on gate-yards (if no gate-yard receipts, enter 0)		Cubic yards	☐	☐
(J)	Compaction rate of emplaced waste (for example, enter 3 for 3 to 1 compaction). If wastes are being compacted but compaction rate is unknown, enter default value of 2 for a conservative result. If no compaction, enter 1.	2.0			

Calculations

Note: If the calculations are not performed automatically by the worksheet, complete them manually using the provided formulas.

Do not add values for K, L, and M

(K)	**Net waste capacity** K=B - A*(C+D)*4840/3 - B*E/100	582,091	Cubic yards
(L)	**Remaining permitted waste capacity** L=K - (F+H)*6/J - (G+I)/J	435,103	Cubic yards
(M)	**Estimated remaining site life** M=L/(H*6/J + I/J)	1,494.4	Years

Notes:

K: 4,840 = square yards in acre

L: 6 = number of uncompacted cubic yards in 1 ton

Form Completed by:___James Thompson_____

Telephone number:_____575-678-1941_____

I. 2007 General Information Form

Facility Information January 1-December 31, 2007

Permit/Registration #

County: Socorro — Check One: ☑ Open Facility ☐ Closed Facility

Facility Name WSMR Stallion Range Center Landfill — Phone 575-678-1007

Contact Person Javier Mendoza — E-Mail Address javier.mendoza@us.amry.mil

Facility Mailing Address 100 Headquarters Ave. ATTN: IMSW-WSM-PW

City: White Sands Missile Range (WSMR) — State: NM — Zip Code: 88002

Physical Location of Facility (City/County Road) Range Road 7, near Stallion Range Center, WSMR, NM

Facility Operator US Army WSMR — Phone 575-678-8966

Contact Person Thomas A. Ladd — E-mail Address ta.ladd@us.army.mil

Street Address 100 Headquarters Ave. ATTN: IMSW-WSM-PW

City WSMR — State: NM — Zip Code: 88002

Facility Owner Same — Phone

Contact Person — E-mail Address

Street Address

City — State: — Zip Code:

Land Owner US Army WSMR — Phone 575-678-2220

Contact Person Gary D. Giebel — E-mail Address gary.giebel@us.army.mil

Street Address 100 Headquarters Ave. ATTN: IMSW-WSM-ZA

City WSMR — State: NM — Zip Code: 88002

Financial Assurance

☑ Check One Box

☐ Updated Financial Assurance Attached

☐ Financial Assurance required but not Attached (Explain on Comment Sheet)

☑ Financial Assurance not required (Explain on Comment Sheet)

Questions?
Call 505-827-0197,
or 505-476-3561

Landfills Only

Check One: ☑ Open Landfill ☐ Closed Landfill

Capacity Information for Open Landfills ***(If not provided explain on Comment Sheet)***

Provide Landfill Capacity **Used** during 2006 819.9 (Cubic Yards)

Provide **Remaining** Landfill Capacity 34761 (Cubic Yards) (See *V. Capacity Worksheet*.)

Provide **Remaining** Landfill Life 42.4 (Years) (See *V. Capacity Worksheet*.)

Number of acres at current site, not permitted, that could be used for diposal in the future 40

Were there any changes in operations that reduced the active life of the landfill by 25% or more?

☑ No ☐ Yes (Attach Notification)

Monitoring Results for Open Landfills (and Closed Landfill in Post-Closure Care)

☑ **No** ☐ **Yes** Summary of Landfill Gas Monitoring Results Enclosed (if not explain on Comment Sheet)

☑ **No** ☐ **Yes** Summary of Landfill Ground Water Monitoring Results Enclosed (if not explain on Comment Sheet)

☑ **No** ☐ **Yes** Summary of Leachate Generated & Treated or Disposed Enclosed (if not explain on Comment Sheet)

Closure and Post-Closure Activity — Date of Closure

Total Acreage Used for Disposal (as of 12/31/06) (Acres)

Intermediate Cover 0 (Acres) — Area Seeded 0 (Acres)

Total Acreage with Final Cover Installed (per Closure Plan) 0 (Acres)

II. 2007 Material and Solid Waste Management Form

Facility Name: WSMR Stallion Range Center Landfill	**PRINT** Name, Title and Telephone # of the Person Completing Form: James Thompson, Task Coordinator, 575-678-1941
County: Socorro — Permit or Registration #	Facility Type: ☑ Landfill ☐ Recycling ☐ Composting ☐ Transfer/Convenience Center

	Material Type (See Instructions)	Method ☒ Mark One: Weighed	Method ☒ Mark One: Estimated	Waste Origin: Amount of In-State Material Received in **Tons** (a)	Waste Origin: Amount Out-of State Materials Received in **Tons** (b)	Managed On-Site: Landfilled or Treated (c)	Managed On-Site: Composted or Mulched (d)	Managed On-Site: Beneficially Used (e)	Sent Off-Site to be: Treated, Disposed, Incinerated (f)	Sent Off-Site to be: Recycled, Mulched, Composted (g)	Sent Off-Site to be: Beneficially Used (h)	Sent to: Provide Facility Name, City and State (i)
1	MSW											
2	C & D											
3	Clean Fill											
Special Wastes:												
4	Industrial Waste											
5	Regulated Asbestos											
6	Infectious Waste											
7	Ash											
8	PCS											
9	Offal											
10	Bio-Solids (Treated Sewage Sludge)											
11	Other Sludges											
12	Other Special Waste											
Other Materials:												
13	Brush/Green Waste											
14	Scrap Tires											
15	Motor Oil											
16	Antifreeze											
17	Lead Acid Batteries											
18	HHW											
19	Other Wastes		x			273.30						Office waste deposited at WSMR Stallion Landfill, WSMR, NM
20	**TOTAL**					273.30						

Please refer to the enclosed tables *Volume to Weight Conversion Factors* to convert cubic yards and gallons to TONS.

Questions?
Call 505-827-0197
or 505-476-3561

III. 2007 Recyclable Materials Form

Facility Name: WSMR Stallion Range Center Landfill	**PRINT** Name, Title & Telephone # of Person Completing Form: James Thompson, Task Coordinator, 575-678-1941
County: Socorro / Permit or Registration #	Facility Type: ☑ Landfill ☐ Recycling ☐ Composting ☐ Transfer/Convenience Center

	Type of Recyclable	Method ☒ Mark One: Weighed	Method: Estimated	Material Origin: Amount of In-State Materials Received in **Tons** (a)	Material Origin: Amount of Out-of-State Materials Received in **Tons** (b)	Managed On-Site: (c) Beneficially Used or Re-used	Sent Off-Site to be: (d) Recycled or Processed	Sent Off-Site to be: (e) Beneficially Used	Facility sent to: (f) Provide Facility Name and City/State
Paper:									
1	Mixed Paper								
2	Cardboard (OCC)								
3	Newspaper (ONP)								
4	Office Paper								
5	Phone Books								
6	Chip Board								
Containers:									
7	Plastics								
8	Aluminum								
9	Steel Cans								
10	Glass								
11	Mixed Containers								
Other Materials:									
12	Scrap Metals/ White Goods								
13	Carpet Padding								
14	Pallets								
15	Electronic Scrap								
16	Plastic Films								
17	Other Plastics								
18	Household Items								
19	Textiles/Clothing								
20	Other								
21	**TOTAL**								

Please refer to the enclosed tables *Volume to Weight Conversion Factors* to convert cubic yards and gallons to TONS.

Questions?
Call 505-827-0197
or 505-476-3561

IV. 2007 Comment Sheet

Name of Facility:	WSMR Stallion Range Center Landfill
Name of Person completing form:	James Thompson, White Sands Technical Services, LLC

Financial Assurance not enclosed because:

Not necessary since WSMR is a Federal government facility and is exempt from this requirement.

Gas Monitoring Results not enclosed because:

None. Exempt (NMAC 20.9.1.108.B)

Ground Water Monitoring Results not enclosed because:

None. Exempt (NMAC 20.9.1.108.B)

Leachate Generation Report not enclosed because:

None. Exempt (NMAC 20.9.1.108.B)

No leachate collection system exists.

Capacity Information not provided because:

Questons?
Call 505-827-0197or 505-476-3561

Revised 12/13/07

V. Capacity Worksheet

Landfill Capacity Calculation Worksheet for__ WSMR Stallion Range Center Landfill

All owners operators are required to provide information regarding landfill capacity. To calculate your landfill's remaining capacity you may use this Excel worksheet, a terrain computer model program such as "TerraModel ToolPak", or hire an engineering firm to complete the calculations. If you use the worksheet it will calculate the values K, L and M for you, all you need to do is input the information as requested for Items A through J. A completed SAMPLE is also provided for your reference and to understand the process. Once completed include this form as part of your Annual Report.

There are threesheets in this data base. Click on the labeled tabs below to acess sheets

Enter your data here

Landfill information

(A)	Total landfill area	5.0	Acres
(B)	Total permitted volume (gross capacity)	82,280	Cubic yards
(C)	Thickness of liner protective soil layer	0.0	Feet
(D)	Thickness of final cover	2.5	Feet
(E)	Estimated percentage of gross capacity taken by daily and intermediate covers (if unknown, use default value of 25%)	25.0	%

Waste Information

Note: The worksheet allows you to enter the amount of received waste based on combination of two different types of records: tonnage and gate-yards. Combined, these records should represent the total received waste. Mark appropriate boxes if values are actual or estimated .

				Actual	Estimated
(F)	Waste received through 2006 based on tonnage (if no tonnage receipts, enter 0)	1,987.5	Tons	☐	X
(G)	Waste received through 2006 based on gate-yards (if no gate-yard receipts, enter 0)		Cubic yards	☐	☐
(H)	Waste received in 2007 based on tonnage (if no tonnage receipts, enter 0)	273.3	Tons	☐	X
(I)	Waste received in 2007 based on gate-yards (if no gate-yard receipts, enter 0)		Cubic yards	☐	☐
(J)	Compaction rate of emplaced waste (for example, enter 3 for 3 to 1 compaction). If wastes are being compacted but compaction rate is unknown, enter default value of 2 for a conservative result. If no compaction, enter 1.	2.0			

Calculations

Note: If the calculations are not performed automatically by the worksheet, complete them manually using the provided formulas.

Do not add values for K, L, and M

(K)	**Net waste capacity** K=B - A*(C+D)*4840/3 - B*E/100	41,543	Cubic yards
(L)	**Remaining permitted waste capacity** L=K - (F+H)*6/J - (G+I)/J	34,761	Cubic yards
(M)	**Estimated remaining site life** M=L/(H*6/J + I/J)	42.4	Years

Notes:

K: 4,840 = square yards in acre

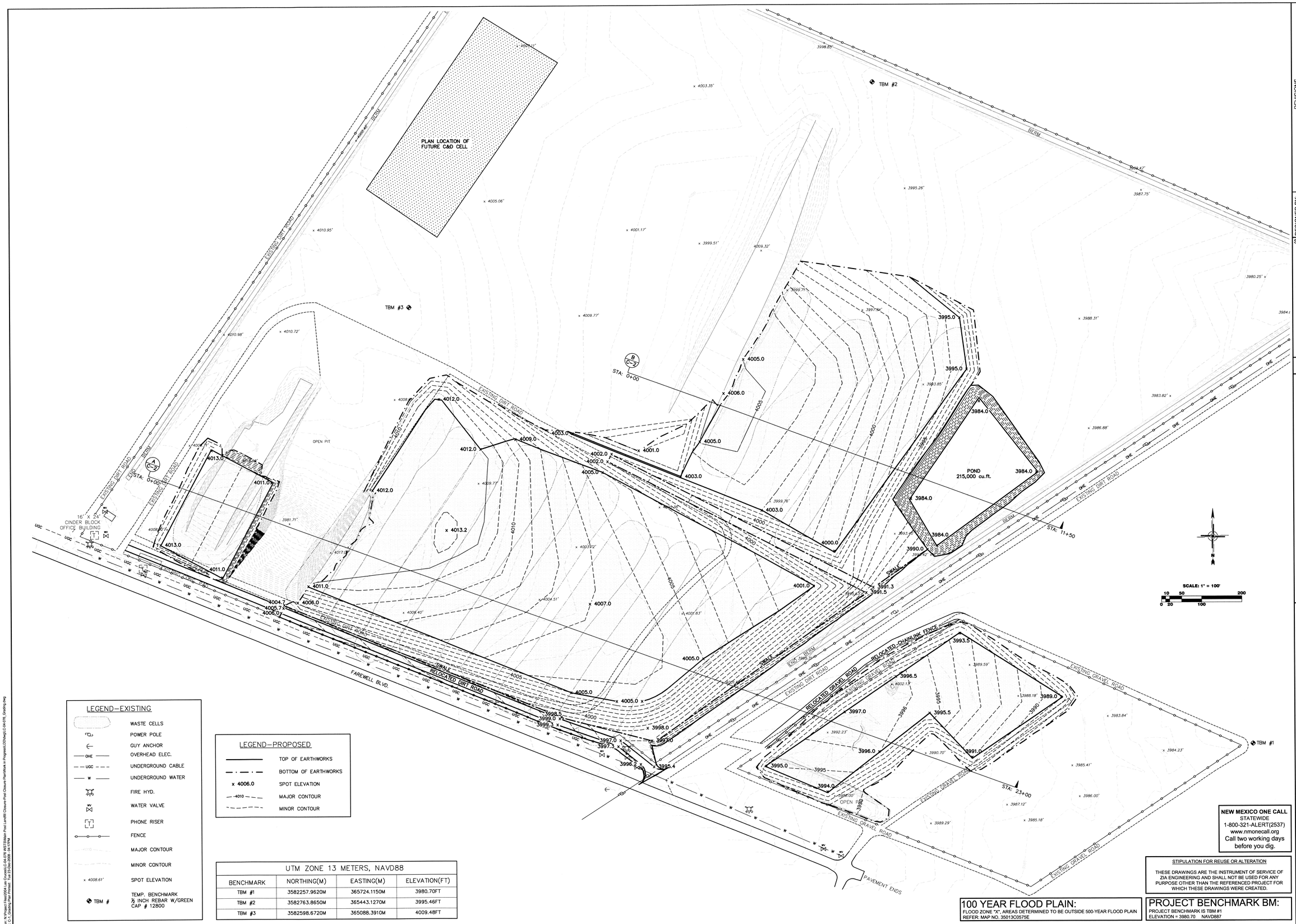
L: 6 = number of uncompacted cubic yards in 1 ton

Form Completed by:___James Thompson_____

Telephone number:_____575-678-1941_____

APPENDIX C

Construction Drawings [in pocket]



LEGEND–EXISTING

- WASTE CELLS
- POWER POLE
- GUY ANCHOR
- OVERHEAD ELEC.
- UNDERGROUND CABLE
- UNDERGROUND WATER
- FIRE HYD.
- WATER VALVE
- PHONE RISER
- FENCE
- MAJOR CONTOUR
- MINOR CONTOUR
- x 4008.61' SPOT ELEVATION
- TBM # TEMP. BENCHMARK ½ INCH REBAR W/GREEN CAP # 12800

LEGEND–PROPOSED

- TOP OF EARTHWORKS
- BOTTOM OF EARTHWORKS
- x 4006.0 SPOT ELEVATION
- 4010 MAJOR CONTOUR
- MINOR CONTOUR

UTM ZONE 13 METERS, NAVD88			
BENCHMARK	NORTHING(M)	EASTING(M)	ELEVATION(FT)
TBM #1	3582257.9620M	365724.1150M	3980.70FT
TBM #2	3582763.8650M	365443.1270M	3995.46FT
TBM #3	3582598.6720M	365088.3910M	4009.48FT

NEW MEXICO ONE CALL
STATEWIDE
1-800-321-ALERT(2537)
www.nmonecall.org
Call two working days before you dig.

STIPULATION FOR REUSE OR ALTERATION

THESE DRAWINGS ARE THE INSTRUMENT OF SERVICE OF ZIA ENGINEERING AND SHALL NOT BE USED FOR ANY PURPOSE OTHER THAN THE REFERENCED PROJECT FOR WHICH THESE DRAWINGS WERE CREATED.

100 YEAR FLOOD PLAIN:
FLOOD ZONE "X", AREAS DETERMINED TO BE OUTSIDE 500-YEAR FLOOD PLAIN
REFER: MAP NO. 35013C0575E

PROJECT BENCHMARK BM:
PROJECT BENCHMARK IS TBM #1
ELEVATION = 3980.70 NAVD887

REVISIONS

DATE:	COMMENT

DESIGNED BY: K.F.
DRAWN BY: K.C.
APPROVED BY: K.S.
DATE: 12-23-08

Seal: NEW MEXICO 16185 LICENSED PROFESSIONAL ENGINEER 12-23-2008

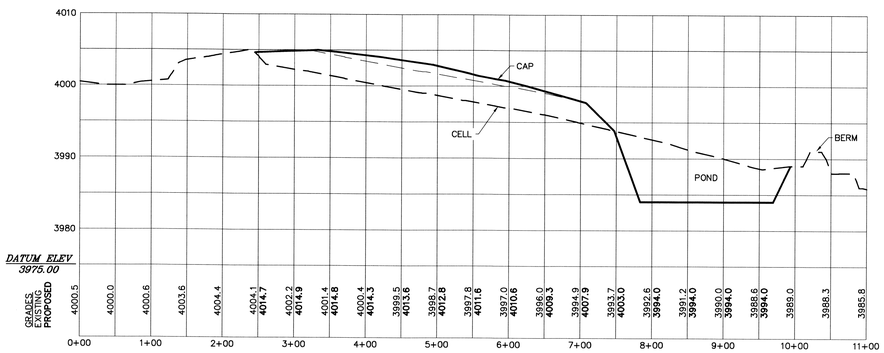
LC-04-076

ZIA ENGINEERING & ENVIRONMENTAL CONSULTANTS, LLC.
755 S. TELSHOR BLVD., SUITE F-201
LAS CRUCES, NEW MEXICO 88011
PHONE: (575) 532-1526
FAX: (575)532-1587

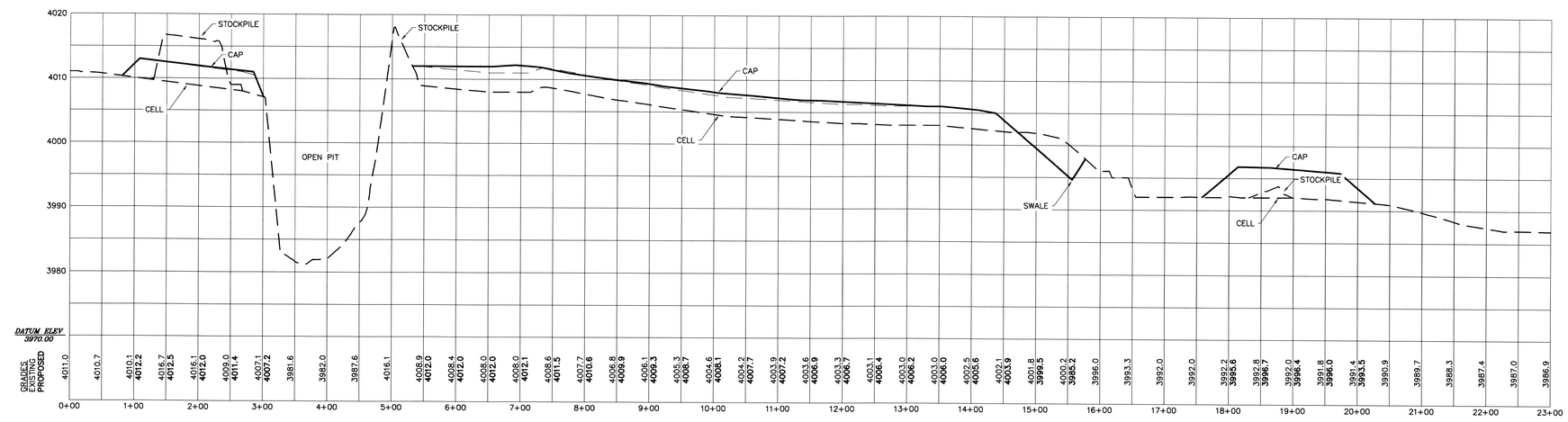
FINAL COVER GRADING SHEET
MAIN POST LANDFILL CLOSURE/POST CLOSURE PLAN
U.S. ARMY WHITE SANDS MISSLE RANGE

C-101

Location: V:\Project\Navy2004 Las Cruces\LC-04-076 WSTS\Main Post Landfill Closure-Post Closure Plan\Work in Progress\LC0\dwg\LC-04-076_Grading.dwg
Layout: C-101 Grading Plan Photo Date: 12-23-2008 9:57 AM



B
C-1
NORTHERN CAP SECTION
HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=10'



A
C-1
SOUTHERN CAP SECTION
HORIZONTAL SCALE: 1"=100'
VERTICAL SCALE: 1"=10'

SCALE: 1" = 100'
10 50 200
0 20 100

NEW MEXICO ONE CALL
STATEWIDE
1-800-321-ALERT(2537)
www.nmonecall.org
Call two working days before you dig.

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FLOOD ZONE "X", AREAS DETERMINED TO BE OUTSIDE 500-YEAR FLOOD PLAIN
REFER: MAP NO. 35013C0575E

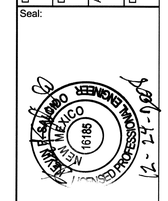
PROJECT BENCHMARK BM:
PROJECT BENCHMARK IS TBM #1
ELEVATION = 3980.70 NAVD887

REVISIONS

DATE:	COMMENT

DESIGNED BY: K.F.
DRAWN BY: K.C.
APPROVED BY: K.S.
DATE: 12-23-08

Seal:



LC-04-076

ZIA ENGINEERING & ENVIRONMENTAL CONSULTANTS, LLC.
755 S. TELSHOR BLVD., SUITE F-201
LAS CRUCES, NEW MEXICO 88011
PHONE: (575) 532-1526
FAX: (575)532-1587

FINAL COVER SECTIONS SHEET

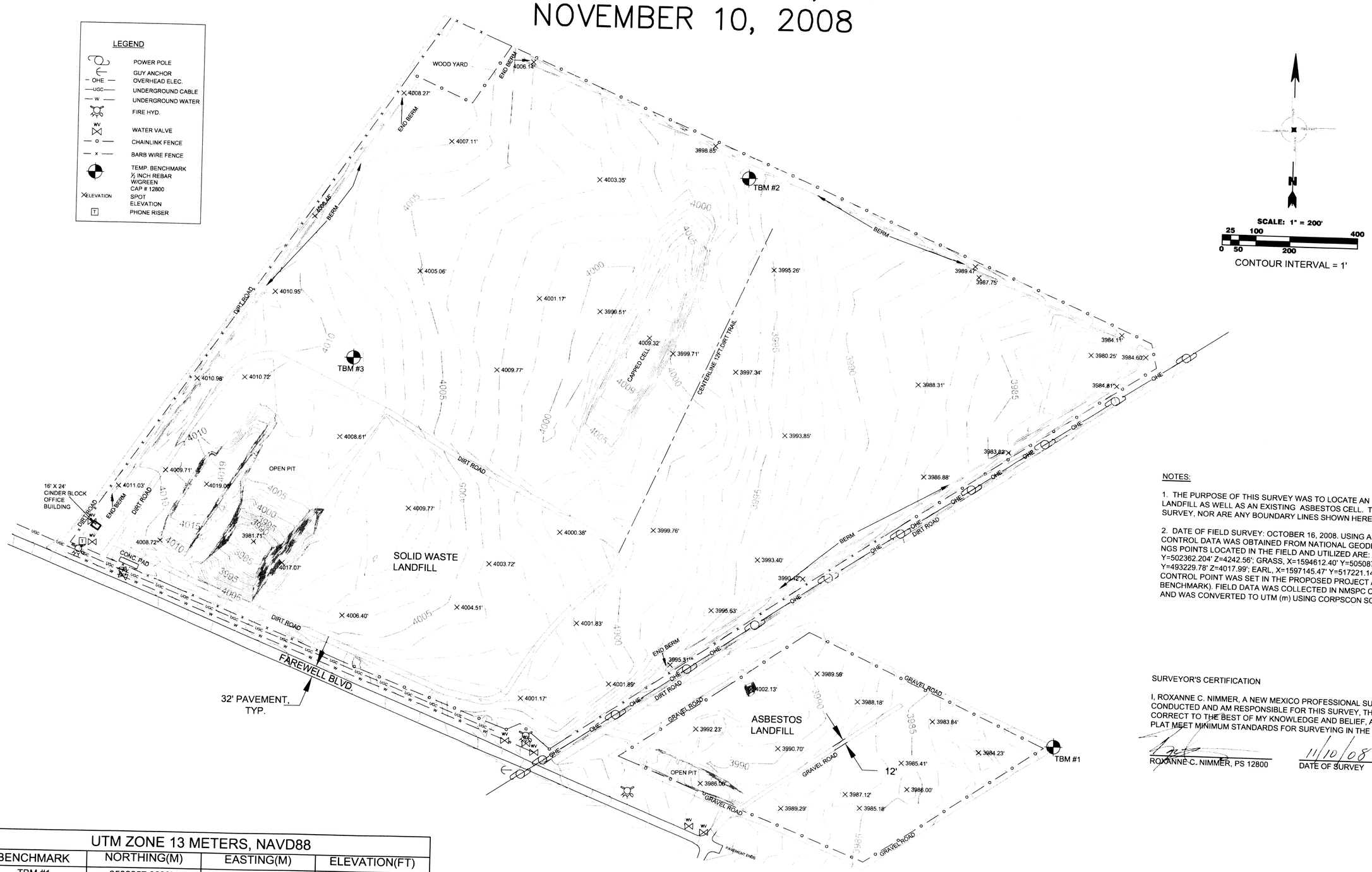
MAIN POST LANDFILL CLOSURE/POST CLOSURE PLAN

U.S. ARMY WHITE SANDS MISSLE RANGE

C-102

Location: N:\Project Files\2004 Lab Closure\LC-04-076 WSTM\Main Post Landfill Closure-Post Closure Plan\Work in Progress\LDO\dwg\LC-04-076_Sections.dwg
Input: C-2_Sections Printed: Tue 23-Dec-2008 04:36PM

TOPOGRAPHIC SURVEY OF MAIN POST LANDFILL
WHITE SANDS MISSILE RANGE
DONA ANA COUNTY, NM
NOVEMBER 10, 2008



NOTES:

1. THE PURPOSE OF THIS SURVEY WAS TO LOCATE AN EXISTING SOLID WASTE LANDFILL AS WELL AS AN EXISTING ASBESTOS CELL. THIS IS NOT A BOUNDARY SURVEY, NOR ARE ANY BOUNDARY LINES SHOWN HEREON.

2. DATE OF FIELD SURVEY: OCTOBER 16, 2008. USING A LEICA RTK GPS SYSTEM 1200, CONTROL DATA WAS OBTAINED FROM NATIONAL GEODETIC SURVEY DATA SHEETS. NGS POINTS LOCATED IN THE FIELD AND UTILIZED ARE: A 336, X=1569586.614' Y=502362.204' Z=4242.56'; GRASS, X=1594612.40' Y=505087.22' Z=3977.3'; C, X=1601225.97 Y=493229.78' Z=4017.99'; EARL, X=1597145.47' Y=517221.14' Z=3981.8'. INTERVISIBLE CONTROL POINT WAS SET IN THE PROPOSED PROJECT AREA (SHOWN AS TEMP. BENCHMARK). FIELD DATA WAS COLLECTED IN NMSPC CENTRAL ZONE (ft) (NAD 83) AND WAS CONVERTED TO UTM (m) USING CORPSCON SOFTWARE.

SURVEYOR'S CERTIFICATION

I, ROXANNE C. NIMMER, A NEW MEXICO PROFESSIONAL SURVEYOR CERTIFY THAT I CONDUCTED AND AM RESPONSIBLE FOR THIS SURVEY, THAT THIS SURVEY IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF, AND THAT THE SURVEY AND PLAT MEET MINIMUM STANDARDS FOR SURVEYING IN THE STATE OF NEW MEXICO.

ROXANNE C. NIMMER, PS 12800

11/10/08
DATE OF SURVEY

ROXANNE C. NIMMER
NEW MEXICO
12800
REGISTERED PROFESSIONAL SURVEYOR

UTM ZONE 13 METERS, NAVD88			
BENCHMARK	NORTHING(M)	EASTING(M)	ELEVATION(FT)
TBM #1	3582257.9620M	365724.1150M	3980.70FT
TBM #2	3582763.8650M	365443.1270M	3995.46FT
TBM #3	3582598.6720M	365088.3910M	4009.48FT

Zia Engineering & Environmental Consultants, Inc.
755 S. Telshor Blvd., Suite F-201
Las Cruces, New Mexico 88011
Phone: (575) 532-1526
Fax: (575) 532-1587

File ID: u\survey\shared\LC 04-076
MPL Landfill Topo

APPENDIX D

HELP Analysis

2008 HELP MODEL ANALYSIS
MAIN POST LANDFILL

INTRODUCTION

The Hydrologic Evaluation of Landfill Performance (HELP) Model computer program is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of landfills. The program was developed to conduct water balance analysis of landfill, cover systems and solid waste disposal and containment facilities. The HELP program was developed by the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, for the U.S. Environmental Protection Agency (EPA).

The New Mexico Solid Waste Management Regulations require that municipal landfill cells have an infiltration layer of at least 18 inches of earthen material having a saturated hydraulic conductivity no greater than 1 x 10-5 centimeters per second (cm/sec). An erosion protection layer that consists of a minimum of six inches of topsoil for vegetative cover is also required. This is known as a prescriptive cover.

If an alternative cover design is proposed it must achieve an equivalent reduction in infiltration as the infiltration layer of a prescriptive cover. The HELP Model simulation can be used to demonstrate that the design of the alternative cover provides equivalent reduction in infiltration as the prescriptive cover.

White Sands Missile Range intends to close all existing municipal and construction and demolition cells utilizing an alternative cover design. Native earthen material will be used for cover material. The hydraulic conductivity of the soils at the site varies from 4.0 x l0-4 to 2.6 x 10-6 cm/sec. To meet the requirements for closure, White Sands will use the HELP Model to demonstrate that 30 inches of cover with a hydraulic conductivity of 4.0 x 10-4 cm/sec or less provides an equivalent reduction in infiltration as a prescriptive cover design. The HELP Model was run for two simulations, one for a prescriptive cover and the other for an alternative cover. Several parameters required to run the HELP model are site specific weather data, soil data, and design data.

Two modifications to the 1999 HELP Model were made to run the 2008 simulation for the prescriptive and alternative cover. The minimum slope was adjusted from 2 percent to 5 percent and the slope length was adjusted from 1,500 feet to 750 feet. The aforementioned changed caused the SCS runoff curve number to change from 86.2 to 87.0 for the prescriptive cover and from 77.9 to 79.2 for the alternative cover.

WEATHER DATA

The weather data required for the HELP Model is classified into four groups: evapotranspiration, precipitation, temperature, and solar radiation data. The user may enter weather data using several options: data provided for selected U.S. cities that the user may select as default data, or the user may manually input data.

The Whites Sands National Monument weather station, which is approximately 20 miles north of the Main Post Landfill, was used to provide the precipitation and temperature data. Evapotranspiration and solar radiation data was generated by the model based on the precipitation data and latitude, and by using default data from El Paso, Texas. Climatological input parameters are provided as Attachment A and precipitation and temperature data used are provided in Attachment B.

SOIL DATA

The soil data required by the HELP Model includes the number of layers, layer types, properties of the layers, and initial moisture contents for each layer. For the purposes of modeling, the Main Post Landfill was divided into two layers, a 6-inch vegetative layer and a cover component.

For the prescriptive cover, 18 inches of earthen material with a hydraulic conductivity of 1 x 10-5 cm/sec and 6 inches of soil that is capable of sustaining native plant growth is prescribed. The topsoil was assigned a soil texture number of 7, which is a soil with a hydraulic conductivity of 1.9 x 10-5 cm/sec.

For the alternative cover, the cover material was assigned a user hydraulic conductivity value of 4.0 x 10-4 cm/sec. The hydraulic conductivity value for the cover material was obtained from soil sampling results, which is provided as Attachment C. These soil samples were taken from several locations on site for physical parameters. The value used in the model (4.0 x 10-4cm/sec) is the greatest hydraulic conductivity value and can therefore be considered a conservative value. A soil texture number of 6 were assigned to the topsoil cover, which is associated with a hydraulic conductivity of 7.2 x 10-4 cm/sec. This value is higher than the 30-inch cover-material hydraulic conductivity because the topsoil percent compaction will be lower than that of the lower layer.

The initial moisture contents for each layer was assigned, which were based on typical values for soils and municipal solid waste in semi-arid climates. Layer types also had to be specified and are described in the table below. The table below represents the values for each of the layers for a prescriptive and alternative cover.

Layer	Layer Type*	Soil Texture Number	Layer Thickness (inches)	Total Porosity (vol/vol)	Field Capacity (vol/vol)	Wilting Point (vol/vol)	Saturated Hydraulic Conductivity (cm/sec)	Initial Soil Water Content (vol/vol)
Vegetative Cover for Prescriptive Cover	1	9	6	0.501	0.284	0.135	1.9x10-5	0.172
Cover Material for Prescriptive Cover	1	**	18	0.419	0.307	0.18	1.0x10-5	0.212
Vegetative Cover for Alternative Cover	1	6	6	0.501	0.284	0.135	7.2x10-4	0.111
Cover Material for Alternative Cover	1	**	30	0.398	0.244	0.136	4.0x10-4	0.134

* The four types of layers and their code number in the HELP Model are vertical percolation (I), lateral drainage (2), barrier soil liner (3), and geomembrane liner (4).
** Hydraulic conductivity manually inputted-see text for details.

The area allowing run-off was estimated to be 100 percent based on the Guidance Document provided by the New Mexico Solid Waste Bureau in Attachment D. Soil input parameters are provided as Attachment A.

HELP MODEL RESULTS

Two simulations of the HELP Model were run for a 5-year duration using data from 1984 to 1988. The first simulation was for a prescriptive cover, the second for an alternative cover. The HELP Model generated output data for the average annual precipitation, amount of runoff evapotranspiration, percolation/leakage through the cover, and change in water storage for the different layers. Evapotranspiration is the most significant factor in removal of moisture, amounting to 13.531 inches of the 14.38 inches of rainfall occurring at the site. Runoff was minimal due to high evapotranspiration rates. The HELP Model results are provided in Attachment E.

SUMMARY

Based on the HELP Model results, there is minimal potential for the generation of leachate through the Main Post Landfill. The average annual total value for percolation through the alternative cover over the existing municipal cells is predicted at 0.13521 inches per year, versus 0.18749 inches from a prescriptive cover. Therefore, the HELP Model successfully demonstrated that the alternative cover described in the sections above provides equivalent reduction in infiltration as the prescriptive cover.

Attachment A

Summary of Help Model Input Parameters

SUMMARY OF HELP MODEL INPUT PARAMETERS
MAIN POST LANDFILL
WHITE SANDS MISSILE RANGE, NEW MEXICO

Climatological Data:
Most Representative HELP Model Default City: El Paso, Texas

- 50 years of rainfall data utilizing site specific (White Sands National Monument) data as provided by SWB as HELP files data (Attachment C):
    - White Sands National Monument, NM daily precipitation data
    - White Sands National Monument, NM normal mean monthly temperature data
    - Main Post Landfill, White Sands Missile Range, NM Latitude: 32'22'
- Leaf Index: 0.8 (conservative value, within range of typical default parameters for the area)
- Evaporative Zone Depth-24 inches (input value actually 28 inches but only 24 inches available)
- All other parameters remain at El Paso, TX default settings (growing season, humidity, etc.)

General Design Data
Default Soil Characteristics utilized with the following modifications:

- Topsoil layer is modeled as Soil Texture No. 9, with a saturated hydraulic conductivity of 1.9 x 1 0-4 centimeters per second.
- Cover layer modeled as Soil type No. 23, with a modified saturated hydraulic conductivity of 1.0 x 10-5 centimeters per second.
- Both layers classified as a layer type No. 1.
- Curve Number: Computed from default soil data using a soil texture of No. 9, cover is a poor stand of grass, slope=5 percent and a slope length of 750 feet. The resulting CN=87.0.
- Area allowing runoff: 100 percent
- Model Area: 40 acres
- Initial moisture conditions specified-calculated using recommended equation.

Simulation Data
5 year simulated model run:

- Topsoil Cover is modeled as Soil Texture No. 6, with a hydraulic conductivity of 7.2 x 10-4 centimeters per second.
- Final cover: 30 inches with a hydraulic conductivity of 4.4 x 10-4 centimeters per second - (to simulate the soils predominant in the area).
- CN changes to 79.2 due to soil texture type.

Attachment B

White Sands National Monument Temperature and Precipitation Data

Station	WHITE SANDS NATIONAL MONUMENT			Parameter	
County	OTERO			Record Cnt	
State	NM			Coverage 5	years
Id	299686	Latitude	32:47:00 N	Begin Dat	Jan-84
Elevation	3994 ft.	Longtitude	106:11:00 W	End Date	Jan-90

Daily Precipitation in inches

1984	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	1.64	0	0.19	0	0	0	0	
3	0.02	0	0	0	0	0	0	0.13	0.06	0.3	0	0	
4	0	0	0	0	0	0	0	0.09	0	0.25	0	0.51	
5	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	0	0.1	0	0	0	0	
8	0.29	0	0	0	0	0	0	0	0	0	0	0.03	
9	0	0	0	0	0	0	0	0.25	0	0	0	0	
10	0	0	0	0	0	0	0	0.59	0	0	0	0	
11	0	0	0	0	0	0	0.68	0.02	0	0.1	0	0	
12	0	0	0	0	0	0	0	0	0	0.11	0	0.26	
13	0	0	0	0	0	0.08	0	0.13	0	0	0	0.6	
14	0	0	0	0	0	0	0	0	0	0	0	0.6	
15	0	0	0	0	0.11	0.89	0	0	0	0.08	0	0.28	
16	0	0	0	0	0.72	0.3	0	0	0	0	0	0	
17	0	0	0	0	0.03	0.01	0	0	0	0	0.33	0	
18	0	0	0	0	0	0	0.47	0	0	0.12	0.06	0	
19	0	0	0	0	0	0.82	0	0	0	0	0.04	0.08	
20	0	0	0	0	0	0	0	0	0	0.04	0.07	0	
21	0	0	0	0	0	0	0.15	0	0	0.14	0	0	
22	0	0	0	0	0	0	0	0	0	0.06	0	0	
23	0	0	0	0	0	0	0	0.21	0	0.27	0	0	
24	0	0	0	0	0	0.08	0.14	0.27	0	0.45	0.61	0	
25	0	0	0	0	0	0	0	0.67	0	0	0.02	0	
26	0	0	0	0	0	0	0	0.19	0.12	0.11	0	0	
27	0	0	0	0	0	0	0.14	0	0.06	0	0	0	
28	0	0	0	0	0	0	0	0	0	0	0	0	
29	0	0	0	0	0	0	0	0	0	0	0	0	
30	0	*****	0	0	0	0	0	0.1	0	0	0	0	
31	0	*****	0	*****	0	*****	0	0	*****	0	*****	0	
Total	0.31	0	0	0	0.86	2.18	1.58	2.84	0.24	2.03	1.13	2.36	13.53
Mean	0.01	0	0	0	0.03	0.13	0.05	0.09	0.01	0.07	0.04	0.08	0.04
Max	0.29	0	0	0	0.72	1.64	0.68	0.67	0.12	0.45	0.61	0.6	0.48

1985	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0	0.01	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0.22	0.31	0	0	0	0	
3	0	0	0	0	0	0	0	0.5	0.16	0	0	0	
4	0	0.17	0	0	0	0	0.03	0.03	0	0	0	0	
5	0	0	0	0	0	0.38	0	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	0	0	0	1.01	0	0	
8	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0.3	0	0.07	0	0	
10	0	0	0	0	0	0	0	0	0.11	0	0	0	
11	0	0	0	0	0	0	0	0.31	0	1.06	0	0	
12	0.03	0	0	0	0	0	0	0	0	0	0	0.05	
13	0.36	0	0	0	0	0	0	0	0	0	0	0	
14	0.04	0	0	0	0	0	0	0	0.04	0	0	0	
15	0	0	0.16	0	0	0	0.23	0	0.03	0.07	0	0	
16	0.28	0	0	0	0	0	0	0	0	0.12	0	0	
17	0	0	0	0	0.45	0	0	0	0	1.77	0	0	
18	0	0	0	0	0.05	0	0.13	1.24	0	0	0	0	
19	0	0	0.08	0	0	0.14	0.05	0	0.42	0	0	0	
20	0	0	0.1	0	0	0	0	0	0.5	0	0	0	
21	0	0	0	0	0	0	0	0	0	0	0	0	
22	0	0	0	0	0	0	0.45	0	0	0	0	0	
23	0	0.21	0	0	0	0	0.02	0	0	0	0	0	
24	0	0	0	0	0	0	0	0	0	0	0	0	
25	0	0	0	0	0	0.33	0	0	0	0	0	0	
26	0	0	0	0	0	0	0	0	0	0	0	0	
27	0	0	0	0.22	0	0	0.25	0	0	0	0	0	
28	0	0.03	0	0.6	0	0	0	0	0.16	0	0	0	
29	0	*****	0	0	0	0	0.08	0	0	0.03	0	0	
30	0	*****	0	0	0	0	0.31	0	0	0	0.05	0	
31	0	*****	0	*****	0	*****	0.05	0	*****	0	*****	0	
Total	0.71	0.42	0.24	0.82	0.5	0.85	1.82	2.69	1.42	4.13	0	0.05	13.65

Mean	0.04	0.02	0.01	0.03	0.02	0.03	0.06	0.09	0.05	0.13	0	0	0.04
Max	0.36	0.21	0.16	0.6	0.45	0.38	0.45	1.24	0.5	1.77	0.05	0.05	0.52

1986	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0.01	0	0	0	0	0	0	0	0	0	0	0	
2	0	0.02	0	0	0	0	0	0	0	0.24	1.13	0	
3	0	0	0	0	0	0	0.06	0	0	0.26	1.31	0	
4	0	0.16	0	0	0	0	0	0	0.06	0	0	0	
5	0	0.04	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	0.11	0.1	0	0	
7	0.01	0.05	0	0	0	0	0.02	0	0	0	0	0.11	
8	0	0.01	0	0	0	0	0	0	0	0	0	0.52	
9	0	0.05	0	0	0	0	0.03	0	0	0	0	0	
10	0	0.24	0	0	0	0	0.16	0	0	0.1	0	0.15	
11	0	0	0.07	0	0	0	0	0	0	0.05	0	0	
12	0	0	0	0	0	0	0	0	0.12	0.14	0	0	
13	0	0	0.11	0	0	0	0	0	0	0	0.24	0	
14	0	0	0.13	0	0	0	0	0.85	0	0	0	0	
15	0	0	0	0	0	0	0	0.05	0.5	0	0	0	
16	0	0	0	0	0	0	0	0	0	0.05	0	0.22	
17	0	0	0	0	0.03	0	0.27	0	0	0	0	0.5	
18	0	0	0	0	0	0.12	0.02	0	0	0	0	0	
19	0	0	0.04	0	0	0.08	0	0	0	0.03	0.34	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	
21	0	0	0	0	0	0	0.23	0	0	0	0	0	
22	0	0	0	0	0	0	0.26	0	0	0	0	0	
23	0	0	0	0	0	0.02	0	0.37	0.21	0	0	0.09	
24	0	0	0	0.01	0	0.46	0	0	0.8	0	0	0	
25	0	0	0	0	0	0.48	0	0	0	0	0	0	
26	0	0	0	0	0	0.32	0	0	0	0	0	0	
27	0	0	0	0	0.05	0	0	0.01	0	0	0	0	
28	0	0	0	0	0.02	0	0	0	0	0	0	0	
29	0	*****	0	0	0	0	0	0	0	0	0	0	
30	0	*****	0	0	0.27	0	0	0.46	0	0	0	0	
31	0	*****	0	*****	0	*****	0	0	*****	0	*****	0	
Total	0.02	0.57	0.35	0.01	0.37	1.48	1.06	1.74	1.8	0.97	3.02	1.59	12.98
Mean	0	0.02	0.01	0	0.01	0.05	0.03	0.06	0.06	0.03	0.1	0.05	0.03
Max	0.01	0.24	0.13	0.01	0.27	0.48	0.27	0.85	0.8	0.26	1.31	0.52	0.43

1987	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0	0	0	0	0	0	0	0	0	0	0.35	0	
2	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0.04	0	0	0	0	
4	0	0	0	0.03	0	0	0	0.63	0.05	0	0	0	
5	0	0	0	0	0	0	0	0	0	0	0.11	0	
6	0	0	0	0	0	0	0	0	0	0	0.14	0	
7	0	0	0	0	0	0.35	0	0	0	0	0	0	
8	0	0	0	0	0	0.03	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0.6	0	0	0	0	
10	0	0	0.04	0	0	0	0	0	0	0	0	0	
11	0	0	0.05	0	0	0	0	0.3	0	0	0	0	
12	0	0	0	0	0.1	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0.67	
14	0	0	0	0	0	0	0	0	0.22	0	0	0.45	
15	0	0	0	0	0.03	0.04	0	0	0	0.09	0	0	
16	0	0	0	0	0	0	0	0	0	0	0	0	
17	0.21	0	0	0	0	0	0	0	0	0	0	0	
18	0	0.28	0	0	0	0	0	0*	0.02	0	0	0.11	
19	0	0	0	0	0.13	0	0	0	0	0	0	0.01	
20	0	0.07	0	0	0	0	0	0	0	0	0	0	
21	0	0.38	0	0	0	0	0.22	0	0	0	0	0	
22	0	0	0	0	0	0	0	0.01	0	0	0	0	
23	0	0	0	0	0.3	0	0.04	0	0	0.17	0	0	
24	0	0	0	0	0.15	0	0	1.9	0	0	0	0	
25	0	0	0	0	0.1	0.13	0.03	0	0.15	0	0	*****	
26	0	0	0	0	0	0	0	0.15	0	0	0	0.5	
27	0	0	0	0	0	1.4	0	0	0	0	0	0.02	
28	0	0	0	0	0	0	0	0	0	0	0	0	
29	0	*****	0.51	0	0	0	0.29	0	0.12	0	0	0	
30	0	*****	0	0.06	0	0	0	0	0	0	0	0	
31	0	*****	0	*****	0	*****	0	0	*****	0	*****	0	
Total	0.21	0.73	0.6	0.09	0.81	1.95	0.58	3.63	0.56	0.26	0.6	1.76	11.78
Mean	0.01	0.03	0.02	0	0.03	0.07	0.02	0.12	0.02	0.01	0.02	0.06	0.03
Max	0.21	0.38	0.51	0.06	0.3	1.4	0.29	1.9	0.22	0.17	0.35	0.67	0.54

1988	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0.05	0.1	0	0	0	

3	0	0	0.1	0	0	0	0	0.1	0	0	0	0	
4	0	0.02	0	0	0	0	0.02	0.98	0	0	0	0	
5	0	1.21	0	0	0	0	0	0	0	0	0	0	
6	0.12	0	0	0	0	0	0.51	0.83	0	0	0	0	
7	0	0	0	0	0	0	0	0.57	0	0	0	0	
8	0	0	0	0	0	0	0	2.25	0	0	0	0	
9	0	0	0	0	0	0	0.38	0	0	0.05	0	0.68	
10	0	0	0	0	0	0	0.07	0	0	0.06	0	0	
11	0	0	0	0	0	0.15	0	0.35	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0.25	0	0	0	0	
15	0	0	0	0	0	0.76	0	1.22	0	0	0	0	
16	0	0	0	0.04	0.13	0	0	1.22	0	0	0	0	
17	0	0	0	0	0	0	0.31	0.13	0	0	0	0	
18	0.08	0.14	0	0	0	0	0	0	0	0	0	0	
19	0	0	0	0	0	0	0.15	0	0	0	0	0.54	
20	0.02	0	0	0	0	0	0	0	0	0	0	0	
21	0	0	0	0	0	0	0	0	0.77	0.12	0	0	
22	0	0	0	0	0	0	0	0	0	0	0	0	
23	0	0	0	0	0	0	0	0.46	0	0	0	0	
24	0	0	0	0	0	0	0	0	0	0	0	0	
25	0	0	0	0	0.05	0.33	0	0	0	0	0	0	
26	0	0	0	0	0	0	0	0.59	0	0	0	0	
27	0	0	0	0	0	0	0	0.2	0	0	0	0	
28	0	0	0	0	0	0	0	0.2	0	0	0	0	
29	0	0	0	0.04	0	0	0	0.38	0	0	0	0	
30	0	*****	0	0	0	0	0	0	0	0	0	0	
31	0	*****	0	*****	0	*****	0	0	*****	0	*****	0	
Total	0.22	1.37	0.1	0.08	0.18	1.24	1.5	9.78	0.87	0.23	0	1.22	16.79
Mean	0.01	0.05	0	0	0.01	0.04	0.05	0.32	0.03	0.01	0	0.04	0.05
Max.	0.08	1.21	0.1	0.04	0.13	0.76	0.38	2.25	0.77	0.12	0	0.68	0.54

1989	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	0	0	0	0	
4	0.03	0	0.2	0	0	0	0	0	0	0	0	0	
5	0.01	0	0	0	0	0	0	0	0.63	0	0	0	
6	0	0	0	0	0	0	0	0	1.17	0	0	0	
7	0	0.25	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	0	0	0	0	
10	0	0	0	0	0.46	0	0	0	0	0	0	0	
11	0	0	0	0	0	0	0	0	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0.15	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	0	0	0	0	0	
16	0	0.5	0	0	0.02	0	0.19	0	0	0	0	0	
17	0	0	0	0	0	0	0	0	0	0	0	0	
18	0	0	0	0	0	0	0	0.15	0	0	0	0	
19	0	0	0	0	0	0	0	0	0	0	0	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	
21	0	0	0.1	0	0	0	0	0	0	0	0.12	0	
22	0	0	0	0	0	0	0.79	0	0.16	0	0	0	
23	0	0	0	0	0	0	0.23	0	0	0	0	0	
24	0	0	0	0	0	0	0	0	0	0	0	0	
25	0	0	0	0	0	0	0.05	0	0	0	0	0	
26	0	0	0	0	0	0	0	0	0	0	0	0	
27	0.2	0	0.15	0	0	0	0	0	0	0	0	0	
28	0	0	0	0	0	0	0.52	1.5	0	0	0	0.12	
29	0	*****	0	0	0	0	0.19	0	0	0	0	0.32	
30	0	*****	0	0	0	0	0	0.11	0	0	0	0	
31	0	*****	0	*****	0	*****	0	0	*****	0	*****	0	
Total	0.24	0.75	0.45	0	0.48	0	1.97	1.76	2.11	0	0.12	0.44	8.32
Mean	0.01	0.03	0.01	0	0.02	0	0.06	0.06	0.07	0	0	0.01	0.02
Max.	0.2	0.5	0.2	0	0.46	0	0.79	1.5	1.17	0	0.12	0.32	0.44

Station	WHITE SANDS NATIONAL MONUMENT			Parameter	
County	OTERO			Record Cnt	
State	NM			Coverage	5 years
Id	299686	Latitude	32:47:00 N	Begin Date	Jan-84
Elevation	3994 ft.	Longtitude	106:11:00 W	End Date	Jan-90

Daily Maximum Temperature, in degrees Farenheit

1984	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	58	62	73	78	83	97	100	97	92	83	73	55	
2	55	63	74	66	83	91	94	93	90	84	72	64	
3	51	66	73	66	88	83	100	92	90	79	75	57	
4	57	62	73	72	91	88	100	90	88	73	77	48	
5	62	59	63	80	91	81	99	89	87	74	73	52	
6	66	63	50	80	91	88	98	94	87	80	70	56	
7	65	66	61	73	86	92	98	91	93	81	76	55	
8	61	62	70	78	79	92	98	90	96	80	78	63	
9	62	66	72	78	90	92	103	79	99	81	72	64	
10	61	70	68	73	96	100	101	81	101	77	65	65	
11	55	68	72	87	95	97	96	83	98	71	64	57	
12	54	57	73	84	100	100	92	90	97	68	65	48	
13	53	66	79	84	99	96	96	80	96	64	75	43	
14	56	72	80	76	94	92	100	89	97	79	72	38	
15	55	63	81	77	84	88	103	89	93	73	68	40	
16	57	68	81	79	76	88	102	86	88	71	68	54	
17	56	65	83	88	82	88	93	90	91	72	50	58	
18	51	57	80	85	87	85	89	93	91	72	57	50	
19	62	57	67	83	90	83	96	94	89	70	50	54	
20	51	49	75	82	93	91	96	95	89	62	54	55	
21	45	60	82	75	98	95	92	96	89	58	57	58	
22	55	68	80	80	97	96	93	95	89	55	57	49	
23	54	67	62	82	96	97	95	90	94	50	55	52	
24	56	67	72	86	95	95	96	86	93	45	46	52	
25	59	68	73	79	99	96	89	86	86	49	52	57	
26	58	61	70	66	99	98	88	88	79	53	50	61	
27	58	55	66	84	101	96	93	95	77	54	43	63	
28	64	58	62	85	93	93	94	97	76	69	55	63	
29	66	59	74	78	92	98	94	98	71	73	62	64	
30	62	*****	73	80	93	97	94	95	75	76	62	64	
31	59	*****	73	*****	97	*****	96	92	*****	71	*****	56	
Mean	58	63	72	79	92	92	96	90	89	69	63	55	77
Max.	66	72	82	88	101	100	103	98	101	84	78	65	87

1985	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	56	23	70	70	85	93	102	97	99	64	71	60	
2	40	42	68	80	85	96	100	93	97	75	63	62	
3	38	43	60	83	87	94	95	90	96	84	71	66	
4	58	48	59	82	89	92	99	94	85	83	74	65	
5	60	55	72	82	89	88	103	96	87	76	78	61	
6	61	56	78	82	90	94	102	100	89	85	73	65	
7	56	55	73	79	87	100	102	101	92	87	70	62	
8	63	62	82	74	91	103	100	96	89	77	75	69	
9	59	60	80	78	94	103	98	97	92	74	70	67	
10	59	62	83	81	94	102	101	91	93	78	73	59	
11	52	59	82	84	82	97	98	87	92	76	72	51	
12	47	64	74	86	84	90	100	91	87	73	68	37	
13	37	65	62	86	85	95	100	94	89	77	58	43	
14	35	64	63	85	76	102	103	96	86	75	51	44	
15	45	67	58	87	89	105	97	96	83	74	57	48	
16	40	76	62	90	90	105	97	96	89	68	64	55	
17	46	75	62	90	89	102	98	96	92	68	73	55	
18	58	76	72	88	83	97	101	91	90	65	64	56	
19	66	71	66	88	88	91	98	89	87	70	59	59	
20	58	68	66	84	86	96	91	90	83	71	56	55	
21	38	74	72	83	88	100	92	96	82	76	69	57	
22	42	68	72	73	82	99	92	99	87	76	71	65	
23	49	56	70	75	88	96	91	101	86	76	69	61	
24	59	67	79	87	91	96	96	95	87	79	73	57	
25	59	65	82	85	96	92	90	98	87	80	71	59	
26	50	74	78	83	96	92	90	100	80	78	62	60	
27	60	67	76	77	98	90	85	96	89	78	66	62	
28	62	66	77	73	97	93	95	96	87	77	64	64	

29	61	*****	72	75	97	98	94	96	73	77	64	64	
30	60	*****	54	85	91	99	99	96	74	75	60	67	
31	49	*****	64	*****	88	*****	97	95	*****	75	*****	64	
Mean	52	62	68	82	89	97	97	95	88	76	67	59	78
Max.	66	76	83	90	98	105	103	101	99	87	78	69	88

1986	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	61	65	74	81	94	81	97	101	91	87	79	57	
2	59	59	76	78	89	84	84	100	91	83	73	59	
3	59	63	66	73	89	86	91	98	90	77	51	63	
4	60	63	71	73	90	91	94	97	88	78	64	61	
5	50	51	75	80	87	96	94	96	91	76	61	56	
6	62	56	78	82	87	96	97	98	92	77	67	58	
7	59	51	75	89	85	98	94	98	90	74	63	59	
8	48	43	79	86	83	96	95	94	86	82	65	59	
9	49	45	72	83	78	97	92	92	90	78	60	53	
10	58	47	69	82	82	92	90	89	88	74	64	48	
11	59	55	67	80	89	91	96	93	90	71	56	38	
12	61	65	67	84	90	96	100	95	89	68	57	45	
13	60	69	55	85	91	97	100	97	88	61	58	50	
14	54	71	55	87	91	100	98	94	88	70	47	54	
15	64	74	62	87	90	100	94	93	87	72	48	55	
16	62	70	73	86	89	103	92	96	89	70	59	55	
17	64	71	72	81	86	100	89	101	90	76	71	46	
18	68	79	58	74	77	96	89	98	92	83	65	44	
19	66	83	55	67	87	90	93	99	95	81	69	48	
20	72	76	65	78	93	95	94	101	93	80	66	52	
21	71	73	71	87	97	96	91	100	93	77	67	52	
22	62	65	76	90	96	97	84	99	90	74	67	52	
23	70	72	79	86	92	87	89	94	86	75	59	45	
24	68	76	83	86	93	71	91	84	73	74	59	51	
25	64	80	82	87	94	80	96	91	79	74	57	50	
26	58	82	83	83	93	83	101	91	79	73	54	50	
27	64	77	82	80	90	90	100	89	85	74	56	51	
28	68	65	83	84	87	95	102	84	84	77	61	49	
29	72	*****	77	86	90	97	101	87	84	73	64	54	
30	73	*****	83	89	89	98	103	86	84	76	61	56	
31	70	*****	85	*****	*****	*****	101	92	*****	80	*****	56	
Mean	62	66	73	82	86	92	95	94	88	76	62	52	77
Max.	73	83	85	90	97	103	103	101	95	87	79	63	88

1987	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	58	60	59	76	83	93	101	98	87	81	74	58	
2	63	68	65	74	82	95	102	103	87	88	74	64	
3	56	71	69	70	78	92	103	101	89	82	76	69	
4	58	67	69	65	82	86	102	99	79	84	76	69	
5	67	67	70	62	82	85	101	94	84	90	72	71	
6	58	62	74	61	82	87	100	98	87	88	75	64	
7	62	61	77	63	82	84	100	98	90	89	70	68	
8	57	63	75	69	81	80	101	96	89	89	66	64	
9	50	65	68	76	83	87	102	92	91	87	62	64	
10	52	72	66	80	87	82	99	87	92	92	63	69	
11	56	73	62	83	85	89	97	90	92	87	63	72	
12	62	71	69	82	87	93	100	89	94	87	66	67	
13	62	70	78	77	89	98	100	92	93	87	68	56	
14	62	67	74	73	86	97	95	95	87	86	73	38	
15	57	61	76	85	88	101	95	94	83	76	65	26	
16	52	58	73	88	90	101	89	94	87	78	51	28	
17	44	56	63	92	91	102	93	97	88	77	62	39	
18	33	55	71	91	89	101	94	100	80	79	58	43	
19	36	52	72	88	81	98	98	100	84	80	60	51	
20	39	45	70	77	82	98	90	99	89	78	65	51	
21	41	37	72	76	84	98	94	98	88	73	72	52	
22	42	44	70	72	87	98	98	96	85	77	68	57	
23	47	55	62	80	83	102	97	91	83	75	71	67	
24	54	59	62	81	83	103	98	88	86	74	66	59	
25	58	64	60	76	85	102	95	85	84	82	69	*****	
26	64	62	65	81	84	91	95	81	84	79	62	30	
27	66	52	67	82	83	88	93	82	88	82	50	25	
28	68	55	63	80	81	92	95	83	87	83	54	34	
29	71	*****	49	82	85	97	96	85	87	81	60	37	
30	72	*****	49	78	90	95	94	89	82	82	56	60	
31	68	*****	67	*****	87	*****	99	89	*****	76	*****	49	

Mean	56	60	67	77	85	94	97	93	87	82	66	53	76
Max.	72	73	77	92	91	103	103	103	94	92	76	72	82

1988	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	45	67	74	62	87	87	92	95	87	85	78	57	
2	48	70	70	78	82	94	94	94	88	84	79	61	
3	50	70	59	84	80	93	97	90	84	84	80	66	
4	55	59	64	86	82	91	98	87	81	85	84	61	
5	48	42	70	82	90	94	94	83	80	83	79	56	
6	58	37	73	83	89	96	91	91	83	83	81	62	
7	55	53	73	87	82	96	95	87	87	83	82	57	
8	56	60	69	89	78	96	92	88	92	82	83	48	
9	53	62	69	88	85	100	88	79	94	81	77	35	
10	57	64	71	77	89	97	81	83	95	78	77	40	
11	51	62	65	78	89	97	91	91	87	64	74	53	
12	58	65	56	86	85	97	97	91	88	77	69	50	
13	55	71	57	88	93	94	100	94	87	80	78	54	
14	58	67	59	87	95	94	99	94	86	83	78	60	
15	62	61	71	84	96	88	96	89	89	82	74	55	
16	61	71	69	83	94	91	100	87	90	84	58	58	
17	59	70	66	64	94	96	97	87	91	87	67	52	
18	59	55	65	72	87	97	92	89	91	86	67	56	
19	41	47	70	79	78	98	96	90	91	85	56	54	
20	39	56	78	79	80	98	86	89	88	84	55	53	
21	45	64	80	78	82	97	88	94	86	85	59	62	
22	45	69	82	79	83	99	96	92	84	82	61	56	
23	50	66	81	74	89	98	100	92	78	82	66	55	
24	49	73	86	74	89	97	100	95	83	84	70	56	
25	47	71	84	78	90	93	98	96	86	84	70	64	
26	58	75	85	83	90	85	97	94	88	83	57	57	
27	59	72	89	85	96	87	94	90	89	83	51	47	
28	65	75	85	84	95	93	91	79	88	76	56	48	
29	66	77	79	78	92	96	91	68	89	79	58	51	
30	67	*****	81	87	86	96	93	86	78	78	56	45	
31	67	*****	78	*****	78	*****	93	88	*****	78	*****	52	
Mean	54	64	73	81	87	95	94	89	87	82	69	54	77
Max.	67	77	89	89	96	100	100	96	95	87	84	66	87

1989	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	59	66	73	84	81	96	105	91	88	90	68	52	
2	60	65	67	82	89	95	106	95	89	91	64	54	
3	55	66	67	83	93	92	107	97	93	92	67	54	
4	55	68	63	84	94	90	100	96	95	90	73	59	
5	59	71	45	82	91	91	100	97	87	82	75	65	
6	59	67	59	87	93	92	100	94	87	83	74	65	
7	59	29	79	91	99	94	98	89	88	80	74	60	
8	43	39	80	91	99	94	97	87	92	81	71	53	
9	46	50	85	92	95	93	97	91	92	82	70	61	
10	54	63	85	88	88	95	96	95	89	84	73	70	
11	65	74	88	77	85	95	95	100	92	86	78	67	
12	60	71	89	83	85	97	100	98	92	87	75	43	
13	41	69	85	80	80	92	100	94	85	89	75	50	
14	49	60	81	80	83	86	99	93	79	90	75	57	
15	56	59	80	86	84	92	101	95	84	89	71	62	
16	56	52	82	88	84	102	101	94	87	81	64	54	
17	59	57	83	89	72	102	99	94	90	79	66	55	
18	64	53	82	87	87	102	106	92	92	68	67	61	
19	63	65	83	91	92	105	103	94	93	64	65	59	
20	58	65	80	93	95	105	96	89	92	68	71	58	
21	53	60	65	96	101	104	94	91	92	75	69	59	
22	60	65	72	96	100	98	92	92	93	78	67	44	
23	67	70	75	89	102	96	89	92	77	80	63	44	
24	67	76	77	88	101	96	77	94	82	82	71	55	
25	60	80	77	85	101	98	82	85	89	85	70	59	
26	60	80	74	82	94	100	90	91	89	84	70	56	
27	56	80	66	82	92	102	87	91	84	77	67	60	
28	56	70	74	80	94	103	88	91	83	76	57	59	
29	56	*****	82	80	94	101	88	83	86	75	46	55	
30	59	*****	81	81	94	100	88	86	88	70	50	51	
31	68	*****	75	*****	93	*****	89	84	*****	64	*****	49	
Mean	57	64	76	86	91	97	96	92	88	81	68	56	79
Max.	68	80	89	96	102	105	107	100	95	92	78	70	90

Station	WHITE SANDS NATIONAL MONUMENT			Parameter	
County	OTERO			Record Cnt	
State	NM			Coverage 5	years
Id	299686	Latitude	32:47:00 N	Begin Dat	Jan-84
Elevation	3994 ft.	Longtitude	106:11:00 W	End Date	Jan-90

Daily Minimum Temperature, in degrees Farenheit

1984	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	23	9	14	45	38	53	69	61	60	49	35	20	
2	28	15	21	25	49	49	70	63	58	53	30	20	
3	34	14	26	25	43	48	69	61	55	54	30	22	
4	20	20	27	22	43	51	64	61	51	46	29	28	
5	17	14	26	27	65	52	62	65	43	45	27	29	
6	25	13	19	36	62	56	60	62	46	42	28	23	
7	23	14	18	46	48	64	62	62	44	39	49	22	
8	30	20	21	28	56	62	65	57	50	38	42	30	
9	27	10	27	42	36	63	70	63	50	41	48	30	
10	26	23	30	29	51	55	70	64	52	45	27	23	
11	20	27	40	45	44	64	64	62	57	53	19	36	
12	20	12	35	40	42	65	60	65	62	43	24	39	
13	30	9	39	30	52	69	64	62	56	41	28	38	
14	22	23	34	34	48	55	62	59	59	34	28	29	
15	25	25	36	29	55	61	59	60	64	47	33	26	
16	22	12	47	32	53	58	68	54	50	39	30	19	
17	21	35	28	29	46	61	66	53	49	45	34	22	
18	18	14	34	63	49	61	63	55	50	46	35	28	
19	14	22	24	55	48	58	64	60	48	43	28	30	
20	20	18	24	47	51	59	68	60	53	46	22	31	
21	5	6	27	29	46	59	63	58	52	42	24	28	
22	12	11	52	33	51	63	62	58	53	39	23	28	
23	13	26	23	28	54	62	59	57	51	41	27	21	
24	21	10	23	35	55	64	56	59	60	39	30	29	
25	10	32	35	40	58	65	57	56	53	35	34	28	
26	12	27	34	31	48	63	55	60	52	36	32	30	
27	14	16	42	25	55	67	57	59	54	39	19	33	
28	21	14	21	25	58	63	57	65	51	33	19	50	
29	15	15	18	38	52	61	59	59	49	34	31	38	
30	22	*****	39	29	52	56	58	56	48	34	19	28	
31	17	*****	23	*****	51	*****	65	57	*****	38	*****	26	
Mean	20	35	39	35	50	60	63	60	53	42	29	26	43
Min.	5	6	14	22	36	48	55	53	43	33	19	19	29

1985	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	29	14	30	35	44	60	67	67	61	40	46	28	
2	15	6	32	25	55	49	73	64	72	43	28	22	
3	11	15	28	29	48	59	53	65	67	45	30	33	
4	14	30	20	29	50	51	58	61	62	41	31	24	
5	18	25	15	40	54	50	55	62	56	37	37	22	
6	19	17	27	42	52	45	61	63	54	41	44	27	
7	24	15	37	42	47	57	60	63	53	57	35	26	
8	35	18	35	41	48	63	61	61	48	57	32	24	
9	29	29	42	38	49	59	58	65	51	54	50	34	
10	24	37	42	47	68	58	58	65	62	55	48	38	
11	20	18	40	39	43	60	70	63	62	52	48	17	
12	24	16	46	53	44	69	60	65	59	37	35	14	
13	22	25	38	41	46	55	55	62	57	41	34	7	
14	10	20	31	47	32	60	62	56	59	41	32	7	
15	23	28	38	38	31	65	68	66	63	36	21	15	
16	27	28	32	40	54	63	57	57	55	52	21	13	
17	19	24	27	60	55	60	59	59	57	45	25	10	
18	23	30	25	52	49	57	62	61	60	41	36	13	
19	24	36	40	49	49	61	63	63	56	39	32	14	
20	25	44	35	46	47	65	59	65	56	44	17	15	
21	12	37	31	46	46	59	57	68	50	48	20	15	
22	19	35	33	47	47	63	60	62	46	46	33	17	
23	29	29	25	36	47	59	57	62	49	46	32	17	
24	30	28	25	28	52	72	63	63	47	36	32	20	
25	33	25	33	51	54	66	67	60	48	40	43	16	
26	28	26	48	46	47	55	65	59	44	41	52	20	
27	33	29	53	44	50	47	65	63	48	42	32	17	
28	36	46	52	49	51	58	65	64	57	38	26	16	

29	30	*****	45	37	53	57	71	62	47	39	38	16	
30	40	*****	26	45	54	63	66	60	44	41	44	18	
31	24	*****	22	*****	60	*****	62	53	*****	38	*****	28	
Mean	24	26	34	42	49	59	61	62	55	44	34	19	42
Min.	10	6	15	25	31	45	53	53	44	36	17	7	29

1986	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	30	36	21	54	48	45	63	62	68	38	45	21	
2	21	42	31	45	47	53	65	61	60	62	43	18	
3	19	28	37	42	57	57	68	65	62	56	42	19	
4	19	35	26	30	50	57	67	62	53	50	34	19	
5	22	31	26	29	*****	58	65	64	54	53	28	30	
6	18	26	29	36	47	59	67	69	53	52	29	41	
7	26	37	41	35	56	64	64	64	60	45	44	44	
8	13	22	40	48	49	71	69	65	58	43	36	42	
9	10	26	49	50	34	58	63	73	58	48	29	29	
10	13	26	35	39	35	53	61	65	51	51	29	28	
11	14	21	42	49	39	48	61	62	46	48	28	14	
12	14	33	35	54	44	59	66	65	52	44	30	17	
13	16	34	37	50	42	68	70	70	59	31	32	18	
14	16	32	39	41	43	62	64	65	55	31	30	21	
15	22	42	29	52	45	59	68	68	59	29	30	23	
16	20	46	31	54	49	68	62	62	56	43	33	38	
17	19	31	40	50	48	63	62	66	54	37	33	37	
18	27	38	29	32	34	63	60	63	54	43	36	35	
19	20	36	33	39	44	66	56	60	57	45	38	25	
20	19	43	21	30	45	62	55	73	60	50	37	24	
21	33	36	21	37	53	62	62	61	63	45	30	32	
22	28	23	25	47	53	66	62	72	67	29	36	32	
23	21	21	23	46	49	62	60	61	61	36	32	32	
24	20	32	28	48	54	61	59	64	55	37	18	24	
25	23	30	37	49	54	62	56	60	45	35	20	22	
26	15	29	31	56	57	62	60	65	46	33	22	21	
27	14	39	31	44	60	64	59	65	46	27	22	20	
28	15	28	40	36	51	59	63	63	50	31	21	30	
29	17	*****	37	55	56	66	64	64	48	34	23	23	
30	19	*****	37	58	50	68	63	63	38	33	33	26	
31	29	*****	38	*****	53	*****	62	59	*****	40	*****	16	
Mean	20	32	33	45	48	61	62	65	55	41	31	26	43
Min.	10	21	21	29	34	45	55	60	38	27	18	14	31

1987	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	21	26	19	25	46	57	65	64	53	42	51	12	
2	26	22	22	33	49	58	55	62	52	42	48	13	
3	22	21	24	25	44	61	61	70	52	45	39	20	
4	18	35	25	37	42	49	58	68	55	39	38	23	
5	25	39	25	30	44	51	57	66	60	39	44	31	
6	23	20	24	27	44	54	54	62	52	45	53	26	
7	24	17	25	29	45	60	62	70	55	44	32	22	
8	34	16	33	25	40	57	58	63	54	46	31	18	
9	18	27	33	32	40	55	58	64	58	43	28	12	
10	18	26	42	37	48	56	65	67	55	52	25	20	
11	12	26	32	31	50	54	69	68	53	50	22	22	
12	13	31	28	60	55	52	62	64	51	46	27	22	
13	18	25	28	29	54	56	59	63	61	55	22	28	
14	18	40	38	25	49	63	65	58	60	53	41	20	
15	37	31	41	27	49	59	61	61	47	50	33	-5	
16	29	38	33	35	56	59	63	56	46	38	21	-5	
17	19	27	30	37	57	52	66	50	48	44	17	6	
18	1	29	20	39	59	53	63	53	60	43	36	26	
19	4	32	39	38	58	53	62	53	42	38	11	29	
20	17	26	45	43	49	51	69	58	48	38	10	35	
21	12	28	27	52	48	47	65	71	52	35	19	24	
22	10	19	36	44	45	62	65	61	48	49	24	25	
23	16	21	28	30	54	52	68	65	47	53	21	34	
24	17	21	28	41	48	56	67	64	43	40	30	29	
25	23	29	23	39	47	68	65	62	54	43	19	*****	
26	20	40	29	39	64	62	61	61	47	43	33	19	
27	20	22	28	43	46	62	70	58	55	36	13	-5	
28	34	21	28	42	49	59	69	53	49	48	12	0	
29	31	*****	25	42	46	56	63	54	48	46	13	5	
30	25	*****	19	46	39	56	64	50	47	43	16	5	
31	36	*****	21	*****	48	*****	64	52	*****	48	*****	26	

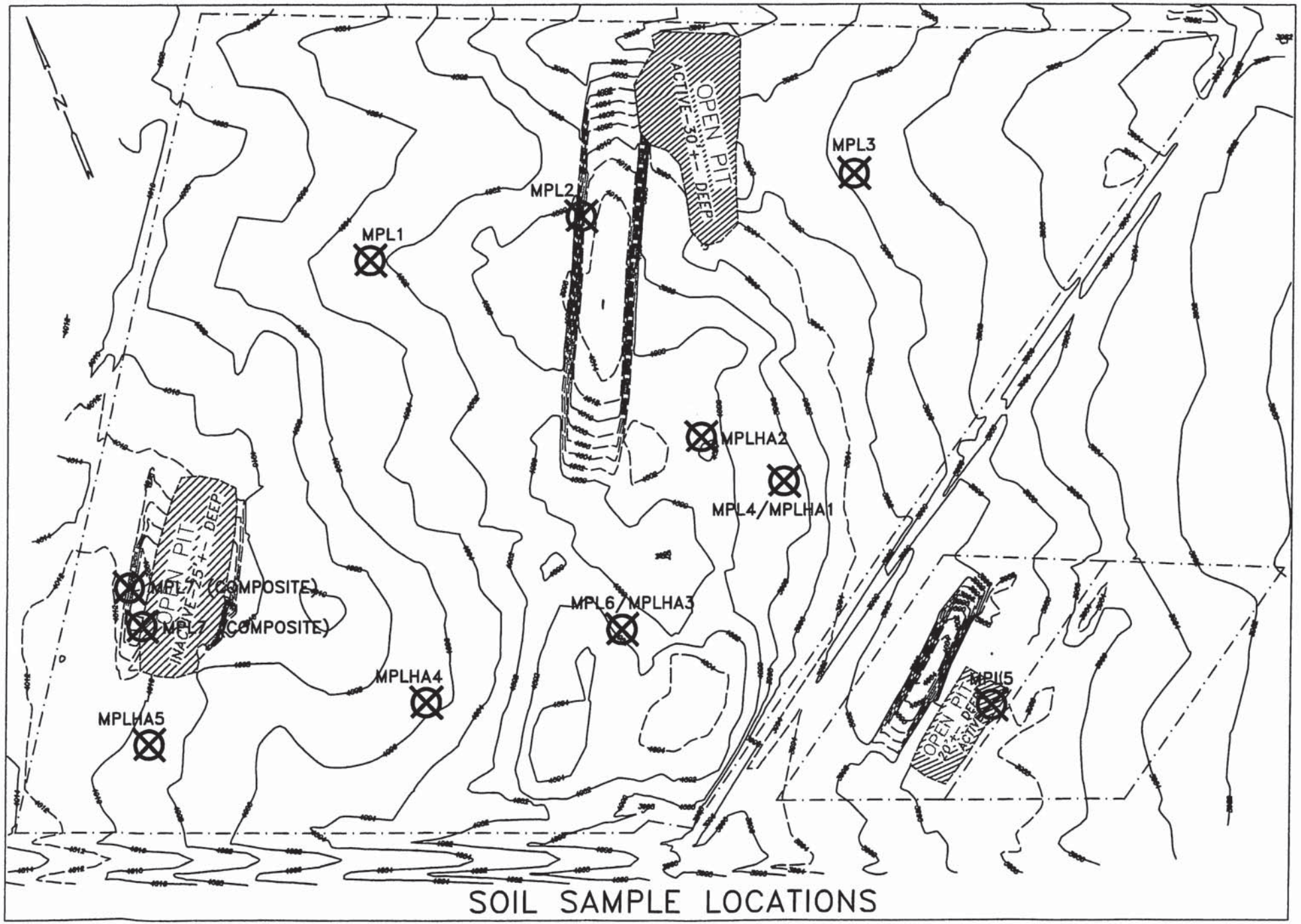
Mean	21	26	29	36	49	56	63	61	52	44	28	18	40
Min.	1	16	19	25	39	47	55	50	42	35	10	-5	28

1988	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	28	33	43	32	50	36	68	67	60	39	33	13	
2	32	43	33	33	36	46	61	66	61	43	46	15	
3	23	43	36	33	30	54	66	70	58	42	35	13	
4	26	42	26	33	37	55	63	64	54	47	29	15	
5	29	32	26	37	49	65	64	63	44	41	36	25	
6	41	29	32	37	55	56	66	58	46	44	29	19	
7	26	34	35	38	38	62	65	65	44	44	30	21	
8	22	24	35	47	41	49	67	65	48	46	50	28	
9	23	27	25	40	35	46	63	62	47	49	49	23	
10	22	26	41	29	41	48	63	65	54	52	33	32	
11	23	23	28	27	48	63	63	65	52	38	44	25	
12	31	22	19	31	44	61	61	63	61	36	29	23	
13	20	21	16	35	47	63	63	61	57	41	35	23	
14	21	32	11	40	51	72	72	63	57	42	42	21	
15	15	21	21	32	50	68	68	63	44	54	42	19	
16	38	21	32	43	52	70	70	63	52	42	18	32	
17	28	29	33	35	60	64	64	60	58	43	17	19	
18	29	35	21	28	60	67	67	60	57	45	18	25	
19	34	37	13	34	59	60	60	65	45	47	25	43	
20	21	21	16	45	41	67	67	66	55	52	14	25	
21	13	20	19	44	42	58	58	63	57	48	12	21	
22	23	23	29	47	42	62	56	68	57	46	12	26	
23	13	27	29	31	48	59	56	62	50	42	17	31	
24	19	29	39	35	48	68	62	66	40	36	37	20	
25	8	27	29	31	54	59	65	65	45	35	47	23	
26	20	47	31	37	49	62	59	65	46	36	38	43	
27	19	40	38	42	56	65	65	66	47	38	17	16	
28	23	31	43	49	55	62	66	62	44	39	11	8	
29	21	31	34	45	60	62	61	60	42	37	15	8	
30	35	*****	26	38	63	60	57	61	44	37	10	11	
31	25	*****	32	*****	44	*****	57	59	*****	32	*****	11	
Mean	24	30	29	36	48	58	63	64	51	42	29	22	41
Min.	8	20	11	27	30	36	56	58	40	32	10	8	28

1989	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1	11	45	38	36	42	51	70	67	60	42	29	24	
2	29	40	33	40	41	62	58	67	59	41	20	15	
3	26	35	50	50	44	59	62	68	58	54	19	13	
4	35	35	27	32	42	50	62	68	59	51	22	14	
5	39	51	20	42	46	46	69	72	64	55	32	12	
6	30	14	19	32	47	49	69	66	64	46	34	17	
7	30	16	31	35	47	51	58	67	64	44	26	21	
8	13	13	28	41	49	47	60	61	61	46	29	17	
9	6	24	31	55	51	48	60	58	52	42	17	12	
10	9	24	35	40	57	48	72	56	58	39	22	28	
11	24	24	33	24	59	52	65	53	51	38	24	17	
12	24	41	35	36	49	57	60	67	64	42	24	-2	
13	22	31	42	44	41	51	65	69	52	40	28	0	
14	7	32	38	36	41	52	63	63	52	35	28	3	
15	10	33	32	41	40	62	73	59	48	49	28	11	
16	9	28	31	44	40	66	74	58	47	39	16	27	
17	9	30	39	44	44	55	70	57	51	40	19	14	
18	23	41	32	42	38	53	60	68	60	33	21	26	
19	13	29	34	45	48	58	75	59	65	33	20	19	
20	20	35	38	42	44	59	65	60	65	25	35	12	
21	14	31	28	45	44	76	60	59	55	42	34	10	
22	24	16	22	56	50	66	63	59	58	49	32	9	
23	25	23	24	57	52	51	63	58	50	32	25	0	
24	32	25	40	49	52	71	65	63	45	32	21	7	
25	24	27	34	46	51	64	63	66	47	42	37	12	
26	16	28	40	43	45	62	61	62	48	42	37	9	
27	29	38	40	34	64	50	57	63	44	27	34	16	
28	23	32	30	26	64	62	61	63	37	36	27	40	
29	22	*****	30	35	60	71	62	65	38	36	24	26	
30	16	*****	36	41	56	70	63	64	43	26	20	31	
31	22	*****	27	*****	54	*****	63	60	*****	27	*****	25	
Mean	21	30	33	41	48	57	64	63	54	40	26	16	41
Min.	6	13	19	24	38	46	57	53	37	25	16	-2	28

Attachment C

Soil Sampling Results



SOIL SAMPLE LOCATIONS

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Moisture Density Relations of Soils

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Date: OCTOBER 22, 1999

Project: MEVATEC Q.C.
MPL SAMPLES

PEI File No.: 99-121

Date Sampled: 9-9-99

Soil Type: SILTY SAND

Sample Location: MPL 1

Laboratory Test Method: ASTM D-698-A

Trial No.	Wet Density pcf	Dry Density pcf	Moisture Percent
1	133.1	123.0	8.2
2	135.0	123.7	9.1
3	138.2	125.3	10.3
4	138.4	124.4	11.3
5	137.2	122.4	12.1

Maximum Dry Density 125.3 Optimum Moisture Content 10.3%

Remarks:

Lab No.: 36393

Reviewed By: D. W. B.

Reviewed By:

Certified By: Willie H. Bagley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Particle Size Analysis of Soils
(ASTM D-422)

MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Project: MEVATEC Q.C.
MPL SAMPLES
File No.: 99-121
Date: Oct 22, 1999

	UNIFIED	AASHTO
Soil Type and Class.: SILTY SAND	SM	A-2-4

Sampled From: MPL 1

Lab No.: 36393

BEFORE WASH		POST WASH	
Dry + Container	221.80	Dry + Container	156.30
Container Wt.		Container Wt.	
Dry Soil Wt.	221.80	Dry Soil Wt.	156.30
WT PASSING #4		Init. Prop. Wt.	

SIEVE NUMBER	WT. RETAINED	% RETAINED	% PASSING	SPEC.
3"				
2"				
1-1/2				
1				
3/4				
1/2				
3/8	.00	.0	100.0	
#4	4.80	2.2	97.8	
#10	22.50	10.1	89.9	
#20	50.10	22.6	77.4	
#40	77.40	34.9	65.1	
#60	101.00	45.5	54.5	
#140	142.60	64.3	35.7	
#200	155.30	70.0	30.0	
PAN	156.20			

SOIL LOST= .10 PERCENT ERROR= .05

Remarks: SANDY/NON-PLASTIC
LL:
PL:
PI:

Reviewed By: Reviewed By: Certified By:

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

COEFFICIENT OF PERMEABILITY
FALLING HEAD

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

PROJECT: MEVETEC Q.C
MPL SAMPLES

FILE NO.: 99-121

DATE OF REPORT: OCTOBER 21, 1999

SAMPLE LOCATION: MPL 1

LAB NO.: 36393

TEST SPECIMEN CONDITIONS AT BEGINNING OF TEST:
WET UNIT WEIGHT: 127.2 PCF % MOISTURE: 10.3
DRY UNIT WEIGHT: 115.2 PCF % COMPACTION: 92.0

PROCTOR INFORMATION:
MAXIMUM DRY DENSITY: 125.3
OPTIMUM MOISTURE CONTENT: 10.3

COEFFICIENT OF PERMEABILITY (cm/sec.): k_{20}= 2.8 X 10^{-5}

Remarks:

Reviewed By: B. W. B.

Reviewed By:

Certified By: William H. Brayley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Moisture Density Relations of Soils

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Date: OCTOBER 22, 1999

Project: MEVATEC Q.C.
MPL SAMPLES

PEI File No.: 99-121

Date Sampled: 9-9-99

Soil Type: SILTY SAND

Sample Location: MPL 2

Laboratory Test Method: ASTM D-698-A

Trial No.	Wet Density pcf	Dry Density pcf	Moisture Percent
1	125.3	114.6	9.4
2	130.9	118.0	11.0
3	136.2	121.4	12.2
4	134.0	117.4	14.1
5	133.1	115.4	15.3

Maximum Dry Density 121.4 Optimum Moisture Content 12.2%

Remarks:

Lab No.: 36394

Reviewed By: K.W.G.

Reviewed By:

Certified By: William H. Bagley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

COEFFICIENT OF PERMEABILITY
FALLING HEAD

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

PROJECT: MEVETEC Q.C
MPL SAMPLES

FILE NO.: 99-121

DATE OF REPORT: OCTOBER 21, 1999

SAMPLE LOCATION: MPL 2

LAB NO.: 36394

TEST SPECIMEN CONDITIONS AT BEGINNING OF TEST:
WET UNIT WEIGHT: 125.3 PCF % MOISTURE: 12.2
DRY UNIT WEIGHT: 111.7 PCF % COMPACTION: 92.0

PROCTOR INFORMATION:
MAXIMUM DRY DENSITY: 121.4
OPTIMUM MOISTURE CONTENT: 12.2

COEFFICIENT OF PERMEABILITY (cm/sec.): k_{20}= 2.4 X 10^{-5}

Remarks:

Reviewed By: B. W. B.

Reviewed By:

Certified By: William H. Dingley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Particle Size Analysis of Soils
(ASTM D-422)

MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Project: MEVATEC Q.C.
MPL SAMPLES
File No.: 99-121
Date: Oct 22, 1999

	UNIFIED	AASHTO
Soil Type and Class.: SILTY SAND	SM	A-2-4

Sampled From: MPL 2

Lab No.: 36394

BEFORE WASH		POST WASH	
Dry + Container	300.20	Dry + Container	217.60
Container Wt.		Container Wt.	
Dry Soil Wt.	300.20	Dry Soil Wt.	217.60
WT PASSING #4		Init. Prop. Wt.	

SIEVE NUMBER	WT. RETAINED	% RETAINED	% PASSING	SPEC.
3"				
2"				
1-1/2				
1				
3/4				
1/2	.00	.0	100.0	
3/8	2.90	1.0	99.0	
#4	12.70	4.2	95.8	
#10	38.70	12.9	87.1	
#20	70.90	23.6	76.4	
#40	110.00	36.6	63.4	
#60	142.80	47.6	52.4	
#140	195.60	65.2	34.8	
#200	214.80	71.6	28.4	
PAN	217.40			

SOIL LOST= .20 PERCENT ERROR= .07

Remarks: SANDY/NON-PLASTIC
LL:
PL:
PI:

Reviewed By: B. W. B.

Reviewed By:

Certified By: William H. Kingsley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Moisture Density Relations of Soils

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Date: OCTOBER 22, 1999

Project: MEVATEC Q.C.
MPL SAMPLES

PEI File No.: 99-121

Date Sampled: 9-9-99

Soil Type: SILTY SAND

Sample Location: MPL 3

Laboratory Test Method: ASTM D-698-A

Trial No.	Wet Density pcf	Dry Density pcf	Moisture Percent
1	130.5	121.6	7.3
2	138.3	127.3	8.7
3	138.1	125.8	9.7
4	137.3	124.0	10.7
5	136.0	121.7	11.8

Maximum Dry Density 127.3 Optimum Moisture Content 8.7%

Remarks:

Lab No.: 36395

Reviewed By: J. W. S.

Reviewed By:

Certified By: William H. Hagley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

COEFFICIENT OF PERMEABILITY
FALLING HEAD

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

PROJECT: MEVETEC Q.C
MPL SAMPLES

FILE NO.: 99-121

DATE OF REPORT: OCTOBER 21, 1999

SAMPLE LOCATION: MPL 3

LAB NO.: 36395

TEST SPECIMEN CONDITIONS AT BEGINNING OF TEST:
WET UNIT WEIGHT: 127.3 PCF % MOISTURE: 9.0
DRY UNIT WEIGHT: 116.8 PCF % COMPACTION: 91.8

PROCTOR INFORMATION:
MAXIMUM DRY DENSITY: 127.3
OPTIMUM MOISTURE CONTENT: 8.7

COEFFICIENT OF PERMEABILITY (cm/sec.): $k_{20} = 2.6 \times 10^{-6}$

Remarks:

Reviewed By: B. W. B.

Reviewed By:

Certified By: William H. Rangley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Particle Size Analysis of Soils
(ASTM D-422)

MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Project: MEVATEC Q.C.
MPL SAMPLES
File No.: 99-121
Date: Oct 22, 1999

	UNIFIED	AASHTO
Soil Type and Class.: SILTY SAND	SM	A-4

Sampled From: MPL 3

Lab No.: 36395

BEFORE WASH		POST WASH	
Dry + Container	182.50	Dry + Container	98.60
Container Wt.		Container Wt.	
Dry Soil Wt.	182.50	Dry Soil Wt.	98.60
WT PASSING #4		Init. Prop. Wt.	

SIEVE NUMBER	WT. RETAINED	% RETAINED	% PASSING	SPEC.
3"				
2"				
1-1/2				
1				
3/4				
1/2				
3/8	.00	.0	100.0	
#4	3.20	1.8	98.2	
#10	13.90	7.6	92.4	
#20	29.70	16.3	83.7	
#40	46.90	25.7	74.3	
#60	61.70	33.8	66.2	
#140	87.50	47.9	52.1	
#200	97.70	53.5	46.5	
PAN	98.60			

SOIL LOST= 0 PERCENT ERROR= 0

Remarks: SANDY/NON-PLASTIC
LL:
PL:
PI:

Reviewed By: B. W. B.

Reviewed By:

Certified By: William R. Pogeley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

COEFFICIENT OF PERMEABILITY
FALLING HEAD

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

PROJECT: MEVETEC Q.C
MPL SAMPLES

FILE NO.: 99-121

DATE OF REPORT: OCTOBER 21, 1999

SAMPLE LOCATION: MPL 4

LAB NO.: 36396

TEST SPECIMEN CONDITIONS AT BEGINNING OF TEST:
WET UNIT WEIGHT: 126.5 PCF
DRY UNIT WEIGHT: 115.4 PCF
% MOISTURE: 9.7
% COMPACTION: 92.3

PROCTOR INFORMATION:
MAXIMUM DRY DENSITY: 125.1
OPTIMUM MOISTURE CONTENT: 9.9

COEFFICIENT OF PERMEABILITY (cm/sec.): $k_{20} = 4.2 \times 10^{-6}$

Remarks:

Reviewed By: B. W. B.

Reviewed By:

Certified By: William H. Bagley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Moisture Density Relations of Soils

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Date: OCTOBER 22, 1999

Project: MEVATEC Q.C.
MPL SAMPLES

PEI File No.: 99-121

Date Sampled: 9-9-99

Soil Type: SILTY SAND

Sample Location: MPL 4

Laboratory Test Method: ASTM D-698-A

Trial No.	Wet Density pcf	Dry Density pcf	Moisture Percent
1	122.9	115.0	6.9
2	133.7	123.0	8.7
3	137.4	125.0	9.9
4	137.4	124.0	10.8
5	137.3	122.8	11.8

Maximum Dry Density 125.0 Optimum Moisture Content 9.9%

Remarks:

Lab No.: 36396

Reviewed By: B. W. G.

Reviewed By:

Certified By: William H. Kingsley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Particle Size Analysis of Soils
(ASTM D-422)

MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Project: MEVATEC Q.C.
MPL SAMPLES
File No.: 99-121
Date: Oct 22, 1999

	UNIFIED	AASHTO
Soil Type and Class.: SILTY SAND	SM	A-2-4

Sampled From: MPL 4

Lab No.: 36396

BEFORE WASH		**POST WASH**	
Dry + Container	203.40	Dry + Container	153
Container Wt.		Container Wt.	
Dry Soil Wt.	203.40	Dry Soil Wt.	153
WT PASSING #4		Init. Prop. Wt.	

SIEVE NUMBER	**WT. RETAINED**	**% RETAINED**	**% PASSING**	**SPEC.**
3"				
2"				
1-1/2				
1				
3/4				
1/2	.00	.0	100.0	
3/8	2.60	1.3	98.7	
#4	11.10	5.5	94.5	
#10	25.40	12.5	87.5	
#20	46.80	23.0	77.0	
#40	76.40	37.6	62.4	
#60	100.40	49.4	50.6	
#140	137.30	67.5	32.5	
#200	151.10	74.3	25.7	
PAN	153.00			

SOIL LOST= 0 PERCENT ERROR= 0

Remarks: SANDY/NON-PLASTIC
LL:
PL:
PI:

Reviewed By: A. W. B.

Reviewed By:

Certified By: William H. Bingley

OCT 27 1999
DIVISION II

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Moisture Density Relations of Soils

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Date: OCTOBER 22, 1999

Project: MEVATEC Q.C.
MPL SAMPLES

PEI File No.: 99-121

Date Sampled: 9-9-99

Soil Type: SILTY SAND

Sample Location: MPL 5

Laboratory Test Method: ASTM D-698-A

Trial No.	Wet Density pcf	Dry Density pcf	Moisture Percent
1	122.0	111.1	9.9
2	124.0	111.6	11.1
3	126.1	112.9	11.8
4	125.9	111.0	13.5
5	125.2	108.9	14.9

Maximum Dry Density 112.9 Optimum Moisture Content 11.8%

Remarks:

Lab No.: 36397

Reviewed By: D.W.B.

Reviewed By:

Certified By:

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

COEFFICIENT OF PERMEABILITY
FALLING HEAD

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

PROJECT: MEVETEC Q.C
MPL SAMPLES

FILE NO.: 99-121

DATE OF REPORT: OCTOBER 21, 1999

SAMPLE LOCATION: MPL 5

LAB NO.: 36397

TEST SPECIMEN CONDITIONS AT BEGINNING OF TEST:
WET UNIT WEIGHT: 116.1 PCF
DRY UNIT WEIGHT: 103.9 PCF
% MOISTURE: 11.8
% COMPACTION: 92.0

PROCTOR INFORMATION:
MAXIMUM DRY DENSITY: 112.9
OPTIMUM MOISTURE CONTENT: 11.8

COEFFICIENT OF PERMEABILITY (cm/sec.): $k_{20} = 4.0 \times 10^{-4}$

Remarks:

Reviewed By: B.W.B.

Reviewed By:

Certified By: William H. Hughes

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Particle Size Analysis of Soils
(ASTM D-422)

MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Project: MEVATEC Q.C.
MPL SAMPLES
File No.: 99-121
Date: Oct 22, 1999

	UNIFIED	AASHTO
Soil Type and Class.: SILTY SAND	SM	A-2-4

Sampled From: MPL 5

Lab No.: 36397

BEFORE WASH		POST WASH	
Dry + Container	221.70	Dry + Container	190.0
Container Wt.		Container Wt.	
Dry Soil Wt.	221.70	Dry Soil Wt.	190.0
WT PASSING #4		Init. Prop. Wt.	

SIEVE NUMBER	WT. RETAINED	% RETAINED	% PASSING	SPEC.
3"				
2"				
1-1/2				
1				
3/4				
1/2				
3/8	.00	.0	100.0	
#4	2.20	1.0	99.0	
#10	7.50	3.4	96.6	
#20	23.80	10.7	89.3	
#40	62.60	28.2	71.8	
#60	104.10	47.0	53.0	
#140	174.90	78.9	21.1	
#200	189.00	85.3	14.7	
PAN	190.00			

SOIL LOST= 0 PERCENT ERROR= 0

Remarks: SANDY/NON-PLASTIC
LL:
PL:
PI:

Reviewed By: B. W. B.

Reviewed By:

Certified By: William [illegible]

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Moisture Density Relations of Soils

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Date: OCTOBER 22, 1999

Project: MEVATEC O.C.
MPL SAMPLES

PEI File No.: 99-121

Date Sampled: 9-9-99

Soil Type: SILTY SAND

Sample Location: MPL 6

Laboratory Test Method: ASTM D-698-A

Trial No.	Wet Density pcf	Dry Density pcf	Moisture Percent
1	128.1	116.7	9.8
2	132.0	119.0	10.9
3	135.6	120.6	12.5
4	135.0	119.1	13.3
5	133.6	117.0	14.2

Maximum Dry Density 120.6 Optimum Moisture Content 12.5%

Remarks:

Lab No.: 36398

Reviewed By: B. W. B.

Reviewed By:

Certified By: William H. Kingsley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

COEFFICIENT OF PERMEABILITY
FALLING HEAD

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

PROJECT: MEVETEC Q.C
MPL SAMPLES

FILE NO.: 99-121

DATE OF REPORT: OCTOBER 21, 1999

SAMPLE LOCATION: MPL 6

LAB NO.: 36398

TEST SPECIMEN CONDITIONS AT BEGINNING OF TEST:
WET UNIT WEIGHT: 124.7 PCF
DRY UNIT WEIGHT: 110.9 PCF
% MOISTURE: 12.5
% COMPACTION: 91.9

PROCTOR INFORMATION:
MAXIMUM DRY DENSITY: 120.6
OPTIMUM MOISTURE CONTENT: 12.4

COEFFICIENT OF PERMEABILITY (cm/sec.): $k_{20} = 5.8 \times 10^{-6}$

Remarks:

Reviewed By: G. W. G.

Reviewed By:

Certified By: William H. Bradley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Particle Size Analysis of Soils
(ASTM D-422)

MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Project: MEVATEC Q.C.
MPL SAMPLES
File No.: 99-121
Date: Oct 22, 1999

	UNIFIED	AASHTO
Soil Type and Class.: SILTY SAND	SM	A-2-4

Sampled From: MPL 6

Lab No.: 36398

BEFORE WASH		POST WASH	
Dry + Container	208.60	Dry + Container	138.0
Container Wt.		Container Wt.	
Dry Soil Wt.	208.60	Dry Soil Wt.	138.0
WT PASSING #4		Init. Prop. Wt.	

SIEVE NUMBER	WT. RETAINED	% RETAINED	% PASSING	SPEC.
3"				
2"				
1-1/2				
1				
3/4				
1/2				
3/8	.00	.0	100.0	
#4	5.00	2.4	97.6	
#10	19.00	9.1	90.9	
#20	40.90	19.6	80.4	
#40	66.20	31.7	68.3	
#60	87.54	42.0	58.0	
#140	122.30	58.6	41.4	
#200	136.30	65.3	34.7	
PAN	138.00			

SOIL LOST= 0 PERCENT ERROR= 0

Remarks: SANDY/NON-PLASTIC
LL:
PL:
PI:

Reviewed By: B. W. B.

Reviewed By:

Certified By: William A. Bingaley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Moisture Density Relations of Soils

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Date: OCTOBER 22, 1999

Project: MEVATEC Q.C.
MPL SAMPLES

PEI File No.: 99-121

Date Sampled: 9-9-99

Soil Type: SILTY SAND

Sample Location: MPL 7

Laboratory Test Method: ASTM D-698-A

Trial No.	Wet Density pcf	Dry Density pcf	Moisture Percent
1	129.6	119.4	8.6
2	132.2	121.2	9.1
3	137.1	124.9	9.8
4	137.5	123.9	11.0
5	137.0	122.3	12.0

Maximum Dry Density 124.9 Optimum Moisture Content 9.8%

Remarks:

Lab No.: 36399

Reviewed By: B.W.B.

Reviewed By:

Certified By:

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

DEC 17 '99

COEFFICIENT OF PERMEABILITY
FALLING HEAD

ATTN: MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

PROJECT: MEVETEC Q.C
MPL SAMPLES

FILE NO.: 99-121

DATE OF REPORT: OCTOBER 21, 1999

SAMPLE LOCATION: MPL 7

LAB NO.: 36399

TEST SPECIMEN CONDITIONS AT BEGINNING OF TEST:
WET UNIT WEIGHT: 126.2 PCF % MOISTURE: 9.8
DRY UNIT WEIGHT: 114.9 PCF % COMPACTION: 92.0

PROCTOR INFORMATION:
MAXIMUM DRY DENSITY: 124.9
OPTIMUM MOISTURE CONTENT: 9.8

COEFFICIENT OF PERMEABILITY (cm/sec.): $k_{20} = 1.1 \times 10^{-4}$

Remarks:

Reviewed By: B.W.B.

Reviewed By:

Certified By: William H. Bingeley

PRECISION ENGINEERING, INC.
P. O. BOX 422, LAS CRUCES,
NEW MEXICO 88004
505-523-7674

Particle Size Analysis of Soils
(ASTM D-422)

#N/A!
MS. BRIGITTE BURCHFIELD
MEVATEC CORPORATION
BUILDING S-146W
P.O. BOX 399
WSMR, NM 88002

Project: MEVATEC Q.C.
MPL SAMPLES
File No.: 99-121
Date: Oct 22, 1999

	UNIFIED	AASHTO
Soil Type and Class.: SILTY SAND	SM	A-2-4

Sampled From: MPL 7

Lab No.: 36399

BEFORE WASH		POST WASH	
Dry + Container	214.80	Dry + Container	161.6
Container Wt.		Container Wt.	
Dry Soil Wt.	214.80	Dry Soil Wt.	161.6
WT PASSING #4		Init. Prop. Wt.	

SIEVE NUMBER	WT. RETAINED	% RETAINED	% PASSING	SPEC.
3"				
2"				
1-1/2				
1				
3/4				
1/2				
3/8	.00	.0	100.0	
#4	6.10	2.8	97.2	
#10	19.40	9.0	91.0	
#20	40.40	18.8	81.2	
#40	70.24	32.7	67.3	
#60	98.10	45.7	54.3	
#140	146.20	68.1	31.9	
#200	160.10	74.5	25.5	
PAN	161.50			

SOIL LOST= .10 PERCENT ERROR= .05

Remarks: SANDY/NON-PLASTIC
LL:
PL:
PI:

Reviewed By: B. W. G.

Reviewed By:

Certified By: William H. Kenyon Jr.

Attachment D

Summary of Help Model Input Parameters

Guidance Document

for

Performance Demonstration for an Alternate Cover Design under Section 502.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling

and

Performance Demonstration for an Alternate Liner Design under Section 306.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling

This document is for guidance only and is subject to change. However, any deviations from this document must be fully justified to the satisfaction of the Department.

Prepared by the
New Mexico Environment Department
Solid Waste Bureau
Permit Section
April 1, 1998

Under Section 502.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling

1. Existing Solid Waste Landfills without a Liner System:

A prescriptive landfill cover system must, in accordance with Section 502.A.1, consist of an infiltration layer comprised of a minimum of 18 inches of earthen material with the required hydraulic conductivity (K) and a minimum of 6 inches of soil that is capable of sustaining native plant growth as an erosion layer (Figure 1). The cover component of 18 inches of earthen material must be equivalent to the least hydraulically conductive natural subsoils or a saturated hydraulic conductivity of no greater than 1×10^{-5} cm/sec. For example, if the hydraulic conductivity of the natural subsoils is 5×10^{-6} cm/sec, then the K of the infiltration layer material must be equivalent to these soils. *However, this example is for modeling purposes only. If the K of the underlying subsoils is less than 1×10^{-5} cm/sec (e.g., 5×10^{-6} cm/sec), then an alternative cover design must be proposed since 1×10^{-5} cm/sec is the lowest acceptable actual K for soils used in covers due to desiccation and root penetration (see example below).* If the hydraulic conductivity of the natural subsoils is greater than 1×10^{-5} cm/sec (e.g., 1×10^{-4} cm/sec), the K of the infiltration layer material must equate to the 1×10^{-5} cm/sec requirement.

If the infiltration layer meets the minimum hydraulic conductivity of 1×10^{-5} cm/sec or that of the natural subsoils and the minimum 18 inch condition then a Hydrologic Evaluation of Landfill Performance (HELP) Model simulation is not required. If an alternative cover design is proposed, it must achieve an equivalent reduction in infiltration as the infiltration layer specified in Section 502.A.1.a. Therefore, a HELP Model simulation is required to demonstrate that the design of such a cover provides equivalent reduction in infiltration as the prescriptive cover design. If the natural subsoils have a hydraulic conductivity of less than 1×10^{-5} cm/sec (e.g., 5×10^{-6} cm/sec), then the cover must achieve equivalent reduction in infiltration as that of the prescriptive cover but with an 18 inch infiltration layer with a hydraulic conductivity of 5×10^{-6} cm/sec.

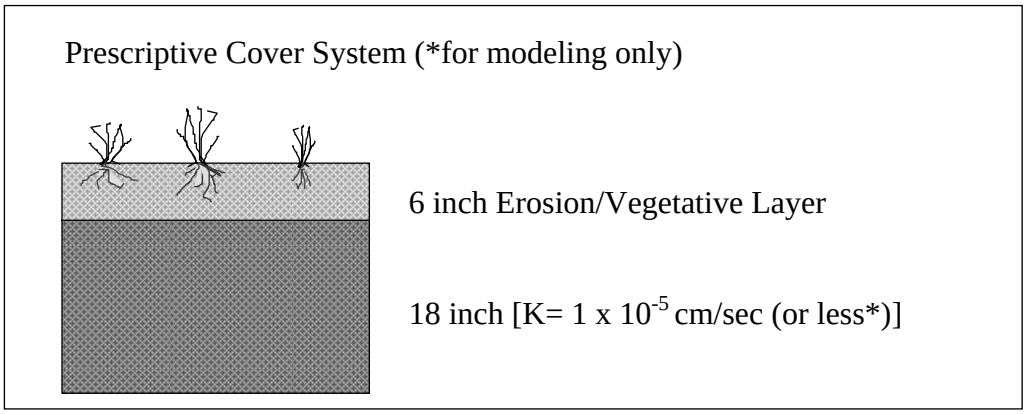


Figure 1. Prescriptive Cover System

A demonstration of equivalent reduction in infiltration is determined by using the EPA HELP Model. The HELP Model simulations need to compare the prescriptive cover and the alternative cover design (Figure 2). The simulation for the prescriptive cover must include the erosion, infiltration and intermediate cover layers. The alternative cover design simulation includes the intermediate and alternative cover layers. The two designs are to be simulated for years 1 through 5 with "poor" vegetation during the post-closure care period to demonstrate equivalency (Simulations #1 & #2). In New Mexico, it is assumed for a conservative value that the vegetation will be between "bare ground" and "fair vegetation" designated as "poor vegetation". Precipitation (wettest 5 consecutive year period using Climatedata CD or NOAA data files: discs or manual entry), evapotranspiration, temperature (use values associated with wettest 5 consecutive years of precipitation), and solar radiation data must be site specific and identical for both alternative and prescriptive cover designs simulations. Provide justification for all input parameters in the model utilizing the attached forms. Indicate characteristics of on-site or other sources of soil proposed for the construction of cover and the parameter values in the model. It is anticipated that the entire area of the landfill or cell will be modeled. The Department recommends initializing the soil moisture content to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point]. Other values deviating from this range may be used but must be fully justified. The leaf area index may be between 0.8 and 1.6 depending on the site location. The evaporative zone depth may be between 18" and 28" depending on the site location.

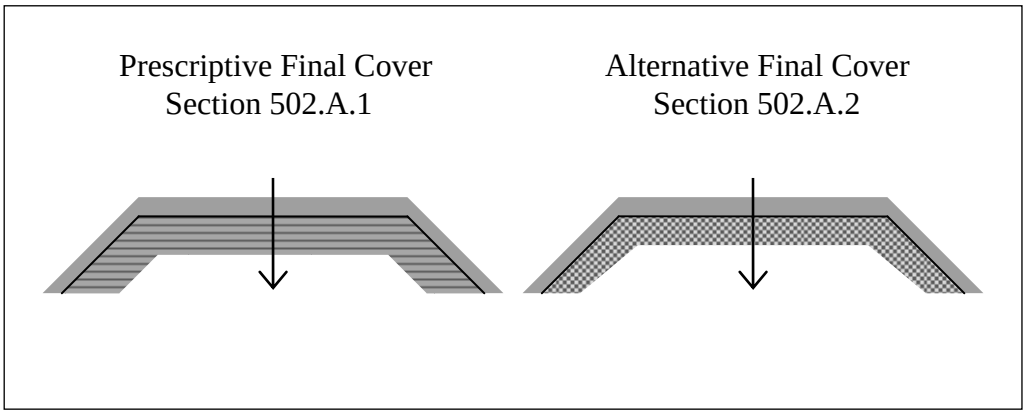


Figure 2

For example, comparing the prescriptive cover of:

1) 6 inches of topsoil
2) 18 inches of compacted soil ($K = 5 \times 10^{-6}$ cm/sec* - to meet natural subsoils $K = 5 \times 10^{-6}$)
3) Intermediate cover layer (optional* for modeling purposes) [*unless an intermediate cover layer is used for modeling purposes with a proposed alternative cover system (see below), then an intermediate cover layer must be used for modeling purposes]

with a proposed alternative cover system of:

1) 6 inches of topsoil
2) 30 inches of compacted ($K = 1 \times 10^{-5}$ cm/sec*)
3) Intermediate cover layer (optional for modeling purposes)

* K = 5 x 10^{-6} cm/sec is for modeling purposes only since 1 x 10^{-5} cm/sec is the lowest acceptable actual K for soils used in covers. Even if soils with K = 5 x 10^{-6} cm/sec are available for use in the cover, over time the K will increase to 1 x 10^{-5} cm/sec due to desiccation and root penetration.

Input Parameters for HELP Simulation #1 (Prescriptive Cover)

Weather data

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 18" to 28" corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Clovis would be 20"; Santa Fe and Roswell would be 24"; Las Cruces, Albuquerque, and Farmington would be 28")

Maximum leaf area index: 0.8 to 1.6 corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 3 - e.g., Clovis would be 1.6; Santa Fe and Roswell would be 1.2; Farmington would be 1.0; Las Cruces and Albuquerque would be 0.8)

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from the wettest 5 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with the wettest 5 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 2 for "poor"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; "closed"

Surface area: entire disposal area of landfill

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6" of topsoil, 18" of infiltration layer, 12" of intermediate cover layer* [*optional for modeling purposes (unless an intermediate cover layer is used for modeling purposes with a proposed alternative cover system in Simulation #2, then an intermediate cover layer must be used for modeling purposes)]

Layer type: "1" vertical percolation layer for all cover materials

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): The K of the infiltration layer must be the greatest actual value (unless greater than $1x\ 10^{-5}$ cm/sec*) of the underlying soil [e.g., If the actual (two tested samples - different locations) K of the underlying soil = $1x\ 10^{-6}$ cm/sec and 2×10^{-6}, then model 18" of 2×10^{-6} cm/sec for the infiltration layer; *If the K of the underlying soil = 5×10^{-5} cm/sec, then model 18" of $1x\ 10^{-5}$ cm/sec].

Input Parameters for HELP Simulation #2 (Proposed Alternate Cover)

Weather data (must be the same as Simulation #1)

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 18" to 28" corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Clovis would be 20"; Santa Fe and Roswell would be 24"; Las Cruces, Albuquerque, and Farmington would be 28")

Maximum leaf area index: 0.8 to 1.6 corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 3 - e.g., Clovis would be 1.6; Santa Fe and Roswell would be 1.2; Farmington would be 1.0; Las Cruces and Albuquerque would be 0.8)

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from the wettest 5 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with the wettest 5 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 2 for "poor"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; "closed"

Surface area: entire disposal area of landfill

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6" of topsoil, 18" to proposed thickness of infiltration layer, 12" of intermediate cover layer* (*optional for modeling purposes)

Layer type: "1" vertical percolation layer for all* cover materials including GCLs used (*consult with the Department if a FML is proposed to be used in the cover)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): The K must be tested for the actual value unless the K is less than 1×10^{-5} cm/sec* (e.g., If the tested K is 5×10^{-5} cm/sec, then model the proposed thickness of the infiltration layer at 5×10^{-5} cm/sec. However, if the tested K is 2×10^{-6}, the lowest value to be modeled would be 1×10^{-5} cm/sec). *1×10^{-5} cm/sec is the lowest acceptable K for soils used in covers due to desiccation and root penetration; unless a GCL is proposed, then the actual K may be modeled for the GCL layer (i.e., 0.24" at 3×10^{-9} cm/sec).

2. New Solid Waste Landfills:

As in the above case, the cover for the proposed landfill with a prescriptive or alternative liner must achieve an equivalent protection as the liner. If an alternative final cover is proposed for the landfill, then a demonstration must be submitted to the Bureau for approval pursuant to Section 502.A. It must be determined by this demonstration that the proposed final cover design includes an infiltration layer that achieves an equivalent reduction in infiltration as the bottom liner (Figure 3). A HELP Model simulation comparison is acceptable for this demonstration for a 5 year period with vegetation. Precipitation (wettest 5 consecutive year period using Climatedata CD or NOAA data

files: discs or manual entry), evapotranspiration, temperature (use values associated with wettest 5 consecutive years of precipitation) , and solar radiation data must be site specific and identical for both liner and cover design simulations. Provide justification for all input parameters in the model utilizing the attached forms. Demonstrate the relationship of the characteristics of on-site or other sources of soil proposed for the construction of cover or liner and the parameter values in the model. It is anticipated that the entire area of the landfill or cell will be modeled. The Department recommends initializing the soil moisture content to be at least the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point]. Other values deviating from this range may be used but must be fully justified.

For example, the comparison must include a HELP Model simulation for the liner and the proposed final cover systems as below (see Simulations #4 & #3, respectively).

The simulation for an alternative liner system* could include:

1) the drainage/protective layer of the liner with leachate collection system,
2) the 60-mil HDPE FML,
3) the 0.25 inch ($K = 3 \times 10^{-9}$) GCL (geosynthetic clay liner),
4) the 6 inches of compacted in situ soil used as the prepared subgrade, and
5) with the solid waste cell open and no runoff.

*Any alternative liner system must meet the demonstration as described in the "Performance Demonstration For An Alternative Liner Design under Section 306.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling".

A liner system is compared with a HELP Model simulation for a proposed final cover:

1) 18 inches non-compacted material (6 inches of topsoil with poor grass and 12 inches of non-compacted soil),
2) the 0.25 inch GCL ($K = 3 \times 10^{-9}$),
3) 12 inches of intermediate cover (6 inches of compacted soil and 6 inches of non-compacted soil), and
4) with the solid waste cell closed and final placement of the cover to include runoff.

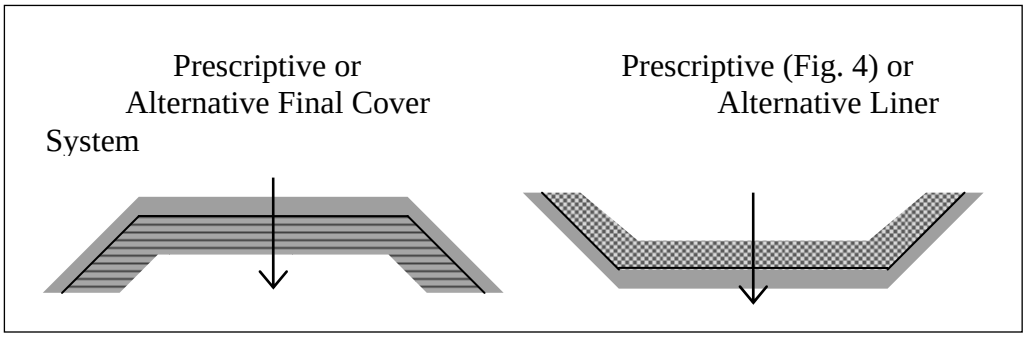


Figure 3

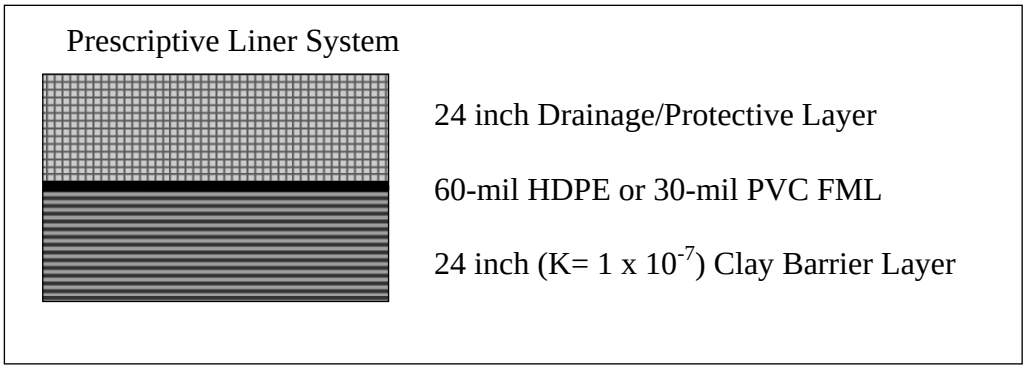


Figure 4

Input Parameters for HELP Simulation #3 (Proposed Alternate Cover)

Weather data

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 18" to 28" corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Clovis would be 20"; Santa Fe and Roswell would be 24"; Las Cruces, Albuquerque, and Farmington would be 28")

Maximum leaf area index: 0.8 to 1.6 corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 3 - e.g., Clovis would be 1.6; Santa Fe and Roswell would be 1.2; Farmington would be 1.0; Las Cruces and Albuquerque would be 0.8)

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from the wettest 5 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with the wettest 5 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 2 for "poor"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; "closed"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6" of topsoil, Proposed thickness of infiltration layer or rooting medium or drainage layer, Possible GCL (0.24") or FML, subgrade thickness for GCL or FML (minimum of 6"), 12" of intermediate cover layer* (*optional for modeling purposes)

Layer type: Type "1" - vertical percolation layer for all* cover materials including GCLs used (*consult with the Department if a FML is proposed to be used in the cover)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): The K must be tested for the actual value unless the K is less than 1 x 10^{-5} cm/sec* (e.g., If the tested K is 5 x 10^{-5} cm/sec, then model the proposed thickness of the infiltration layer at 5 x 10^{-5} cm/sec. However, if the tested K is 2 x 10^{-6}, the lowest value to be modeled would be 1 x 10^{-5} cm/sec). *1 x 10^{-5} cm/sec is the lowest acceptable K for soils used in covers due to desiccation and root penetration; unless a GCL is proposed, then the actual K may be modeled for the GCL layer (i.e., 0.24" at 3 x 10^{-9} cm/sec).

<u>Input Parameters for HELP Simulation #4 (Prescriptive Liner or Proposed Alternate Liner - Tier I)</u>

Weather data (must be the same as Simulation #3)

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 12" to 18" corresponding with bare ground (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Santa Fe and Roswell would be 14"; Las Cruces, Albuquerque, and Farmington would be 18")

Maximum leaf area index: 0.0 corresponding with bare ground

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from the wettest 5 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with the wettest 5 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 1 for "bare ground"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 0%; "open"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 24" of drainage/protection layer, possible geonet*, FML, 24" of 1 x 10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner. (*A demonstration that no more than one foot of head will be on the liner must be made for this simulation. Therefore, a geonet may be necessary if the 24" drainage layer material is incapable of transmitting leachate so 12" of head is not on the liner.)

Layer type: Type "2" for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type "4" for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of "good"; Type "3" for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): For the 24" of drainage/protection layer use the tested K* for modeling the prescriptive liner design and for a proposed alternate liner design; for a possible geonet use the lowest value from the manufacture's specifications; for the FML use a K* value which is the greatest value from the manufacture's specifications; 24" of 1 x 10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL (3 x 10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner. (*must be the same value in both Simulation #5 & #6)

Performance Demonstration for an Alternate Liner Design under Section 306.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling

1. Permit applicants proposing an alternate liner in accordance with Section 306.A.2 must demonstrate the liner "... provides equivalent protection as the composite liner ... and ensures concentration values listed in Section 1110 will not be exceeded in the uppermost aquifer ... ". This requires that a two tier demonstration be made:

Tier 1 - the alternative liner provides equivalent protection, and

Tier 2 - the alternate liner ensures the uppermost aquifer will be protected.

The first tier of this demonstration may be satisfied through mathematical modeling using the EPA Hydrologic Evaluation of Landfill Performance (HELP) model. Two computer modeling analyses must be performed - (1) an analysis of the composite liner as specified in Section 306.A.1 and (2) an analysis of the proposed alternate liner as specified in Section 306.A.2. Each of these analyses must be performed under identical hydrologic and climatologic loading conditions of five years with no solid waste in the landfill (see Simulations #5 & 6). This time period is necessary to adequately evaluate the performance of the two liners. A successful demonstration of equivalent protection has been made when the analyses show equal or less percolation/leakage through the bottom layer of the proposed alternate liner than the percolation/leakage through the bottom layer of the Section 306.A.1 composite liner (Figure 5).

The second tier of the demonstration must include HELP modeling of the actual design conditions and the entire operational development of the landfill as closely as possible by doing a succession of model simulations which consider the factors in Section 306.A.2.a. To aid in accomplishing this, each successive computer simulation must use the previous simulation's moisture content output as the input for the following simulation (Figure 6). The modeling design method must be fully described. If no leakage is indicated at the end of the second simulation (#8) and subsequent simulations (#9 & #10) continue to indicate no leakage, then a successful demonstration has been made that the uppermost aquifer will be protected as required by Section 306.A.2 and it will not be necessary to perform a fate and transport modeling.

2. Justification for all input parameters in the HELP modeling must be provided utilizing the attached forms. Demonstrate the relationship of the characteristics of the soil proposed for the construction and operation of the landfill and the parameter values used in the model. Show justification for the soil and waste moisture content parameters as well as geomembrane liner data and storm water runoff fractions. The initial moisture content of the soil should be initialized by the use in the HELP model. The Department recommends initializing the soil moisture content to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point]. Other values deviating from this range may be used but must be fully justified.

3(1) First Tier of the Demonstration

Two simulations must be made, one of the Section 306.A.1 specified liner and one of the proposed alternate liner, both using the same precipitation (wettest 5 consecutive year period using Climatedata or NOAA tapes), temperature (use values associated with 5 wettest consecutive years), solar radiation, and evapotranspiration data (see Simulations #5 & #6). Current historic NOAA weather data from the nearest representative weather station as published by the National Climatic Data Center in Asheville, North Carolina must be used for the precipitation and temperature files. Both simulations must be made for the landfill in the open condition with no run-off and a Leaf Area Index of zero. *Simulations:*

#5 a A simulation for the specified liner design must be performed using a 24 inch protective layer, lateral drainage layer (which may be integral with the protective layer), an FML, and a 24 inch barrier layer of soil with a saturated hydraulic conductivity of 1 x 10^{-7} cm/sec. This simulation must be performed using no solid waste and for a five year period.

#6 A simulation for the proposed alternate liner design must be performed using a 24 inch protective layer, a lateral drainage layer (which may be integral with the protective layer), and the other proposed liner layer (the bottom layer must be modeled as a barrier layer). This simulation must be performed using no solid waste and for a five year period.

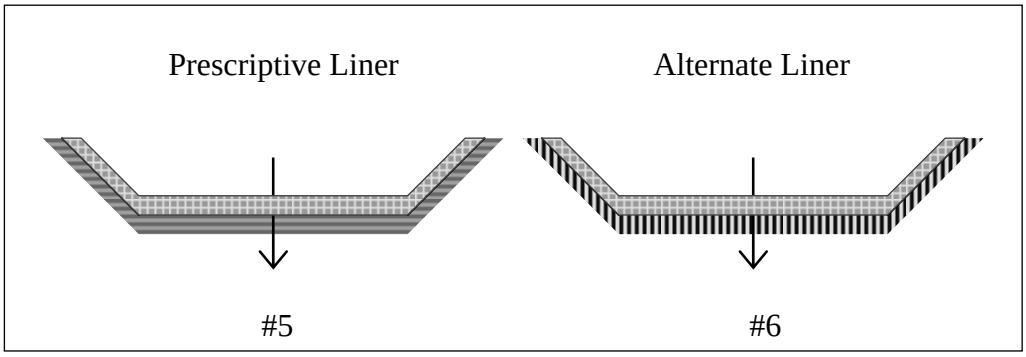


Figure 5

Compare the average annual percolation from the bottom layer of the two simulations. If the percolation is equivalent, a successful demonstration has been made for the first tier.

<u>Input Parameters for HELP Simulation #5* (Prescriptive Liner - Tier I)</u>

same as Simulation #4 with prescriptive liner design

<u>Input Parameters for HELP Simulation #6* (Proposed Alternate Liner - Tier I)</u>

same as Simulation #4 with proposed alternate liner design

*One of these simulations will also serve for the alternate cover design equivalency demonstration.

3(2) Second Tier of the Demonstration

Four simulations encompassing the entire life cycle of the facility to model actual design conditions and operational development as closely as possible must be performed (see Simulations #7, #8, #9 & #10). This is accomplished through a succession of four model simulations: one simulation of the open landfill, a second with the landfill partially filled with solid waste, a third with the landfill in the closed condition with bare ground, and a fourth with the landfill in the closed condition with "poor" vegetation. *Simulations:*

#7 The initial simulation must model the open landfill at start-up when the landfill contains no solid waste. The time period should extend for the anticipated duration of this condition (a minimum of two years).

#8 A succeeding simulation to model conditions of the partially filled landfill for a five year period*. This would incorporate daily and intermediate covers. (*This period may vary in accordance with anticipated operations.)

#9 Model the landfill in the closed condition with bare ground (a minimum of a two years).

#10 Finally, perform a simulation to model the landfill in the closed condition with poor vegetation for remainder of the post-closure care period (a minimum of 28 years).

If the simulations indicate no leakage after the third simulation (#9) and the subsequent simulation (#10), then the simulations have served to demonstrate the concentration values delineated in Section 1110 of the Regulations will not be exceeded in the uppermost aquifer at the relative point of compliance. Therefore, a successful demonstration has been made for the second tier.

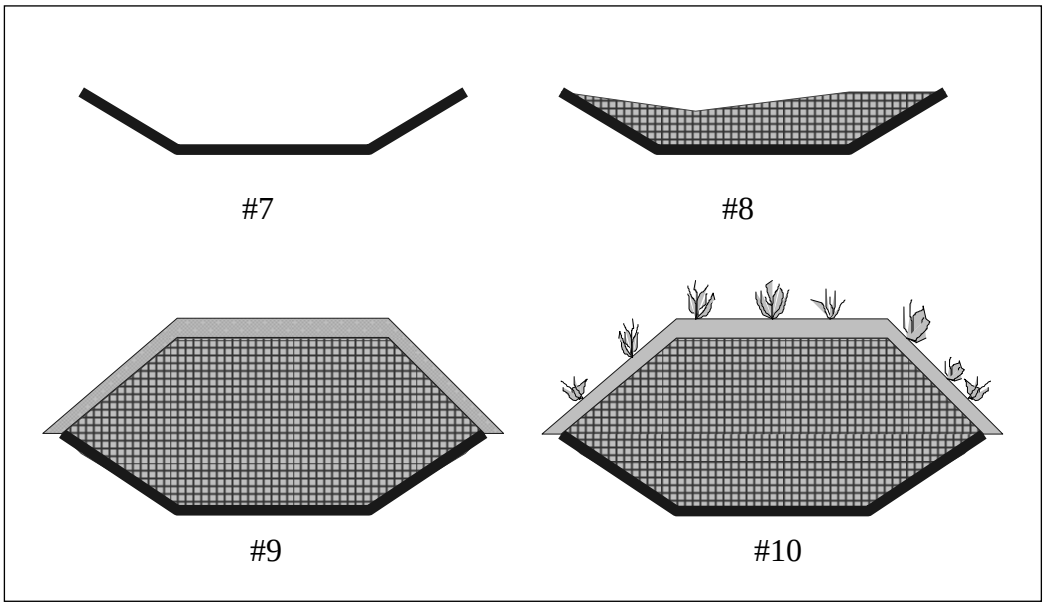


Figure 6

Input Parameters for HELP Simulation #7 (Proposed Alternate Liner - Tier II)

Weather data (must be the same as Simulation #3)

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 12" to 18" corresponding with bare ground (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Santa Fe and Roswell would be 14"; Las Cruces, Albuquerque, and Farmington would be 18")

Maximum leaf area index: 0.0 corresponding with bare ground

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from 2 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with 2 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 1 for "bare ground"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 0%; "open"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 24" of drainage/protection layer, possible geonet, FML, 24" of 1 x 10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner.

Layer type: Type "2" for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type "4" for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of "good"; Type "3" for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): For the 24" of drainage/protection layer use the tested K for modeling the proposed alternate liner design; for a possible geonet use the lowest value from the manufacture's specifications; for the FML use a K value which is the greatest value from the manufacture's specifications; GCL (3 x 10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner.

<u>Input Parameters for HELP Simulation #8 (Proposed Alternate Liner - Tier II)</u>

Weather data (must be the same as Simulation #3)

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 12” to 18” corresponding with bare ground (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Santa Fe and Roswell would be 14”; Las Cruces, Albuquerque, and Farmington would be 18”)

Maximum leaf area index: 0.0 corresponding with bare ground

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from 2 to 5* consecutive years for the appropriate weather reporting station (*may vary with landfill operations)

Temperature: daily* minimum and maximum temperatures corresponding with 2 to 5 years (same years as precipitation) for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: bare ground

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 0%; “open”

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 240” of solid waste (this thickness may vary depending on landfill operations); 24” of drainage/protection layer; possible geonet*; FML; 24” of 1×10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner.

Layer type: Type “1”, vertical percolation layer, must be used for solid waste. Type “2” for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type “4” for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of “good”; Type “3” for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User’s Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content must be initialized to be the value of the previous simulation’s (from Simulation #7) moisture content output as the input for the following simulation (Simulation #8). For compacted municipal solid waste with a HELP soil texture number of “18” use 20%* by volume/volume (which is greater than per mass basis - see EPA HELP User’s Guide for Version 3 for conversion) (*a lower value may be used if justified)

Saturated hydraulic conductivity (K): For compacted municipal solid waste with a HELP soil texture number of “18” will have a K of 1×10^{-3} cm/sec. For the 24” of drainage/protection layer use the tested K for modeling the proposed alternate liner design; for a possible geonet use the lowest value from the manufacture’s specifications; for the FML use a K value which is the greatest value from the manufacture’s specifications; GCL (3×10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner.

<u>Input Parameters for HELP Simulation #9 (Proposed Alternate Liner - Tier II)</u>

Weather data

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 12” to 18” corresponding with bare ground (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Santa Fe and Roswell would be 14”; Las Cruces, Albuquerque, and Farmington would be 18”)

Maximum leaf area index: 0.0 corresponding with bare ground

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from 2 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with 2 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 1 for "bare ground"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; "closed"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6" of topsoil, Proposed thickness of infiltration layer or rooting medium or drainage layer, Possible GCL (0.24") or FML, subgrade thickness for GCL or FML (minimum of 6"), 12" of intermediate cover layer* (*optional for modeling); Proposed thickness of solid waste (this thickness will vary depending on landfill design); 24" of drainage/protection layer; possible geonet*; FML; 24" of 1×10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner.

Layer type: Type “1” - vertical percolation layer for all* cover materials including GCLs used in the cover (*consult with the Department if a FML is proposed to be used in the cover).Type “1”, vertical percolation layer, must be used for solid waste. Type “2” for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type “4” for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of “good”; Type “3” for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User’s Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content must be initialized to be the value of the previous simulation’s (from Simulation #8) moisture content output as the input for the following simulation (Simulation #9).

Saturated hydraulic conductivity (K): The K must be tested for the actual value unless the K is less than 1×10^{-5} cm/sec* (e.g., If the tested K is 5×10^{-5} cm/sec, then model the proposed thickness of the infiltration layer at 5×10^{-5} cm/sec. However, if the tested K is 2×10^{-6}, the lowest value to be modeled would be 1×10^{-5} cm/sec). *1×10^{-5} cm/sec is the lowest acceptable K for soils used in covers due to desiccation and root penetration; unless a GCL is proposed, then the actual K may be modeled for the GCL layer (i.e., 0.24” at 3×10^{-9} cm/sec). For compacted municipal solid waste with a HELP soil texture number of “18” will have a K of 1×10^{-3} cm/sec. For the 24” of drainage/protection layer use the tested K for modeling the proposed alternate liner design; for a possible geonet use the lowest value from the manufacture’s specifications; for the FML use a K value which is the greatest value from the manufacture’s specifications; GCL (3×10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner.

<u>Input Parameters for HELP Simulation #10 (Proposed Alternate Liner - Tier II)</u>

Weather data

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 18” to 28” corresponding with “poor” vegetation (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Clovis would be 20”; Santa Fe and Roswell would be 24”; Las Cruces, Albuquerque, and Farmington would be 28”)

Maximum leaf area index: 0.8 to 1.6 corresponding with “poor” vegetation (see EPA Engineering Documentation for Version 3, Figure 3 - e.g., Clovis would be 1.6; Santa Fe and Roswell would be 1.2; Farmington would be 1.0; Las Cruces and Albuquerque would be 0.8)

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from 28 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with 28 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 2 for “poor”

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; “closed”

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6” of topsoil, Proposed thickness of infiltration layer or rooting medium or drainage layer, Possible GCL (0.24”) or FML, subgrade thickness for GCL or FML (minimum of 6”), 12” of

intermediate cover layer* (*optional for modeling); Proposed thickness of solid waste (this thickness will vary depending on landfill design); 24" of drainage/protection layer; possible geonet*; FML; 24" of 1 x 10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner.

Layer type: Type "1" - vertical percolation layer for all* cover materials including GCLs used (*consult with the Department if a FML is proposed to be used in the cover). Type "1", vertical percolation layer, must be used for solid waste. Type "2" for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type "4" for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of "good"; Type "3" for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content must be initialized to be the value of the previous simulation's (from Simulation #9) moisture content output as the input for the following simulation (Simulation #10).

Saturated hydraulic conductivity (K): The K must be tested for the actual value unless the K is less than 1 x 10^{-5} cm/sec* (e.g., If the tested K is 5 x 10^{-5} cm/sec, then model the proposed thickness of the infiltration layer at 5 x 10^{-5} cm/sec. However, if the tested K is 2 x 10^{-6}, the lowest value to be modeled would be 1 x 10^{-5} cm/sec). *1 x 10^{-5} cm/sec is the lowest acceptable K for soils used in covers due to desiccation and root penetration; unless a GCL is proposed, then the actual K may be modeled for the GCL layer (i.e., 0.24" at 3 x 10^{-9} cm/sec). For compacted municipal solid waste with a HELP soil texture number of "18" will have a K of 1 x 10^{-3} cm/sec. For the 24" of drainage/protection layer use the tested K for modeling the proposed alternate liner design; for a possible geonet use the lowest value from the manufacture's specifications; for the FML use a K value which is the greatest value from the manufacture's specifications; GCL (3 x 10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner.

Equivalency Demonstrations

Typical "New" Landfill:

Alternate Cover Design Equivalency Demonstration (two simulations)

Simulation #3 & (either Simulation #5 or #6)

Average Annual Percolation from bottom layer of Simulation #3 must be less than or equal to (equivalent*) the Average Annual Percolation from the bottom layer of Simulation #5 or #6 (depending on the proposed liner design).

Alternate Liner Design Equivalency Demonstration

Tier I (two simulations) - Simulation #5 & Simulation #6

Average Annual Percolation from bottom layer of Simulation #6 must be less than or equal to (equivalent*) the Average Annual Percolation from the bottom layer of Simulation #5.

Tier II (four simulations) - Simulations #7, #8, #9, #10

Average Annual Percolation from bottom layer of Simulation #7 must decrease to zero for Simulations #9 & #10.

For closing an "old" (no liner system) landfill:

Alternate Cover Design Equivalency Demonstration (two simulations)

Simulation #1 & Simulation #2

Average Annual Percolation from bottom layer of Simulation #2 must be less than or equal to (equivalent*) the Average Annual Percolation from the bottom layer of Simulation #1

Submit hardcopies of all output files and submit all input files on 3.5" diskette.

*If the two Average Annual Percolation values are within 0.00001" of each other, then the demonstration is successful since these values are practically equal (the definition of equivalent) and well within modeling uncertainty.

Attachment E

Summary of Help Model Input Parameters

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\WTSMODEL\WS.D4
TEMPERATURE DATA FILE:      C:\HELP3\WTSMODEL\WS.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\WTSMODEL\WS.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\WTSMODEL\WS.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\WTSMODEL\WS.D10
OUTPUT DATA FILE:           C:\HELP3\WTSMODEL\WSA.OUT


TIME:  16:45     DATE:  12/18/2008


******************************************************************************

     TITLE:  WHITE SANDS MISSILE RANGE ALTERNATIVE COVER

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   6
          THICKNESS                  =      6.00   INCHES
          POROSITY                   =      0.4530 VOL/VOL
          FIELD CAPACITY             =      0.1900 VOL/VOL
          WILTING POINT              =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT =      0.1113 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.720000011000E-03 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.60
                FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                   LAYER  2
                                   --------
```

```
            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                    =     30.00   INCHES
  POROSITY                     =      0.4730 VOL/VOL
  FIELD CAPACITY               =      0.2220 VOL/VOL
  WILTING POINT                =      0.1040 VOL/VOL
  INITIAL SOIL WATER CONTENT   =      0.1335 VOL/VOL
  EFFECTIVE SAT. HYD. COND.    =  0.440000003000E-03 CM/SEC
```

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

```
 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A
          POOR STAND OF GRASS, A SURFACE SLOPE OF  5.%
          AND A SLOPE LENGTH OF  750. FEET.

SCS RUNOFF CURVE NUMBER             =     79.20
FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =     40.000  ACRES
EVAPORATIVE ZONE DEPTH              =     28.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      3.605  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     13.124  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      2.798  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =      4.673  INCHES
TOTAL INITIAL WATER                 =      4.673  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

EVAPOTRANSPIRATION AND WEATHER DATA

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 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          EL PASO               TEXAS

     STATION LATITUDE                       =  32.22 DEGREES
     MAXIMUM LEAF AREA INDEX                =   0.80
     START OF GROWING SEASON (JULIAN DATE)  =     66
     END OF GROWING SEASON (JULIAN DATE)    =    315
     EVAPORATIVE ZONE DEPTH                 =  28.0  INCHES
     AVERAGE ANNUAL WIND SPEED              =   9.20 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  40.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  27.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  46.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  48.00 %


 NOTE:  PRECIPITATION DATA FOR     White Sands Natl MonNew Mexico
          WAS ENTERED FROM A EARTH INFO CLIMATEDATA.


 NOTE:  TEMPERATURE DATA FOR     White Sand Natl     Mon New Mexico
          WAS ENTERED FROM A EARTH INFO CLIMATEDATA.
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NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR EL PASO TEXAS
AND STATION LATITUDE = 32.22 DEGREES

LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

****

DAILY OUTPUT FOR YEAR 1984

DAY	AIR -	SOIL -	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.00	0.000	0.102	0.1251	0.0000	.0000E+00	.0000E+00
2			0.00	0.000	0.105	0.1213	0.0000	.0000E+00	.0000E+00
3			0.02	0.000	0.111	0.1181	0.0000	.0000E+00	.0000E+00
4			0.00	0.000	0.078	0.1153	0.0000	.0000E+00	.0000E+00
5			0.00	0.000	0.061	0.1131	0.0000	.0000E+00	.0000E+00
6			0.00	0.000	0.052	0.1113	0.0000	.0000E+00	.0000E+00
7			0.00	0.000	0.046	0.1096	0.0000	.0000E+00	.0000E+00
8			0.29	0.000	0.035	0.1187	0.0000	.0000E+00	.0000E+00
9			0.00	0.000	0.038	0.1174	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.035	0.1161	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.033	0.1149	0.0000	.0000E+00	.0000E+00
12			0.00	0.000	0.031	0.1138	0.0000	.0000E+00	.0000E+00
13			0.00	0.000	0.030	0.1127	0.0000	.0000E+00	.0000E+00
14			0.00	0.000	0.029	0.1117	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.027	0.1107	0.0000	.0000E+00	.0000E+00
16			0.00	0.000	0.026	0.1098	0.0000	.0000E+00	.0000E+00
17			0.00	0.000	0.025	0.1089	0.0000	.0000E+00	.0000E+00
18			0.00	0.000	0.025	0.1080	0.0000	.0000E+00	.0000E+00
19			0.00	0.000	0.024	0.1072	0.0000	.0000E+00	.0000E+00
20			0.00	0.000	0.023	0.1063	0.0000	.0000E+00	.0000E+00
21	*		0.00	0.000	0.016	0.1058	0.0000	.0000E+00	.0000E+00
22			0.00	0.000	0.009	0.1054	0.0000	.0000E+00	.0000E+00
23			0.00	0.000	0.004	0.1053	0.0000	.0000E+00	.0000E+00
24			0.00	0.000	0.002	0.1052	0.0000	.0000E+00	.0000E+00
25			0.00	0.000	0.001	0.1052	0.0000	.0000E+00	.0000E+00
26			0.00	0.000	0.001	0.1051	0.0000	.0000E+00	.0000E+00
27			0.00	0.000	0.001	0.1051	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.001	0.1051	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.001	0.1051	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.000	0.1051	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
32			0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
33			0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
34			0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
35			0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
36			0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
38			0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00

39	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
40	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
41	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
42	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
43	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
44	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
45	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
46	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
47	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
48	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
49	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
50	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
51	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
52	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
53	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
54	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
55	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
56	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
57	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
58	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
59	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
60	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
61	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
62	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
63	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
64	0.00	0.000	0.000	0.1050	0.0000	.0000E+00	.0000E+00
65	0.32	0.000	0.003	0.1163	0.0000	.0000E+00	.0000E+00
66	0.00	0.000	0.007	0.1161	0.0000	.0000E+00	.0000E+00
67	0.00	0.000	0.007	0.1158	0.0000	.0000E+00	.0000E+00
68	0.00	0.000	0.006	0.1156	0.0000	.0000E+00	.0000E+00
69	0.00	0.000	0.007	0.1153	0.0000	.0000E+00	.0000E+00
70	0.00	0.000	0.008	0.1151	0.0000	.0000E+00	.0000E+00
71	0.00	0.000	0.009	0.1147	0.0000	.0000E+00	.0000E+00
72	0.00	0.000	0.009	0.1144	0.0000	.0000E+00	.0000E+00
73	0.00	0.000	0.009	0.1141	0.0000	.0000E+00	.0000E+00
74	0.00	0.000	0.009	0.1137	0.0000	.0000E+00	.0000E+00
75	0.00	0.000	0.009	0.1134	0.0000	.0000E+00	.0000E+00
76	0.00	0.000	0.009	0.1130	0.0000	.0000E+00	.0000E+00
77	0.00	0.000	0.009	0.1127	0.0000	.0000E+00	.0000E+00
78	0.00	0.000	0.009	0.1124	0.0000	.0000E+00	.0000E+00
79	0.00	0.000	0.009	0.1120	0.0000	.0000E+00	.0000E+00
80	0.00	0.000	0.009	0.1117	0.0000	.0000E+00	.0000E+00
81	0.00	0.000	0.009	0.1114	0.0000	.0000E+00	.0000E+00
82	0.00	0.000	0.009	0.1110	0.0000	.0000E+00	.0000E+00
83	0.00	0.000	0.009	0.1107	0.0000	.0000E+00	.0000E+00
84	0.00	0.000	0.009	0.1104	0.0000	.0000E+00	.0000E+00
85	0.00	0.000	0.009	0.1100	0.0000	.0000E+00	.0000E+00
86	0.00	0.000	0.009	0.1097	0.0000	.0000E+00	.0000E+00
87	0.00	0.000	0.009	0.1094	0.0000	.0000E+00	.0000E+00
88	0.00	0.000	0.009	0.1090	0.0000	.0000E+00	.0000E+00
89	0.00	0.000	0.009	0.1087	0.0000	.0000E+00	.0000E+00
90	0.00	0.000	0.009	0.1084	0.0000	.0000E+00	.0000E+00
91	0.00	0.000	0.009	0.1081	0.0000	.0000E+00	.0000E+00
92	0.00	0.000	0.009	0.1077	0.0000	.0000E+00	.0000E+00
93	0.00	0.000	0.009	0.1074	0.0000	.0000E+00	.0000E+00
94	0.00	0.000	0.009	0.1071	0.0000	.0000E+00	.0000E+00
95	0.00	0.000	0.009	0.1067	0.0000	.0000E+00	.0000E+00
96	0.00	0.000	0.009	0.1064	0.0000	.0000E+00	.0000E+00
97	0.00	0.000	0.009	0.1061	0.0000	.0000E+00	.0000E+00
98	0.00	0.000	0.009	0.1058	0.0000	.0000E+00	.0000E+00
99	0.00	0.000	0.009	0.1054	0.0000	.0000E+00	.0000E+00
100	0.00	0.000	0.011	0.1051	0.0000	.0000E+00	.0000E+00
101	0.00	0.000	0.010	0.1047	0.0000	.0000E+00	.0000E+00

102	0.00	0.000	0.003	0.1046	0.0000	.0000E+00	.0000E+00
103	0.00	0.000	0.002	0.1045	0.0000	.0000E+00	.0000E+00
104	0.00	0.000	0.002	0.1044	0.0000	.0000E+00	.0000E+00
105	0.00	0.000	0.002	0.1044	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.002	0.1043	0.0000	.0000E+00	.0000E+00
107	0.00	0.000	0.002	0.1042	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.002	0.1042	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.003	0.1041	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.003	0.1040	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.003	0.1039	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.002	0.1038	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.002	0.1037	0.0000	.0000E+00	.0000E+00
114	0.00	0.000	0.002	0.1037	0.0000	.0000E+00	.0000E+00
115	0.00	0.000	0.002	0.1036	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.003	0.1035	0.0000	.0000E+00	.0000E+00
117	0.00	0.000	0.002	0.1034	0.0000	.0000E+00	.0000E+00
118	0.00	0.000	0.003	0.1033	0.0000	.0000E+00	.0000E+00
119	0.00	0.000	0.003	0.1032	0.0000	.0000E+00	.0000E+00
120	0.00	0.000	0.002	0.1031	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.002	0.1031	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.003	0.1030	0.0000	.0000E+00	.0000E+00
123	0.00	0.000	0.003	0.1029	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.003	0.1027	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.003	0.1026	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.004	0.1025	0.0000	.0000E+00	.0000E+00
127	0.00	0.000	0.004	0.1024	0.0000	.0000E+00	.0000E+00
128	0.00	0.000	0.003	0.1022	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.004	0.1021	0.0000	.0000E+00	.0000E+00
130	0.00	0.000	0.004	0.1020	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.004	0.1018	0.0000	.0000E+00	.0000E+00
132	0.00	0.000	0.004	0.1017	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.004	0.1015	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.004	0.1014	0.0000	.0000E+00	.0000E+00
135	0.00	0.000	0.005	0.1012	0.0000	.0000E+00	.0000E+00
136	0.11	0.000	0.007	0.1049	0.0000	.0000E+00	.0000E+00
137	0.72	0.000	0.010	0.1302	0.0000	.0000E+00	.0000E+00
138	0.03	0.000	0.139	0.1263	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.273	0.1166	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.161	0.1109	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.061	0.1087	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.063	0.1064	0.0000	.0000E+00	.0000E+00
143	0.00	0.000	0.055	0.1045	0.0000	.0000E+00	.0000E+00
144	0.00	0.000	0.052	0.1026	0.0000	.0000E+00	.0000E+00
145	0.00	0.000	0.037	0.1013	0.0000	.0000E+00	.0000E+00
146	0.00	0.000	0.020	0.1005	0.0000	.0000E+00	.0000E+00
147	0.00	0.000	0.009	0.1002	0.0000	.0000E+00	.0000E+00
148	0.00	0.000	0.008	0.1000	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
150	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
153	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
154	1.64	0.009	0.019	0.1575	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.243	0.1488	0.0000	.0000E+00	.0000E+00
156	0.00	0.000	0.261	0.1395	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.287	0.1292	0.0000	.0000E+00	.0000E+00
158	0.00	0.000	0.273	0.1195	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.333	0.1076	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.157	0.1020	0.0000	.0000E+00	.0000E+00
161	0.00	0.000	0.044	0.1004	0.0000	.0000E+00	.0000E+00
162	0.00	0.000	0.012	0.1000	0.0000	.0000E+00	.0000E+00
163	0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
164	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00

165		0.08	0.000	0.009	0.1025	0.0000	.0000E+00	.0000E+00
166		0.00	0.000	0.005	0.1023	0.0000	.0000E+00	.0000E+00
167		0.89	0.000	0.027	0.1331	0.0000	.0000E+00	.0000E+00
168		0.30	0.000	0.177	0.1375	0.0000	.0000E+00	.0000E+00
169		0.01	0.000	0.239	0.1293	0.0000	.0000E+00	.0000E+00
170		0.00	0.000	0.271	0.1197	0.0000	.0000E+00	.0000E+00
171		0.82	0.000	0.243	0.1403	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.348	0.1278	0.0000	.0000E+00	.1101E-05
173		0.00	0.000	0.316	0.1165	0.0000	.0000E+00	.0000E+00
174		0.00	0.000	0.356	0.1038	0.0000	.0000E+00	.0000E+00
175		0.00	0.000	0.101	0.1002	0.0000	.0000E+00	.0000E+00
176		0.08	0.000	0.021	0.1023	0.0000	.0000E+00	.0000E+00
177		0.00	0.000	0.011	0.1020	0.0000	.0000E+00	.0000E+00
178		0.00	0.000	0.017	0.1013	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.013	0.1009	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.013	0.1004	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.011	0.1000	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.002	0.1000	0.0000	.0000E+00	.0000E+00
183		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
184		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
185		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
186		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
188		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
189		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
190		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
191		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
192		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
193		0.68	0.000	0.023	0.1234	0.0000	.0000E+00	.0000E+00
194	*	0.00	0.000	0.087	0.1203	0.0000	.0000E+00	.0000E+00
195		0.00	0.000	0.251	0.1113	0.0000	.0000E+00	.0000E+00
196		0.00	0.000	0.159	0.1056	0.0000	.0000E+00	.0000E+00
197		0.00	0.000	0.089	0.1024	0.0000	.0000E+00	.0000E+00
198		0.00	0.000	0.059	0.1003	0.0000	.0000E+00	.0000E+00
199		0.00	0.000	0.009	0.1000	0.0000	.0000E+00	.0000E+00
200		0.47	0.000	0.038	0.1154	0.0000	.0000E+00	.0000E+00
201		0.00	0.000	0.184	0.1089	0.0000	.0000E+00	.0000E+00
202		0.00	0.000	0.046	0.1072	0.0000	.0000E+00	.0000E+00
203		0.15	0.000	0.048	0.1109	0.0000	.0000E+00	.0000E+00
204		0.00	0.000	0.226	0.1028	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.045	0.1012	0.0000	.0000E+00	.0000E+00
206		0.14	0.000	0.030	0.1051	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.013	0.1046	0.0000	.0000E+00	.0000E+00
208		0.00	0.000	0.026	0.1037	0.0000	.0000E+00	.0000E+00
209		0.14	0.000	0.039	0.1074	0.0000	.0000E+00	.0000E+00
210		0.00	0.000	0.036	0.1061	0.0000	.0000E+00	.0000E+00
211		0.00	0.000	0.027	0.1051	0.0000	.0000E+00	.1070E-05
212		0.00	0.000	0.036	0.1038	0.0000	.0000E+00	.0000E+00
213		0.00	0.000	0.039	0.1025	0.0000	.0000E+00	.0000E+00
214	*	0.00	0.000	0.024	0.1016	0.0000	.0000E+00	.0000E+00
215		0.19	0.000	0.016	0.1078	0.0000	.0000E+00	.0000E+00
216	*	0.13	0.000	0.120	0.1082	0.0000	.0000E+00	.0000E+00
217	*	0.09	0.000	0.104	0.1077	0.0000	.0000E+00	.0000E+00
218		0.00	0.000	0.023	0.1069	0.0000	.0000E+00	.0000E+00
219		0.00	0.000	0.033	0.1057	0.0000	.0000E+00	.0000E+00
220		0.10	0.000	0.039	0.1079	0.0000	.0000E+00	.0000E+00
221		0.00	0.000	0.132	0.1032	0.0000	.0000E+00	.0000E+00
222	*	0.25	0.000	0.069	0.1039	0.0000	.0000E+00	.0000E+00
223		0.59	0.000	0.000	0.1254	0.0000	.0000E+00	.0000E+00
224		0.02	0.000	0.192	0.1245	0.0000	.0000E+00	.0000E+00
225		0.00	0.000	0.212	0.1169	0.0000	.0000E+00	.0000E+00
226		0.13	0.000	0.171	0.1155	0.0000	.0000E+00	.1072E-05
227	*	0.00	0.000	0.133	0.1107	0.0000	.0000E+00	.0000E+00

228	*	0.00	0.000	0.122	0.1064	0.0000	.0000E+00	.1048E-05
229	*	0.00	0.000	0.113	0.1023	0.0000	.0000E+00	.0000E+00
230		0.00	0.000	0.054	0.1004	0.0000	.0000E+00	.0000E+00
231		0.00	0.000	0.010	0.1000	0.0000	.0000E+00	.0000E+00
232		0.00	0.000	0.002	0.1000	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
234		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
235		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
236		0.21	0.000	0.013	0.1070	0.0000	.0000E+00	.0000E+00
237		0.27	0.000	0.113	0.1126	0.0000	.0000E+00	.0000E+00
238		0.67	0.000	0.161	0.1307	0.0000	.0000E+00	.0000E+00
239		0.19	0.000	0.159	0.1319	0.0000	.0000E+00	.0000E+00
240		0.00	0.000	0.220	0.1240	0.0000	.0000E+00	.1107E-05
241		0.00	0.000	0.261	0.1147	0.0000	.0000E+00	.0000E+00
242		0.00	0.000	0.272	0.1050	0.0000	.0000E+00	.0000E+00
243		0.10	0.000	0.158	0.1029	0.0000	.0000E+00	.0000E+00
244		0.00	0.000	0.049	0.1011	0.0000	.0000E+00	.0000E+00
245		0.00	0.000	0.027	0.1002	0.0000	.0000E+00	.0000E+00
246		0.00	0.000	0.004	0.1000	0.0000	.0000E+00	.0000E+00
247		0.06	0.000	0.019	0.1015	0.0000	.0000E+00	.0000E+00
248		0.00	0.000	0.008	0.1012	0.0000	.0000E+00	.0000E+00
249		0.00	0.000	0.015	0.1007	0.0000	.0000E+00	.0000E+00
250		0.00	0.000	0.013	0.1002	0.0000	.0000E+00	.0000E+00
251		0.00	0.000	0.005	0.1000	0.0000	.0000E+00	.0000E+00
252		0.00	0.000	0.002	0.1000	0.0000	.0000E+00	.0000E+00
253		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.1078E-05
254		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.1081E-05
255		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
256		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
257		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
258		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
259		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
260		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
261		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
262		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
263		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
264		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
265		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
266		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
267		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
268		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
269		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
270		0.12	0.000	0.010	0.1039	0.0000	.0000E+00	.0000E+00
271		0.06	0.000	0.032	0.1049	0.0000	.0000E+00	.0000E+00
272		0.00	0.000	0.050	0.1031	0.0000	.0000E+00	.0000E+00
273		0.00	0.000	0.054	0.1012	0.0000	.0000E+00	.0000E+00
274		0.00	0.000	0.015	0.1006	0.0000	.0000E+00	.0000E+00
275		0.00	0.000	0.011	0.1003	0.0000	.0000E+00	.0000E+00
276		0.00	0.000	0.007	0.1000	0.0000	.0000E+00	.0000E+00
277		0.30	0.000	0.011	0.1103	0.0000	.0000E+00	.0000E+00
278		0.25	0.000	0.094	0.1159	0.0000	.0000E+00	.0000E+00
279		0.00	0.000	0.112	0.1119	0.0000	.0000E+00	.0000E+00
280		0.00	0.000	0.143	0.1068	0.0000	.0000E+00	.0000E+00
281		0.00	0.000	0.123	0.1024	0.0000	.0000E+00	.0000E+00
282		0.00	0.000	0.054	0.1004	0.0000	.0000E+00	.0000E+00
283		0.00	0.000	0.012	0.1000	0.0000	.0000E+00	.0000E+00
284		0.00	0.000	0.001	0.1000	0.0000	.0000E+00	.0000E+00
285		0.10	0.000	0.014	0.1030	0.0000	.0000E+00	.0000E+00
286		0.11	0.000	0.013	0.1065	0.0000	.0000E+00	.0000E+00
287		0.00	0.000	0.071	0.1040	0.0000	.0000E+00	.0000E+00
288		0.00	0.000	0.056	0.1020	0.0000	.0000E+00	.0000E+00
289		0.08	0.000	0.033	0.1037	0.0000	.0000E+00	.0000E+00
290		0.00	0.000	0.011	0.1033	0.0000	.0000E+00	.0000E+00

291		0.00	0.000	0.019	0.1026	0.0000	.0000E+00	.0000E+00
292		0.12	0.000	0.016	0.1063	0.0000	.0000E+00	.0000E+00
293		0.00	0.000	0.076	0.1036	0.0000	.0000E+00	.0000E+00
294		0.04	0.000	0.033	0.1038	0.0000	.0000E+00	.0000E+00
295		0.14	0.000	0.021	0.1081	0.0000	.0000E+00	.0000E+00
296		0.06	0.000	0.068	0.1078	0.0000	.0000E+00	.0000E+00
297		0.27	0.000	0.086	0.1144	0.0000	.0000E+00	.0000E+00
298		0.45	0.000	0.072	0.1279	0.0000	.0000E+00	.0000E+00
299		0.00	0.000	0.051	0.1260	0.0000	.0000E+00	.0000E+00
300		0.11	0.000	0.079	0.1272	0.0000	.0000E+00	.0000E+00
301		0.00	0.000	0.120	0.1229	0.0000	.0000E+00	.0000E+00
302		0.00	0.000	0.095	0.1195	0.0000	.0000E+00	.0000E+00
303		0.00	0.000	0.103	0.1158	0.0000	.0000E+00	.0000E+00
304		0.00	0.000	0.099	0.1123	0.0000	.0000E+00	.0000E+00
305		0.00	0.000	0.104	0.1085	0.0000	.0000E+00	.0000E+00
306		0.00	0.000	0.091	0.1053	0.0000	.0000E+00	.0000E+00
307		0.00	0.000	0.104	0.1015	0.0000	.0000E+00	.0000E+00
308		0.00	0.000	0.036	0.1003	0.0000	.0000E+00	.0000E+00
309		0.00	0.000	0.004	0.1001	0.0000	.0000E+00	.0000E+00
310		0.00	0.000	0.001	0.1001	0.0000	.0000E+00	.0000E+00
311		0.00	0.000	0.001	0.1001	0.0000	.0000E+00	.0000E+00
312		0.00	0.000	0.001	0.1001	0.0000	.0000E+00	.0000E+00
313		0.00	0.000	0.001	0.1000	0.0000	.0000E+00	.0000E+00
314		0.00	0.000	0.001	0.1000	0.0000	.0000E+00	.0000E+00
315	*	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
316		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
317		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
318		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
319		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
320		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
321		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
322		0.33	0.000	0.009	0.1115	0.0000	.0000E+00	.0000E+00
323		0.06	0.000	0.056	0.1117	0.0000	.0000E+00	.0000E+00
324		0.04	0.000	0.055	0.1111	0.0000	.0000E+00	.0000E+00
325		0.07	0.000	0.056	0.1116	0.0000	.0000E+00	.0000E+00
326		0.00	0.000	0.055	0.1097	0.0000	.0000E+00	.0000E+00
327		0.00	0.000	0.064	0.1074	0.0000	.0000E+00	.0000E+00
328		0.00	0.000	0.073	0.1048	0.0000	.0000E+00	.0000E+00
329		0.61	0.000	0.068	0.1241	0.0000	.0000E+00	.0000E+00
330		0.02	0.000	0.060	0.1227	0.0000	.0000E+00	.0000E+00
331		0.00	0.000	0.074	0.1201	0.0000	.0000E+00	.0000E+00
332		0.00	0.000	0.067	0.1177	0.0000	.0000E+00	.0000E+00
333		0.00	0.000	0.062	0.1154	0.0000	.0000E+00	.0000E+00
334		0.00	0.000	0.078	0.1127	0.0000	.0000E+00	.0000E+00
335		0.00	0.000	0.071	0.1101	0.0000	.0000E+00	.0000E+00
336		0.00	0.000	0.080	0.1073	0.0000	.0000E+00	.0000E+00
337		0.00	0.000	0.071	0.1048	0.0000	.0000E+00	.0000E+00
338		0.00	0.000	0.086	0.1017	0.0000	.0000E+00	.0000E+00
339		0.51	0.000	0.082	0.1170	0.0000	.0000E+00	.0000E+00
340		0.00	0.000	0.056	0.1150	0.0000	.0000E+00	.0000E+00
341		0.00	0.000	0.058	0.1129	0.0000	.0000E+00	.0000E+00
342		0.00	0.000	0.068	0.1105	0.0000	.0000E+00	.0000E+00
343		0.03	0.000	0.086	0.1085	0.0000	.0000E+00	.0000E+00
344		0.00	0.000	0.087	0.1054	0.0000	.0000E+00	.0000E+00
345		0.00	0.000	0.085	0.1023	0.0000	.0000E+00	.0000E+00
346		0.00	0.000	0.047	0.1007	0.0000	.0000E+00	.0000E+00
347		0.26	0.000	0.027	0.1090	0.0000	.0000E+00	.0000E+00
348		0.60	0.000	0.052	0.1286	0.0000	.0000E+00	.0000E+00
349		0.60	0.000	0.060	0.1478	0.0000	.0000E+00	.0000E+00
350		0.28	0.000	0.084	0.1548	0.0000	.0000E+00	.0000E+00
351		0.00	0.000	0.073	0.1522	0.0000	.0000E+00	.0000E+00
352		0.00	0.000	0.074	0.1496	0.0000	.0000E+00	.0000E+00
353		0.00	0.000	0.078	0.1468	0.0000	.0000E+00	.0000E+00

354	0.08	0.000	0.088	0.1465	0.0000	.0000E+00	.0000E+00
355	0.00	0.000	0.085	0.1435	0.0000	.0000E+00	.0000E+00
356	0.00	0.000	0.085	0.1404	0.0000	.0000E+00	.0000E+00
357	0.00	0.000	0.079	0.1376	0.0000	.0000E+00	.0000E+00
358	0.00	0.000	0.078	0.1348	0.0000	.0000E+00	.0000E+00
359	0.00	0.000	0.084	0.1318	0.0000	.0000E+00	.0000E+00
360	0.00	0.000	0.089	0.1286	0.0000	.0000E+00	.0000E+00
361	0.00	0.000	0.091	0.1254	0.0000	.0000E+00	.0000E+00
362	0.00	0.000	0.078	0.1226	0.0000	.0000E+00	.0000E+00
363	0.41	0.000	0.116	0.1331	0.0000	.0000E+00	.0000E+00
364	0.00	0.000	0.101	0.1295	0.0000	.0000E+00	.0000E+00
365	0.00	0.000	0.097	0.1261	0.0000	.0000E+00	.0000E+00
366	0.00	0.000	0.083	0.1231	0.0000	.0000E+00	.0000E+00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1984

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.31	0.00	0.32	0.00	0.86	3.82
	1.58	2.94	0.24	2.03	1.13	2.77
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.009
	0.000	0.000	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.973	0.001	0.232	0.140	0.948	3.810
	1.510	2.976	0.254	1.809	1.085	2.407
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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ANNUAL TOTALS FOR YEAR 1984

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.00	2323200.500	100.00
RUNOFF	0.009	1318.595	0.06
EVAPOTRANSPIRATION	16.146	2344375.000	100.91
PERC./LEAKAGE THROUGH LAYER 2	0.000008	1.097	0.00
CHANGE IN WATER STORAGE	-0.155	-22494.676	-0.97
SOIL WATER AT START OF YEAR	4.673	678486.687	
SOIL WATER AT END OF YEAR	4.518	655992.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.445	0.00

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LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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DAILY OUTPUT FOR YEAR 1985

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.00	0.000	0.098	0.1196	0.0000	.0000E+00	.0000E+00
2	*		0.00	0.000	0.067	0.1172	0.0000	.0000E+00	.0000E+00
3	*		0.00	0.000	0.067	0.1148	0.0000	.0000E+00	.0000E+00
4			0.00	0.000	0.086	0.1118	0.0000	.0000E+00	.0000E+00
5			0.00	0.000	0.091	0.1085	0.0000	.0000E+00	.0000E+00
6			0.00	0.000	0.080	0.1057	0.0000	.0000E+00	.0000E+00
7			0.00	0.000	0.062	0.1035	0.0000	.0000E+00	.0000E+00
8			0.00	0.000	0.052	0.1016	0.0000	.0000E+00	.0000E+00
9			0.00	0.000	0.024	0.1007	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.003	0.1006	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.002	0.1006	0.0000	.0000E+00	.0000E+00
12			0.03	0.000	0.011	0.1012	0.0000	.0000E+00	.0000E+00
13	*		0.36	0.000	0.059	0.1019	0.0000	.0000E+00	.0000E+00
14	*		0.04	0.000	0.048	0.1026	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.084	0.1034	0.0000	.0000E+00	.0000E+00
16			0.28	0.000	0.030	0.1176	0.0000	.0000E+00	.0000E+00
17			0.00	0.000	0.048	0.1159	0.0000	.0000E+00	.0000E+00
18			0.00	0.000	0.070	0.1134	0.0000	.0000E+00	.0000E+00
19			0.00	0.000	0.092	0.1101	0.0000	.0000E+00	.0000E+00
20			0.00	0.000	0.087	0.1070	0.0000	.0000E+00	.0000E+00
21	*		0.00	0.000	0.060	0.1049	0.0000	.0000E+00	.0000E+00
22	*		0.00	0.000	0.050	0.1031	0.0000	.0000E+00	.0000E+00
23			0.00	0.000	0.044	0.1015	0.0000	.0000E+00	.0000E+00
24			0.09	0.000	0.038	0.1034	0.0000	.0000E+00	.0000E+00
25			0.02	0.000	0.014	0.1036	0.0000	.0000E+00	.0000E+00
26			0.17	0.000	0.010	0.1093	0.0000	.0000E+00	.0000E+00
27			0.27	0.000	0.025	0.1180	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.074	0.1154	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.088	0.1122	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.102	0.1086	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.065	0.1063	0.0000	.0000E+00	.0000E+00
32	*		0.01	0.000	0.010	0.1063	0.0000	.0000E+00	.0000E+00
33	*		0.00	0.000	0.050	0.1045	0.0000	.0000E+00	.0000E+00
34	*		0.00	0.000	0.040	0.1031	0.0000	.0000E+00	.0000E+00
35			0.17	0.000	0.046	0.1075	0.0000	.0000E+00	.0000E+00
36			0.00	0.000	0.039	0.1061	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.038	0.1048	0.0000	.0000E+00	.0000E+00
38			0.00	0.000	0.035	0.1035	0.0000	.0000E+00	.0000E+00

39	0.00	0.000	0.027	0.1026	0.0000	.0000E+00	.0000E+00
40	0.00	0.000	0.010	0.1022	0.0000	.0000E+00	.0000E+00
41	0.00	0.000	0.010	0.1019	0.0000	.0000E+00	.0000E+00
42	0.00	0.000	0.007	0.1016	0.0000	.0000E+00	.0000E+00
43	0.00	0.000	0.007	0.1013	0.0000	.0000E+00	.0000E+00
44	0.00	0.000	0.006	0.1011	0.0000	.0000E+00	.0000E+00
45	0.00	0.000	0.006	0.1009	0.0000	.0000E+00	.0000E+00
46	0.00	0.000	0.006	0.1007	0.0000	.0000E+00	.0000E+00
47	0.00	0.000	0.006	0.1005	0.0000	.0000E+00	.0000E+00
48	0.00	0.000	0.004	0.1003	0.0000	.0000E+00	.0000E+00
49	0.00	0.000	0.000	0.1003	0.0000	.0000E+00	.0000E+00
50	0.00	0.000	0.000	0.1003	0.0000	.0000E+00	.0000E+00
51	0.00	0.000	0.000	0.1003	0.0000	.0000E+00	.0000E+00
52	0.00	0.000	0.000	0.1003	0.0000	.0000E+00	.0000E+00
53	0.00	0.000	0.000	0.1003	0.0000	.0000E+00	.0000E+00
54	0.21	0.000	0.008	0.1075	0.0000	.0000E+00	.0000E+00
55	0.00	0.000	0.011	0.1072	0.0000	.0000E+00	.0000E+00
56	0.00	0.000	0.010	0.1068	0.0000	.0000E+00	.0000E+00
57	0.00	0.000	0.011	0.1064	0.0000	.0000E+00	.0000E+00
58	0.00	0.000	0.013	0.1059	0.0000	.0000E+00	.0000E+00
59	0.03	0.000	0.019	0.1063	0.0000	.0000E+00	.0000E+00
60	0.00	0.000	0.014	0.1058	0.0000	.0000E+00	.0000E+00
61	0.00	0.000	0.012	0.1053	0.0000	.0000E+00	.0000E+00
62	0.00	0.000	0.013	0.1049	0.0000	.0000E+00	.0000E+00
63	0.00	0.000	0.013	0.1044	0.0000	.0000E+00	.0000E+00
64	0.00	0.000	0.013	0.1039	0.0000	.0000E+00	.0000E+00
65	0.00	0.000	0.013	0.1035	0.0000	.0000E+00	.0000E+00
66	0.00	0.000	0.013	0.1030	0.0000	.0000E+00	.0000E+00
67	0.00	0.000	0.013	0.1025	0.0000	.0000E+00	.0000E+00
68	0.00	0.000	0.013	0.1021	0.0000	.0000E+00	.0000E+00
69	0.00	0.000	0.011	0.1017	0.0000	.0000E+00	.0000E+00
70	0.00	0.000	0.004	0.1015	0.0000	.0000E+00	.0000E+00
71	0.00	0.000	0.004	0.1013	0.0000	.0000E+00	.0000E+00
72	0.00	0.000	0.004	0.1012	0.0000	.0000E+00	.0000E+00
73	0.00	0.000	0.004	0.1011	0.0000	.0000E+00	.0000E+00
74	0.16	0.000	0.009	0.1065	0.0000	.0000E+00	.0000E+00
75	0.00	0.000	0.008	0.1062	0.0000	.0000E+00	.0000E+00
76	0.00	0.000	0.008	0.1059	0.0000	.0000E+00	.0000E+00
77	0.00	0.000	0.008	0.1056	0.0000	.0000E+00	.0000E+00
78	0.08	0.000	0.015	0.1079	0.0000	.0000E+00	.0000E+00
79	0.10	0.000	0.016	0.1109	0.0000	.0000E+00	.0000E+00
80	0.00	0.000	0.009	0.1106	0.0000	.0000E+00	.0000E+00
81	0.00	0.000	0.008	0.1103	0.0000	.0000E+00	.0000E+00
82	0.00	0.000	0.008	0.1100	0.0000	.0000E+00	.0000E+00
83	0.00	0.000	0.009	0.1097	0.0000	.0000E+00	.0000E+00
84	0.00	0.000	0.010	0.1094	0.0000	.0000E+00	.0000E+00
85	0.00	0.000	0.011	0.1090	0.0000	.0000E+00	.0000E+00
86	0.00	0.000	0.011	0.1086	0.0000	.0000E+00	.0000E+00
87	0.00	0.000	0.011	0.1082	0.0000	.0000E+00	.0000E+00
88	0.00	0.000	0.011	0.1078	0.0000	.0000E+00	.0000E+00
89	0.00	0.000	0.011	0.1074	0.0000	.0000E+00	.0000E+00
90	0.00	0.000	0.011	0.1070	0.0000	.0000E+00	.0000E+00
91	0.00	0.000	0.011	0.1066	0.0000	.0000E+00	.0000E+00
92	0.00	0.000	0.011	0.1062	0.0000	.0000E+00	.0000E+00
93	0.00	0.000	0.011	0.1058	0.0000	.0000E+00	.0000E+00
94	0.00	0.000	0.011	0.1054	0.0000	.0000E+00	.0000E+00
95	0.00	0.000	0.011	0.1050	0.0000	.0000E+00	.0000E+00
96	0.00	0.000	0.011	0.1046	0.0000	.0000E+00	.0000E+00
97	0.00	0.000	0.011	0.1042	0.0000	.0000E+00	.0000E+00
98	0.00	0.000	0.011	0.1038	0.0000	.0000E+00	.0000E+00
99	0.00	0.000	0.011	0.1034	0.0000	.0000E+00	.0000E+00
100	0.00	0.000	0.011	0.1030	0.0000	.0000E+00	.0000E+00
101	0.00	0.000	0.012	0.1026	0.0000	.0000E+00	.0000E+00

102	0.00	0.000	0.012	0.1022	0.0000	.0000E+00	.0000E+00
103	0.00	0.000	0.011	0.1018	0.0000	.0000E+00	.0000E+00
104	0.00	0.000	0.011	0.1014	0.0000	.0000E+00	.0000E+00
105	0.00	0.000	0.011	0.1010	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.010	0.1006	0.0000	.0000E+00	.0000E+00
107	0.00	0.000	0.012	0.1002	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.006	0.1000	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
114	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
115	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
117	0.22	0.000	0.007	0.1075	0.0000	.0000E+00	.0000E+00
118	0.60	0.000	0.013	0.1285	0.0000	.0000E+00	.0000E+00
119	0.00	0.000	0.128	0.1239	0.0000	.0000E+00	.0000E+00
120	0.00	0.000	0.235	0.1155	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.215	0.1078	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.173	0.1016	0.0000	.0000E+00	.0000E+00
123	0.00	0.000	0.042	0.1002	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.005	0.1000	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
127	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
128	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
130	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
132	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
135	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
136	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
137	0.45	0.000	0.022	0.1152	0.0000	.0000E+00	.0000E+00
138	0.05	0.000	0.172	0.1109	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.023	0.1100	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.027	0.1091	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.027	0.1081	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.024	0.1073	0.0000	.0000E+00	.0000E+00
143	0.00	0.000	0.023	0.1065	0.0000	.0000E+00	.0000E+00
144	0.00	0.000	0.022	0.1057	0.0000	.0000E+00	.0000E+00
145	0.00	0.000	0.023	0.1049	0.0000	.0000E+00	.0000E+00
146	0.00	0.000	0.022	0.1041	0.0000	.0000E+00	.0000E+00
147	0.00	0.000	0.022	0.1033	0.0000	.0000E+00	.0000E+00
148	0.00	0.000	0.026	0.1023	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.022	0.1015	0.0000	.0000E+00	.0000E+00
150	0.00	0.000	0.026	0.1006	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.012	0.1002	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.005	0.1000	0.0000	.0000E+00	.0000E+00
153	0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
154	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
156	0.38	0.000	0.021	0.1127	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.168	0.1068	0.0000	.0000E+00	.0000E+00
158	0.00	0.000	0.022	0.1060	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.023	0.1051	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.023	0.1043	0.0000	.0000E+00	.0000E+00
161	0.00	0.000	0.023	0.1035	0.0000	.0000E+00	.0000E+00
162	0.00	0.000	0.024	0.1026	0.0000	.0000E+00	.0000E+00
163	0.00	0.000	0.028	0.1017	0.0000	.0000E+00	.0000E+00
164	0.00	0.000	0.028	0.1006	0.0000	.0000E+00	.0000E+00

165		0.00	0.000	0.016	0.1001	0.0000	.0000E+00	.0000E+00
166		0.00	0.000	0.003	0.1000	0.0000	.0000E+00	.0000E+00
167		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
168		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
169		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
170		0.14	0.000	0.011	0.1045	0.0000	.0000E+00	.0000E+00
171		0.00	0.000	0.003	0.1044	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.015	0.1039	0.0000	.0000E+00	.0000E+00
173		0.00	0.000	0.020	0.1032	0.0000	.0000E+00	.0000E+00
174		0.00	0.000	0.022	0.1024	0.0000	.0000E+00	.0000E+00
175		0.00	0.000	0.009	0.1021	0.0000	.0000E+00	.0000E+00
176		0.33	0.000	0.024	0.1130	0.0000	.0000E+00	.0000E+00
177		0.00	0.000	0.158	0.1073	0.0000	.0000E+00	.0000E+00
178		0.00	0.000	0.180	0.1009	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.021	0.1002	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.005	0.1000	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
183		0.22	0.000	0.012	0.1074	0.0000	.0000E+00	.0000E+00
184		0.00	0.000	0.137	0.1025	0.0000	.0000E+00	.0000E+00
185		0.03	0.000	0.034	0.1023	0.0000	.0000E+00	.0000E+00
186		0.00	0.000	0.021	0.1016	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.010	0.1012	0.0000	.0000E+00	.0000E+00
188	*	0.00	0.000	0.006	0.1010	0.0000	.0000E+00	.0000E+00
189	*	0.00	0.000	0.005	0.1008	0.0000	.0000E+00	.0000E+00
190	*	0.00	0.000	0.005	0.1006	0.0000	.0000E+00	.0000E+00
191	*	0.00	0.000	0.005	0.1005	0.0000	.0000E+00	.0000E+00
192		0.00	0.000	0.006	0.1003	0.0000	.0000E+00	.1090E-05
193		0.00	0.000	0.007	0.1000	0.0000	.0000E+00	.1901E-05
194		0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
195	*	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
196		0.23	0.000	0.011	0.1077	0.0000	.0000E+00	.0000E+00
197	*	0.00	0.000	0.079	0.1049	0.0000	.0000E+00	.0000E+00
198	*	0.00	0.000	0.097	0.1015	0.0000	.0000E+00	.0000E+00
199		0.13	0.000	0.026	0.1052	0.0000	.0000E+00	.0000E+00
200		0.05	0.000	0.056	0.1049	0.0000	.0000E+00	.0000E+00
201		0.00	0.000	0.080	0.1021	0.0000	.0000E+00	.0000E+00
202	*	0.00	0.000	0.015	0.1015	0.0000	.0000E+00	.0000E+00
203		0.45	0.000	0.032	0.1164	0.0000	.0000E+00	.0000E+00
204		0.02	0.000	0.159	0.1115	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.237	0.1030	0.0000	.0000E+00	.0000E+00
206		0.00	0.000	0.069	0.1005	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.015	0.1000	0.0000	.0000E+00	.1076E-05
208		0.25	0.000	0.023	0.1081	0.0000	.0000E+00	.0000E+00
209		0.00	0.000	0.119	0.1039	0.0000	.0000E+00	.0000E+00
210		0.08	0.000	0.110	0.1028	0.0000	.0000E+00	.0000E+00
211		0.31	0.000	0.045	0.1123	0.0000	.0000E+00	.1091E-05
212		0.05	0.000	0.167	0.1081	0.0000	.0000E+00	.1956E-05
213		0.00	0.000	0.110	0.1042	0.0000	.0000E+00	.0000E+00
214		0.31	0.000	0.081	0.1123	0.0000	.0000E+00	.0000E+00
215		0.50	0.000	0.173	0.1240	0.0000	.0000E+00	.0000E+00
216		0.03	0.000	0.184	0.1185	0.0000	.0000E+00	.0000E+00
217	*	0.00	0.000	0.122	0.1142	0.0000	.0000E+00	.0000E+00
218		0.00	0.000	0.114	0.1101	0.0000	.0000E+00	.0000E+00
219		0.00	0.000	0.124	0.1057	0.0000	.0000E+00	.0000E+00
220	*	0.00	0.000	0.105	0.1020	0.0000	.0000E+00	.0000E+00
221		0.30	0.000	0.085	0.1096	0.0000	.0000E+00	.0000E+00
222		0.00	0.000	0.079	0.1068	0.0000	.0000E+00	.0000E+00
223		0.31	0.000	0.152	0.1125	0.0000	.0000E+00	.0000E+00
224		0.00	0.000	0.083	0.1095	0.0000	.0000E+00	.0000E+00
225	*	0.00	0.000	0.110	0.1056	0.0000	.0000E+00	.0000E+00
226	*	0.00	0.000	0.114	0.1015	0.0000	.0000E+00	.0000E+00
227		0.00	0.000	0.034	0.1003	0.0000	.0000E+00	.0000E+00

228		0.00	0.000	0.008	0.1000	0.0000	.0000E+00	.3374E-05
229		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
230	*	1.24	0.000	0.068	0.1006	0.0000	.0000E+00	.0000E+00
231		0.00	0.000	0.097	0.1383	0.0000	.0000E+00	.0000E+00
232		0.00	0.000	0.155	0.1328	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.246	0.1240	0.0000	.0000E+00	.0000E+00
234		0.00	0.000	0.272	0.1143	0.0000	.0000E+00	.0000E+00
235		0.00	0.000	0.295	0.1038	0.0000	.0000E+00	.0000E+00
236		0.00	0.000	0.096	0.1003	0.0000	.0000E+00	.0000E+00
237		0.00	0.000	0.009	0.1000	0.0000	.0000E+00	.0000E+00
238		0.00	0.000	0.003	0.0999	0.0000	.0000E+00	.0000E+00
239		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
240		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
241		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
242		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
243		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
244		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
245		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
246		0.16	0.000	0.045	0.1040	0.0000	.0000E+00	.0000E+00
247		0.00	0.000	0.031	0.1029	0.0000	.0000E+00	.0000E+00
248		0.00	0.000	0.069	0.1005	0.0000	.0000E+00	.0000E+00
249	*	0.00	0.000	0.011	0.1001	0.0000	.0000E+00	.0000E+00
250		0.00	0.000	0.004	0.1000	0.0000	.0000E+00	.0000E+00
251		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
252		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
253		0.11	0.000	0.037	0.1025	0.0000	.0000E+00	.0000E+00
254		0.00	0.000	0.030	0.1015	0.0000	.0000E+00	.0000E+00
255		0.00	0.000	0.030	0.1004	0.0000	.0000E+00	.0000E+00
256		0.00	0.000	0.008	0.1001	0.0000	.0000E+00	.0000E+00
257		0.04	0.000	0.034	0.1003	0.0000	.0000E+00	.1115E-05
258		0.03	0.000	0.031	0.1002	0.0000	.0000E+00	.0000E+00
259		0.00	0.000	0.005	0.1001	0.0000	.0000E+00	.0000E+00
260		0.00	0.000	0.003	0.1000	0.0000	.0000E+00	.0000E+00
261		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
262		0.42	0.000	0.092	0.1116	0.0000	.0000E+00	.0000E+00
263		0.50	0.000	0.117	0.1253	0.0000	.0000E+00	.0000E+00
264		0.00	0.000	0.117	0.1211	0.0000	.0000E+00	.0000E+00
265		0.00	0.000	0.154	0.1156	0.0000	.0000E+00	.0000E+00
266	*	0.00	0.000	0.075	0.1129	0.0000	.0000E+00	.0000E+00
267		0.00	0.000	0.161	0.1072	0.0000	.0000E+00	.0000E+00
268		0.00	0.000	0.174	0.1010	0.0000	.0000E+00	.0000E+00
269	*	0.00	0.000	0.000	0.1010	0.0000	.0000E+00	.0000E+00
270		0.00	0.000	0.026	0.1000	0.0000	.0000E+00	.0000E+00
271		0.16	0.000	0.038	0.1044	0.0000	.0000E+00	.0000E+00
272		0.00	0.000	0.022	0.1036	0.0000	.0000E+00	.0000E+00
273		0.00	0.000	0.051	0.1018	0.0000	.0000E+00	.0000E+00
274		0.00	0.000	0.031	0.1007	0.0000	.0000E+00	.0000E+00
275		0.00	0.000	0.015	0.1001	0.0000	.0000E+00	.1121E-05
276		0.00	0.000	0.003	0.1000	0.0000	.0000E+00	.0000E+00
277		0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
278		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.1074E-05
279		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
280	*	1.01	0.000	0.057	0.1006	0.0000	.0000E+00	.0000E+00
281		0.00	0.000	0.088	0.1308	0.0000	.0000E+00	.0000E+00
282		0.07	0.000	0.092	0.1300	0.0000	.0000E+00	.0000E+00
283		0.00	0.000	0.152	0.1246	0.0000	.0000E+00	.0000E+00
284		1.06	0.000	0.142	0.1573	0.0000	.0000E+00	.0000E+00
285		0.00	0.000	0.146	0.1521	0.0000	.0000E+00	.0000E+00
286		0.00	0.000	0.158	0.1465	0.0000	.0000E+00	.0000E+00
287		0.00	0.000	0.152	0.1411	0.0000	.0000E+00	.0000E+00
288		0.07	0.000	0.130	0.1389	0.0000	.0000E+00	.0000E+00
289		0.12	0.000	0.151	0.1378	0.0000	.0000E+00	.0000E+00
290		1.77	0.036	0.165	0.1938	0.0000	.0000E+00	.0000E+00

291		0.00	0.000	0.159	0.1882	0.0000	.0000E+00	.0000E+00
292		0.00	0.000	0.116	0.1840	0.0000	.0000E+00	.0000E+00
293		0.00	0.000	0.129	0.1794	0.0000	.0000E+00	.0000E+00
294		0.00	0.000	0.130	0.1748	0.0000	.0000E+00	.0000E+00
295		0.00	0.000	0.121	0.1704	0.0000	.0000E+00	.0000E+00
296		0.00	0.000	0.150	0.1651	0.0000	.0000E+00	.0000E+00
297		0.00	0.000	0.134	0.1603	0.0000	.0000E+00	.0000E+00
298		0.00	0.000	0.136	0.1554	0.0000	.0000E+00	.0000E+00
299		0.00	0.000	0.124	0.1510	0.0000	.0000E+00	.0000E+00
300		0.00	0.000	0.129	0.1464	0.0000	.0000E+00	.0000E+00
301		0.00	0.000	0.080	0.1435	0.0000	.0000E+00	.0000E+00
302		0.03	0.000	0.072	0.1420	0.0000	.0000E+00	.0000E+00
303		0.00	0.000	0.052	0.1402	0.0000	.0000E+00	.0000E+00
304		0.00	0.000	0.046	0.1385	0.0000	.0000E+00	.0000E+00
305		0.00	0.000	0.042	0.1371	0.0000	.0000E+00	.0000E+00
306		0.00	0.000	0.038	0.1357	0.0000	.0000E+00	.0000E+00
307		0.00	0.000	0.036	0.1344	0.0000	.0000E+00	.0000E+00
308		0.00	0.000	0.034	0.1332	0.0000	.0000E+00	.0000E+00
309		0.00	0.000	0.032	0.1321	0.0000	.0000E+00	.0000E+00
310		0.00	0.000	0.031	0.1310	0.0000	.0000E+00	.0000E+00
311		0.00	0.000	0.029	0.1299	0.0000	.0000E+00	.0000E+00
312		0.00	0.000	0.028	0.1289	0.0000	.0000E+00	.0000E+00
313		0.00	0.000	0.027	0.1279	0.0000	.0000E+00	.0000E+00
314		0.00	0.000	0.027	0.1270	0.0000	.0000E+00	.0000E+00
315		0.00	0.000	0.026	0.1261	0.0000	.0000E+00	.0000E+00
316		0.00	0.000	0.024	0.1252	0.0000	.0000E+00	.0000E+00
317		0.00	0.000	0.023	0.1244	0.0000	.0000E+00	.0000E+00
318		0.00	0.000	0.023	0.1236	0.0000	.0000E+00	.0000E+00
319		0.00	0.000	0.022	0.1228	0.0000	.0000E+00	.0000E+00
320		0.00	0.000	0.021	0.1220	0.0000	.0000E+00	.0000E+00
321		0.00	0.000	0.021	0.1213	0.0000	.0000E+00	.0000E+00
322		0.00	0.000	0.020	0.1206	0.0000	.0000E+00	.0000E+00
323		0.00	0.000	0.020	0.1199	0.0000	.0000E+00	.0000E+00
324		0.00	0.000	0.020	0.1192	0.0000	.0000E+00	.0000E+00
325		0.00	0.000	0.019	0.1185	0.0000	.0000E+00	.0000E+00
326		0.00	0.000	0.019	0.1178	0.0000	.0000E+00	.0000E+00
327		0.00	0.000	0.018	0.1171	0.0000	.0000E+00	.0000E+00
328		0.00	0.000	0.018	0.1165	0.0000	.0000E+00	.0000E+00
329		0.00	0.000	0.018	0.1159	0.0000	.0000E+00	.0000E+00
330		0.00	0.000	0.018	0.1152	0.0000	.0000E+00	.0000E+00
331		0.00	0.000	0.017	0.1146	0.0000	.0000E+00	.0000E+00
332		0.00	0.000	0.017	0.1140	0.0000	.0000E+00	.0000E+00
333		0.00	0.000	0.017	0.1134	0.0000	.0000E+00	.0000E+00
334		0.05	0.000	0.026	0.1143	0.0000	.0000E+00	.0000E+00
335		0.00	0.000	0.016	0.1137	0.0000	.0000E+00	.0000E+00
336		0.00	0.000	0.016	0.1131	0.0000	.0000E+00	.0000E+00
337		0.00	0.000	0.016	0.1126	0.0000	.0000E+00	.0000E+00
338		0.00	0.000	0.016	0.1120	0.0000	.0000E+00	.0000E+00
339		0.00	0.000	0.015	0.1114	0.0000	.0000E+00	.0000E+00
340		0.00	0.000	0.015	0.1109	0.0000	.0000E+00	.0000E+00
341		0.00	0.000	0.015	0.1104	0.0000	.0000E+00	.0000E+00
342		0.00	0.000	0.015	0.1098	0.0000	.0000E+00	.0000E+00
343		0.00	0.000	0.015	0.1093	0.0000	.0000E+00	.0000E+00
344		0.00	0.000	0.015	0.1088	0.0000	.0000E+00	.0000E+00
345		0.00	0.000	0.014	0.1083	0.0000	.0000E+00	.0000E+00
346		0.05	0.000	0.023	0.1092	0.0000	.0000E+00	.0000E+00
347		0.00	0.000	0.014	0.1087	0.0000	.0000E+00	.0000E+00
348	*	0.00	0.000	0.014	0.1082	0.0000	.0000E+00	.0000E+00
349		0.00	0.000	0.014	0.1078	0.0000	.0000E+00	.0000E+00
350		0.00	0.000	0.014	0.1073	0.0000	.0000E+00	.0000E+00
351		0.00	0.000	0.013	0.1068	0.0000	.0000E+00	.0000E+00
352		0.00	0.000	0.013	0.1063	0.0000	.0000E+00	.0000E+00
353		0.00	0.000	0.013	0.1058	0.0000	.0000E+00	.0000E+00

354	0.00	0.000	0.013	0.1054	0.0000	.0000E+00	.0000E+00
355	0.00	0.000	0.013	0.1049	0.0000	.0000E+00	.0000E+00
356	0.00	0.000	0.013	0.1044	0.0000	.0000E+00	.0000E+00
357	0.00	0.000	0.013	0.1040	0.0000	.0000E+00	.0000E+00
358	0.00	0.000	0.012	0.1035	0.0000	.0000E+00	.0000E+00
359	0.00	0.000	0.010	0.1032	0.0000	.0000E+00	.0000E+00
360	0.00	0.000	0.006	0.1030	0.0000	.0000E+00	.0000E+00
361	0.00	0.000	0.005	0.1028	0.0000	.0000E+00	.0000E+00
362	0.00	0.000	0.004	0.1027	0.0000	.0000E+00	.0000E+00
363	0.00	0.000	0.003	0.1026	0.0000	.0000E+00	.0000E+00
364	0.00	0.000	0.002	0.1025	0.0000	.0000E+00	.0000E+00
365	0.00	0.000	0.002	0.1024	0.0000	.0000E+00	.0000E+00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1985

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.26	0.42	0.34	0.82	0.50	0.85
	1.82	2.69	1.42	4.13	0.05	0.05
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.036	0.000	0.000
EVAPOTRANSPIRATION	1.730	0.421	0.319	0.582	0.929	0.857
	1.592	2.919	1.368	3.065	0.729	0.382
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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ANNUAL TOTALS FOR YEAR 1985

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.35	2083619.870	100.00
RUNOFF	0.036	5263.866	0.25
EVAPOTRANSPIRATION	14.893	2162405.750	103.78
PERC./LEAKAGE THROUGH LAYER 2	0.000014	2.003	0.00
CHANGE IN WATER STORAGE	-0.579	-84051.344	-4.03
SOIL WATER AT START OF YEAR	4.518	655992.000	
SOIL WATER AT END OF YEAR	3.939	571940.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.276	0.00

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LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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DAILY OUTPUT FOR YEAR 1986

DAY	AIR -	SOIL -	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.01	0.000	0.009	0.1025	0.0000	.0000E+00	.0000E+00
2			0.00	0.000	0.003	0.1024	0.0000	.0000E+00	.0000E+00
3			0.00	0.000	0.002	0.1023	0.0000	.0000E+00	.0000E+00
4			0.00	0.000	0.001	0.1023	0.0000	.0000E+00	.0000E+00
5			0.00	0.000	0.001	0.1022	0.0000	.0000E+00	.0000E+00
6			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
7			0.01	0.000	0.008	0.1023	0.0000	.0000E+00	.0000E+00
8	*		0.00	0.000	0.002	0.1023	0.0000	.0000E+00	.0000E+00
9	*		0.00	0.000	0.002	0.1022	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
12			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
13			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
14			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
16			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
17			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
18			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
19			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
20			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
21			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
22			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
23			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
24			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
25			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
26			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
27			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
32			0.00	0.000	0.000	0.1022	0.0000	.0000E+00	.0000E+00
33			0.02	0.000	0.008	0.1026	0.0000	.0000E+00	.0000E+00
34			0.00	0.000	0.001	0.1026	0.0000	.0000E+00	.0000E+00
35			0.16	0.000	0.010	0.1079	0.0000	.0000E+00	.0000E+00
36			0.04	0.000	0.012	0.1089	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.005	0.1087	0.0000	.0000E+00	.0000E+00
38			0.05	0.000	0.012	0.1101	0.0000	.0000E+00	.0000E+00
39			0.01	0.000	0.012	0.1100	0.0000	.0000E+00	.0000E+00

40	0.05	0.000	0.013	0.1114	0.0000	.0000E+00	.1990E-05
41	0.24	0.000	0.013	0.1195	0.0000	.0000E+00	.1028E-05
42	0.00	0.000	0.005	0.1193	0.0000	.0000E+00	.0000E+00
43	0.00	0.000	0.005	0.1191	0.0000	.0000E+00	.0000E+00
44	0.00	0.000	0.006	0.1189	0.0000	.0000E+00	.0000E+00
45	0.00	0.000	0.007	0.1186	0.0000	.0000E+00	.0000E+00
46	0.00	0.000	0.007	0.1184	0.0000	.0000E+00	.0000E+00
47	0.00	0.000	0.007	0.1181	0.0000	.0000E+00	.0000E+00
48	0.00	0.000	0.007	0.1178	0.0000	.0000E+00	.0000E+00
49	0.00	0.000	0.007	0.1176	0.0000	.0000E+00	.0000E+00
50	0.00	0.000	0.007	0.1173	0.0000	.0000E+00	.0000E+00
51	0.00	0.000	0.007	0.1171	0.0000	.0000E+00	.0000E+00
52	0.00	0.000	0.007	0.1168	0.0000	.0000E+00	.0000E+00
53	0.00	0.000	0.007	0.1165	0.0000	.0000E+00	.0000E+00
54	0.00	0.000	0.007	0.1163	0.0000	.0000E+00	.0000E+00
55	0.00	0.000	0.007	0.1160	0.0000	.0000E+00	.0000E+00
56	0.00	0.000	0.007	0.1158	0.0000	.0000E+00	.0000E+00
57	0.00	0.000	0.007	0.1155	0.0000	.0000E+00	.0000E+00
58	0.00	0.000	0.007	0.1153	0.0000	.0000E+00	.0000E+00
59	0.00	0.000	0.007	0.1150	0.0000	.0000E+00	.0000E+00
60	0.00	0.000	0.007	0.1148	0.0000	.0000E+00	.0000E+00
61	0.00	0.000	0.007	0.1145	0.0000	.0000E+00	.0000E+00
62	0.00	0.000	0.007	0.1143	0.0000	.0000E+00	.0000E+00
63	0.00	0.000	0.007	0.1140	0.0000	.0000E+00	.0000E+00
64	0.00	0.000	0.007	0.1138	0.0000	.0000E+00	.0000E+00
65	0.00	0.000	0.007	0.1136	0.0000	.0000E+00	.0000E+00
66	0.00	0.000	0.007	0.1133	0.0000	.0000E+00	.0000E+00
67	0.00	0.000	0.007	0.1131	0.0000	.0000E+00	.0000E+00
68	0.00	0.000	0.007	0.1128	0.0000	.0000E+00	.0000E+00
69	0.00	0.000	0.007	0.1126	0.0000	.0000E+00	.0000E+00
70	0.07	0.000	0.013	0.1146	0.0000	.0000E+00	.0000E+00
71	0.00	0.000	0.007	0.1144	0.0000	.0000E+00	.0000E+00
72	0.11	0.000	0.014	0.1178	0.0000	.0000E+00	.0000E+00
73	0.13	0.000	0.014	0.1220	0.0000	.0000E+00	.0000E+00
74	0.00	0.000	0.008	0.1217	0.0000	.0000E+00	.0000E+00
75	0.00	0.000	0.008	0.1214	0.0000	.0000E+00	.0000E+00
76	0.00	0.000	0.008	0.1211	0.0000	.0000E+00	.0000E+00
77	0.00	0.000	0.008	0.1208	0.0000	.0000E+00	.0000E+00
78	0.04	0.000	0.013	0.1217	0.0000	.0000E+00	.0000E+00
79	0.00	0.000	0.007	0.1215	0.0000	.0000E+00	.0000E+00
80	0.00	0.000	0.008	0.1212	0.0000	.0000E+00	.0000E+00
81	0.00	0.000	0.008	0.1209	0.0000	.0000E+00	.0000E+00
82	0.00	0.000	0.008	0.1207	0.0000	.0000E+00	.0000E+00
83	0.00	0.000	0.007	0.1204	0.0000	.0000E+00	.0000E+00
84	0.00	0.000	0.007	0.1202	0.0000	.0000E+00	.0000E+00
85	0.00	0.000	0.007	0.1199	0.0000	.0000E+00	.0000E+00
86	0.00	0.000	0.007	0.1196	0.0000	.0000E+00	.0000E+00
87	0.00	0.000	0.007	0.1194	0.0000	.0000E+00	.0000E+00
88	0.00	0.000	0.007	0.1191	0.0000	.0000E+00	.0000E+00
89	0.00	0.000	0.007	0.1189	0.0000	.0000E+00	.0000E+00
90	0.00	0.000	0.007	0.1186	0.0000	.0000E+00	.0000E+00
91	0.00	0.000	0.007	0.1183	0.0000	.0000E+00	.0000E+00
92	0.00	0.000	0.008	0.1181	0.0000	.0000E+00	.0000E+00
93	0.00	0.000	0.008	0.1178	0.0000	.0000E+00	.0000E+00
94	0.00	0.000	0.008	0.1175	0.0000	.0000E+00	.0000E+00
95	0.00	0.000	0.008	0.1172	0.0000	.0000E+00	.0000E+00
96	0.00	0.000	0.008	0.1170	0.0000	.0000E+00	.0000E+00
97	0.00	0.000	0.008	0.1167	0.0000	.0000E+00	.0000E+00
98	0.00	0.000	0.008	0.1164	0.0000	.0000E+00	.0000E+00
99	0.00	0.000	0.009	0.1161	0.0000	.0000E+00	.0000E+00
100	0.00	0.000	0.009	0.1157	0.0000	.0000E+00	.0000E+00
101	0.00	0.000	0.009	0.1154	0.0000	.0000E+00	.0000E+00
102	0.00	0.000	0.009	0.1151	0.0000	.0000E+00	.0000E+00

103	0.00	0.000	0.009	0.1148	0.0000	.0000E+00	.0000E+00
104	0.00	0.000	0.009	0.1144	0.0000	.0000E+00	.0000E+00
105	0.00	0.000	0.010	0.1141	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.010	0.1137	0.0000	.0000E+00	.0000E+00
107	0.00	0.000	0.010	0.1134	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.010	0.1130	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.010	0.1127	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.010	0.1123	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.011	0.1119	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.011	0.1115	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.012	0.1111	0.0000	.0000E+00	.0000E+00
114	0.01	0.000	0.017	0.1109	0.0000	.0000E+00	.0000E+00
115	0.00	0.000	0.012	0.1104	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.013	0.1100	0.0000	.0000E+00	.0000E+00
117	0.00	0.000	0.013	0.1095	0.0000	.0000E+00	.0000E+00
118	0.00	0.000	0.013	0.1091	0.0000	.0000E+00	.0000E+00
119	0.00	0.000	0.014	0.1086	0.0000	.0000E+00	.0000E+00
120	0.00	0.000	0.015	0.1080	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.015	0.1075	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.016	0.1069	0.0000	.0000E+00	.0000E+00
123	0.00	0.000	0.016	0.1063	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.017	0.1057	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.017	0.1051	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.016	0.1045	0.0000	.0000E+00	.0000E+00
127	0.00	0.000	0.013	0.1041	0.0000	.0000E+00	.0000E+00
128	0.00	0.000	0.017	0.1035	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.016	0.1029	0.0000	.0000E+00	.0000E+00
130	0.00	0.000	0.017	0.1023	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.018	0.1017	0.0000	.0000E+00	.0000E+00
132	0.00	0.000	0.019	0.1010	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.020	0.1003	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.008	0.1000	0.0000	.0000E+00	.0000E+00
135	0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
136	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
137	0.03	0.000	0.010	0.1007	0.0000	.0000E+00	.0000E+00
138	0.00	0.000	0.002	0.1006	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.004	0.1004	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.005	0.1003	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.005	0.1001	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.004	0.1000	0.0000	.0000E+00	.0000E+00
143	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
144	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
145	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
146	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
147	0.05	0.000	0.010	0.1014	0.0000	.0000E+00	.0000E+00
148	0.02	0.000	0.009	0.1017	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.002	0.1017	0.0000	.0000E+00	.0000E+00
150	0.27	0.000	0.013	0.1108	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.012	0.1104	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.012	0.1100	0.0000	.0000E+00	.1119E-05
153	0.00	0.000	0.015	0.1095	0.0000	.0000E+00	.0000E+00
154	0.00	0.000	0.018	0.1088	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.020	0.1081	0.0000	.0000E+00	.0000E+00
156	0.00	0.000	0.021	0.1074	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.022	0.1066	0.0000	.0000E+00	.0000E+00
158	0.00	0.000	0.024	0.1057	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.024	0.1049	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.025	0.1040	0.0000	.0000E+00	.0000E+00
161	0.00	0.000	0.024	0.1031	0.0000	.0000E+00	.0000E+00
162	0.00	0.000	0.024	0.1023	0.0000	.0000E+00	.0000E+00
163	0.00	0.000	0.026	0.1013	0.0000	.0000E+00	.0000E+00
164	0.00	0.000	0.028	0.1003	0.0000	.0000E+00	.0000E+00
165	0.00	0.000	0.009	0.1000	0.0000	.0000E+00	.0000E+00

166		0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
167		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
168		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
169		0.12	0.000	0.013	0.1038	0.0000	.0000E+00	.0000E+00
170		0.08	0.000	0.013	0.1062	0.0000	.0000E+00	.0000E+00
171		0.00	0.000	0.018	0.1055	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.019	0.1048	0.0000	.0000E+00	.0000E+00
173		0.00	0.000	0.026	0.1039	0.0000	.0000E+00	.0000E+00
174		0.02	0.000	0.035	0.1034	0.0000	.0000E+00	.0000E+00
175		0.46	0.000	0.033	0.1186	0.0000	.0000E+00	.0000E+00
176		0.48	0.000	0.032	0.1346	0.0000	.0000E+00	.0000E+00
177		0.32	0.000	0.220	0.1382	0.0000	.0000E+00	.0000E+00
178		0.00	0.000	0.259	0.1289	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.272	0.1192	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.214	0.1115	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.113	0.1075	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.099	0.1040	0.0000	.0000E+00	.0000E+00
183		0.00	0.000	0.090	0.1007	0.0000	.0000E+00	.0000E+00
184		0.06	0.000	0.038	0.1015	0.0000	.0000E+00	.0000E+00
185		0.00	0.000	0.013	0.1010	0.0000	.0000E+00	.0000E+00
186		0.00	0.000	0.017	0.1004	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.011	0.1000	0.0000	.0000E+00	.0000E+00
188		0.02	0.000	0.018	0.1001	0.0000	.0000E+00	.0000E+00
189		0.00	0.000	0.003	0.1000	0.0000	.0000E+00	.0000E+00
190		0.03	0.000	0.019	0.1004	0.0000	.0000E+00	.0000E+00
191		0.16	0.000	0.019	0.1054	0.0000	.0000E+00	.0000E+00
192		0.00	0.000	0.034	0.1042	0.0000	.0000E+00	.1122E-05
193		0.00	0.000	0.041	0.1027	0.0000	.0000E+00	.0000E+00
194		0.00	0.000	0.018	0.1021	0.0000	.0000E+00	.0000E+00
195		0.00	0.000	0.016	0.1015	0.0000	.0000E+00	.0000E+00
196		0.00	0.000	0.009	0.1012	0.0000	.0000E+00	.0000E+00
197	*	0.00	0.000	0.011	0.1008	0.0000	.0000E+00	.0000E+00
198	*	0.27	0.000	0.080	0.1015	0.0000	.0000E+00	.0000E+00
199		0.02	0.000	0.202	0.1011	0.0000	.0000E+00	.0000E+00
200		0.00	0.000	0.014	0.1006	0.0000	.0000E+00	.1079E-05
201		0.00	0.000	0.013	0.1001	0.0000	.0000E+00	.1116E-05
202		0.23	0.000	0.022	0.1075	0.0000	.0000E+00	.0000E+00
203		0.26	0.000	0.042	0.1153	0.0000	.0000E+00	.0000E+00
204		0.00	0.000	0.033	0.1141	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.041	0.1126	0.0000	.0000E+00	.0000E+00
206		0.00	0.000	0.051	0.1108	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.053	0.1089	0.0000	.0000E+00	.0000E+00
208		0.00	0.000	0.055	0.1070	0.0000	.0000E+00	.0000E+00
209		0.00	0.000	0.052	0.1051	0.0000	.0000E+00	.0000E+00
210		0.00	0.000	0.050	0.1033	0.0000	.0000E+00	.0000E+00
211		0.00	0.000	0.055	0.1014	0.0000	.0000E+00	.0000E+00
212		0.00	0.000	0.031	0.1003	0.0000	.0000E+00	.0000E+00
213		0.00	0.000	0.008	0.1000	0.0000	.0000E+00	.0000E+00
214		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
215		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
216		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
217		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
218		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
219		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
220		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
221		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
222		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
223		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
224		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
225		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
226		0.85	0.000	0.043	0.1288	0.0000	.0000E+00	.0000E+00
227		0.05	0.000	0.115	0.1264	0.0000	.0000E+00	.0000E+00
228		0.00	0.000	0.238	0.1179	0.0000	.0000E+00	.0000E+00

229		0.00	0.000	0.232	0.1096	0.0000	.0000E+00	.0000E+00
230		0.00	0.000	0.188	0.1029	0.0000	.0000E+00	.0000E+00
231		0.00	0.000	0.063	0.1007	0.0000	.0000E+00	.0000E+00
232		0.00	0.000	0.016	0.1001	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.004	0.1000	0.0000	.0000E+00	.0000E+00
234		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
235		0.37	0.000	0.026	0.1122	0.0000	.0000E+00	.0000E+00
236		0.00	0.000	0.143	0.1071	0.0000	.0000E+00	.0000E+00
237		0.00	0.000	0.162	0.1013	0.0000	.0000E+00	.0000E+00
238		0.00	0.000	0.032	0.1002	0.0000	.0000E+00	.0000E+00
239		0.01	0.000	0.015	0.1000	0.0000	.0000E+00	.0000E+00
240	*	0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
241		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
242	*	0.46	0.000	0.072	0.1006	0.0000	.0000E+00	.0000E+00
243	*	0.00	0.000	0.068	0.1013	0.0000	.0000E+00	.0000E+00
244		0.00	0.000	0.107	0.1040	0.0000	.0000E+00	.0000E+00
245	*	0.00	0.000	0.099	0.1040	0.0000	.0000E+00	.0000E+00
246		0.00	0.000	0.028	0.1030	0.0000	.0000E+00	.0000E+00
247		0.06	0.000	0.030	0.1041	0.0000	.0000E+00	.0000E+00
248		0.00	0.000	0.008	0.1038	0.0000	.0000E+00	.0000E+00
249		0.11	0.000	0.039	0.1063	0.0000	.0000E+00	.0000E+00
250		0.00	0.000	0.080	0.1035	0.0000	.0000E+00	.0000E+00
251		0.00	0.000	0.026	0.1025	0.0000	.0000E+00	.0000E+00
252		0.00	0.000	0.028	0.1015	0.0000	.0000E+00	.0000E+00
253		0.00	0.000	0.012	0.1011	0.0000	.0000E+00	.0000E+00
254		0.00	0.000	0.009	0.1008	0.0000	.0000E+00	.1069E-05
255		0.12	0.000	0.022	0.1043	0.0000	.0000E+00	.0000E+00
256		0.00	0.000	0.028	0.1032	0.0000	.0000E+00	.0000E+00
257		0.00	0.000	0.017	0.1026	0.0000	.0000E+00	.1122E-05
258		0.50	0.000	0.039	0.1191	0.0000	.0000E+00	.0000E+00
259		0.00	0.000	0.095	0.1157	0.0000	.0000E+00	.0000E+00
260		0.00	0.000	0.162	0.1099	0.0000	.0000E+00	.0000E+00
261		0.00	0.000	0.159	0.1043	0.0000	.0000E+00	.0000E+00
262		0.00	0.000	0.089	0.1011	0.0000	.0000E+00	.0000E+00
263	*	0.00	0.000	0.024	0.1002	0.0000	.0000E+00	.0000E+00
264	*	0.00	0.000	0.006	0.1000	0.0000	.0000E+00	.0000E+00
265		0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
266		0.21	0.000	0.023	0.1066	0.0000	.0000E+00	.0000E+00
267		0.80	0.000	0.096	0.1318	0.0000	.0000E+00	.0000E+00
268		0.00	0.000	0.085	0.1287	0.0000	.0000E+00	.0000E+00
269		0.00	0.000	0.147	0.1235	0.0000	.0000E+00	.0000E+00
270		0.00	0.000	0.145	0.1183	0.0000	.0000E+00	.0000E+00
271		0.00	0.000	0.133	0.1135	0.0000	.0000E+00	.0000E+00
272		0.00	0.000	0.130	0.1089	0.0000	.0000E+00	.0000E+00
273		0.00	0.000	0.138	0.1040	0.0000	.0000E+00	.0000E+00
274		0.00	0.000	0.100	0.1004	0.0000	.0000E+00	.0000E+00
275		0.24	0.000	0.035	0.1077	0.0000	.0000E+00	.0000E+00
276		0.26	0.000	0.116	0.1129	0.0000	.0000E+00	.0000E+00
277		0.00	0.000	0.084	0.1099	0.0000	.0000E+00	.0000E+00
278		0.00	0.000	0.128	0.1053	0.0000	.0000E+00	.0000E+00
279		0.10	0.000	0.120	0.1046	0.0000	.0000E+00	.0000E+00
280		0.00	0.000	0.050	0.1028	0.0000	.0000E+00	.0000E+00
281		0.00	0.000	0.034	0.1016	0.0000	.0000E+00	.0000E+00
282		0.00	0.000	0.013	0.1011	0.0000	.0000E+00	.0000E+00
283		0.10	0.000	0.030	0.1036	0.0000	.0000E+00	.0000E+00
284		0.05	0.000	0.023	0.1046	0.0000	.0000E+00	.0000E+00
285		0.14	0.000	0.036	0.1083	0.0000	.0000E+00	.0000E+00
286		0.00	0.000	0.075	0.1056	0.0000	.0000E+00	.0000E+00
287		0.00	0.000	0.088	0.1025	0.0000	.0000E+00	.0000E+00
288		0.00	0.000	0.029	0.1014	0.0000	.0000E+00	.0000E+00
289		0.05	0.000	0.028	0.1022	0.0000	.0000E+00	.0000E+00
290		0.00	0.000	0.005	0.1021	0.0000	.0000E+00	.0000E+00
291	*	0.00	0.000	0.000	0.1021	0.0000	.0000E+00	.0000E+00

292		0.03	0.000	0.022	0.1024	0.0000	.0000E+00	.0000E+00
293		0.00	0.000	0.005	0.1022	0.0000	.0000E+00	.0000E+00
294		0.00	0.000	0.009	0.1019	0.0000	.0000E+00	.0000E+00
295		0.00	0.000	0.008	0.1016	0.0000	.0000E+00	.0000E+00
296		0.00	0.000	0.008	0.1013	0.0000	.0000E+00	.0000E+00
297		0.00	0.000	0.006	0.1011	0.0000	.0000E+00	.3386E-05
298		0.00	0.000	0.006	0.1009	0.0000	.0000E+00	.0000E+00
299		0.00	0.000	0.006	0.1007	0.0000	.0000E+00	.1159E-05
300		0.00	0.000	0.006	0.1004	0.0000	.0000E+00	.0000E+00
301		0.00	0.000	0.006	0.1002	0.0000	.0000E+00	.1830E-05
302		0.00	0.000	0.006	0.1000	0.0000	.0000E+00	.1123E-05
303		0.00	0.000	0.002	0.1000	0.0000	.0000E+00	.2014E-05
304		0.00	0.000	0.001	0.1000	0.0000	.0000E+00	.0000E+00
305		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
306		1.13	0.000	0.028	0.1393	0.0000	.0000E+00	.0000E+00
307		1.31	0.007	0.084	0.1828	0.0000	.0000E+00	.0000E+00
308		0.00	0.000	0.090	0.1796	0.0000	.0000E+00	.0000E+00
309		0.00	0.000	0.077	0.1769	0.0000	.0000E+00	.0000E+00
310		0.00	0.000	0.080	0.1740	0.0000	.0000E+00	.0000E+00
311		0.00	0.000	0.095	0.1706	0.0000	.0000E+00	.0000E+00
312		0.00	0.000	0.097	0.1672	0.0000	.0000E+00	.0000E+00
313		0.00	0.000	0.086	0.1641	0.0000	.0000E+00	.0000E+00
314		0.00	0.000	0.089	0.1609	0.0000	.0000E+00	.0000E+00
315		0.00	0.000	0.081	0.1580	0.0000	.0000E+00	.0000E+00
316		0.00	0.000	0.089	0.1548	0.0000	.0000E+00	.0000E+00
317		0.24	0.000	0.101	0.1598	0.0000	.0000E+00	.0000E+00
318		0.00	0.000	0.096	0.1564	0.0000	.0000E+00	.0000E+00
319		0.00	0.000	0.101	0.1528	0.0000	.0000E+00	.0000E+00
320		0.00	0.000	0.101	0.1492	0.0000	.0000E+00	.0000E+00
321		0.00	0.000	0.114	0.1451	0.0000	.0000E+00	.0000E+00
322		0.00	0.000	0.097	0.1416	0.0000	.0000E+00	.0000E+00
323		0.34	0.000	0.108	0.1499	0.0000	.0000E+00	.0000E+00
324		0.00	0.000	0.111	0.1460	0.0000	.0000E+00	.0000E+00
325		0.00	0.000	0.097	0.1425	0.0000	.0000E+00	.0000E+00
326		0.00	0.000	0.097	0.1390	0.0000	.0000E+00	.0000E+00
327		0.00	0.000	0.085	0.1360	0.0000	.0000E+00	.0000E+00
328		0.00	0.000	0.071	0.1335	0.0000	.0000E+00	.0000E+00
329		0.00	0.000	0.061	0.1313	0.0000	.0000E+00	.0000E+00
330		0.00	0.000	0.052	0.1294	0.0000	.0000E+00	.0000E+00
331		0.00	0.000	0.046	0.1278	0.0000	.0000E+00	.0000E+00
332		0.00	0.000	0.041	0.1263	0.0000	.0000E+00	.0000E+00
333		0.00	0.000	0.038	0.1250	0.0000	.0000E+00	.0000E+00
334		0.00	0.000	0.035	0.1237	0.0000	.0000E+00	.0000E+00
335		0.00	0.000	0.033	0.1225	0.0000	.0000E+00	.0000E+00
336		0.00	0.000	0.031	0.1214	0.0000	.0000E+00	.0000E+00
337		0.00	0.000	0.030	0.1203	0.0000	.0000E+00	.0000E+00
338		0.00	0.000	0.029	0.1193	0.0000	.0000E+00	.0000E+00
339		0.00	0.000	0.027	0.1183	0.0000	.0000E+00	.0000E+00
340		0.00	0.000	0.026	0.1174	0.0000	.0000E+00	.0000E+00
341		0.11	0.000	0.038	0.1200	0.0000	.0000E+00	.0000E+00
342		0.52	0.000	0.037	0.1372	0.0000	.0000E+00	.0000E+00
343		0.00	0.000	0.024	0.1364	0.0000	.0000E+00	.0000E+00
344		0.15	0.000	0.035	0.1404	0.0000	.0000E+00	.0000E+00
345	*	0.00	0.000	0.059	0.1383	0.0000	.0000E+00	.0000E+00
346	*	0.00	0.000	0.023	0.1375	0.0000	.0000E+00	.0000E+00
347		0.00	0.000	0.022	0.1367	0.0000	.0000E+00	.0000E+00
348		0.00	0.000	0.021	0.1360	0.0000	.0000E+00	.0000E+00
349		0.00	0.000	0.021	0.1352	0.0000	.0000E+00	.0000E+00
350		0.22	0.000	0.033	0.1419	0.0000	.0000E+00	.0000E+00
351		0.50	0.000	0.096	0.1563	0.0000	.0000E+00	.0000E+00
352		0.00	0.000	0.096	0.1529	0.0000	.0000E+00	.0000E+00
353		0.00	0.000	0.064	0.1506	0.0000	.0000E+00	.0000E+00
354		0.00	0.000	0.063	0.1484	0.0000	.0000E+00	.0000E+00

355	0.00	0.000	0.083	0.1454	0.0000	.0000E+00	.0000E+00
356	0.00	0.000	0.086	0.1424	0.0000	.0000E+00	.0000E+00
357	0.09	0.000	0.085	0.1425	0.0000	.0000E+00	.0000E+00
358	0.00	0.000	0.062	0.1403	0.0000	.0000E+00	.0000E+00
359	0.00	0.000	0.067	0.1379	0.0000	.0000E+00	.0000E+00
360	0.00	0.000	0.065	0.1356	0.0000	.0000E+00	.0000E+00
361	0.00	0.000	0.068	0.1332	0.0000	.0000E+00	.0000E+00
362	0.00	0.000	0.062	0.1310	0.0000	.0000E+00	.0000E+00
363	0.00	0.000	0.052	0.1291	0.0000	.0000E+00	.0000E+00
364	0.00	0.000	0.046	0.1275	0.0000	.0000E+00	.0000E+00
365	0.00	0.000	0.041	0.1260	0.0000	.0000E+00	.0000E+00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1986

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.02	0.57	0.35	0.01	0.37	1.48
	1.05	1.74	1.80	0.97	3.02	1.59
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.007	0.000
EVAPOTRANSPIRATION	0.027	0.210	0.250	0.307	0.303	1.562
	1.253	1.430	2.006	1.083	2.348	1.525
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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ANNUAL TOTALS FOR YEAR 1986

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.97	1883244.000	100.00
RUNOFF	0.007	1013.441	0.05
EVAPOTRANSPIRATION	12.302	1786204.370	94.85
PERC./LEAKAGE THROUGH LAYER 2	0.000019	2.781	0.00
CHANGE IN WATER STORAGE	0.661	96023.211	5.10
SOIL WATER AT START OF YEAR	3.939	571940.687	
SOIL WATER AT END OF YEAR	4.600	667963.875	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE 0.0000 0.174 0.00

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LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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DAILY OUTPUT FOR YEAR 1987

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.00	0.000	0.034	0.1248	0.0000	.0000E+00	.0000E+00
2			0.00	0.000	0.035	0.1235	0.0000	.0000E+00	.0000E+00
3			0.00	0.000	0.033	0.1223	0.0000	.0000E+00	.0000E+00
4			0.00	0.000	0.031	0.1212	0.0000	.0000E+00	.0000E+00
5			0.00	0.000	0.030	0.1202	0.0000	.0000E+00	.0000E+00
6			0.00	0.000	0.029	0.1191	0.0000	.0000E+00	.0000E+00
7			0.00	0.000	0.027	0.1182	0.0000	.0000E+00	.0000E+00
8			0.00	0.000	0.026	0.1172	0.0000	.0000E+00	.0000E+00
9			0.00	0.000	0.025	0.1163	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.025	0.1154	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.024	0.1146	0.0000	.0000E+00	.0000E+00
12			0.00	0.000	0.023	0.1138	0.0000	.0000E+00	.0000E+00
13			0.00	0.000	0.023	0.1129	0.0000	.0000E+00	.0000E+00
14			0.00	0.000	0.022	0.1122	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.021	0.1114	0.0000	.0000E+00	.0000E+00
16			0.00	0.000	0.021	0.1107	0.0000	.0000E+00	.0000E+00
17	*		0.21	0.000	0.077	0.1114	0.0000	.0000E+00	.0000E+00
18	*		0.00	0.000	0.057	0.1121	0.0000	.0000E+00	.0000E+00
19	*		0.00	0.000	0.037	0.1121	0.0000	.0000E+00	.0000E+00
20	*		0.00	0.000	0.020	0.1113	0.0000	.0000E+00	.0000E+00
21	*		0.00	0.000	0.020	0.1106	0.0000	.0000E+00	.0000E+00
22	*		0.00	0.000	0.020	0.1099	0.0000	.0000E+00	.0000E+00
23	*		0.00	0.000	0.019	0.1092	0.0000	.0000E+00	.0000E+00
24			0.00	0.000	0.019	0.1086	0.0000	.0000E+00	.0000E+00
25			0.00	0.000	0.018	0.1079	0.0000	.0000E+00	.0000E+00
26			0.00	0.000	0.018	0.1073	0.0000	.0000E+00	.0000E+00
27			0.00	0.000	0.018	0.1066	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.017	0.1060	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.017	0.1054	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.017	0.1048	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.017	0.1042	0.0000	.0000E+00	.0000E+00
32			0.00	0.000	0.016	0.1036	0.0000	.0000E+00	.0000E+00
33			0.00	0.000	0.016	0.1030	0.0000	.0000E+00	.0000E+00
34			0.00	0.000	0.012	0.1026	0.0000	.0000E+00	.0000E+00
35			0.00	0.000	0.008	0.1023	0.0000	.0000E+00	.0000E+00
36			0.00	0.000	0.006	0.1021	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.005	0.1019	0.0000	.0000E+00	.0000E+00
38			0.00	0.000	0.004	0.1018	0.0000	.0000E+00	.0000E+00
39			0.00	0.000	0.003	0.1017	0.0000	.0000E+00	.0000E+00
40			0.00	0.000	0.002	0.1016	0.0000	.0000E+00	.0000E+00

41		0.00	0.000	0.002	0.1015	0.0000	.0000E+00	.0000E+00
42		0.00	0.000	0.002	0.1015	0.0000	.0000E+00	.0000E+00
43		0.00	0.000	0.001	0.1014	0.0000	.0000E+00	.0000E+00
44		0.00	0.000	0.001	0.1014	0.0000	.0000E+00	.0000E+00
45		0.00	0.000	0.001	0.1014	0.0000	.0000E+00	.0000E+00
46		0.00	0.000	0.001	0.1014	0.0000	.0000E+00	.0000E+00
47		0.00	0.000	0.000	0.1013	0.0000	.0000E+00	.0000E+00
48		0.00	0.000	0.000	0.1013	0.0000	.0000E+00	.0000E+00
49		0.28	0.000	0.014	0.1108	0.0000	.0000E+00	.0000E+00
50		0.00	0.000	0.008	0.1106	0.0000	.0000E+00	.0000E+00
51		0.07	0.000	0.019	0.1124	0.0000	.0000E+00	.0000E+00
52		0.38	0.000	0.020	0.1252	0.0000	.0000E+00	.0000E+00
53	*	0.00	0.000	0.008	0.1250	0.0000	.0000E+00	.0000E+00
54		0.00	0.000	0.011	0.1246	0.0000	.0000E+00	.0000E+00
55		0.00	0.000	0.010	0.1242	0.0000	.0000E+00	.0000E+00
56		0.00	0.000	0.010	0.1238	0.0000	.0000E+00	.0000E+00
57		0.00	0.000	0.010	0.1235	0.0000	.0000E+00	.0000E+00
58		0.00	0.000	0.010	0.1231	0.0000	.0000E+00	.0000E+00
59		0.00	0.000	0.010	0.1227	0.0000	.0000E+00	.0000E+00
60		0.00	0.000	0.010	0.1224	0.0000	.0000E+00	.0000E+00
61		0.00	0.000	0.010	0.1220	0.0000	.0000E+00	.0000E+00
62		0.00	0.000	0.010	0.1217	0.0000	.0000E+00	.0000E+00
63		0.00	0.000	0.010	0.1214	0.0000	.0000E+00	.0000E+00
64		0.00	0.000	0.010	0.1210	0.0000	.0000E+00	.0000E+00
65		0.00	0.000	0.009	0.1207	0.0000	.0000E+00	.0000E+00
66		0.00	0.000	0.009	0.1203	0.0000	.0000E+00	.0000E+00
67		0.00	0.000	0.009	0.1200	0.0000	.0000E+00	.0000E+00
68		0.00	0.000	0.009	0.1197	0.0000	.0000E+00	.0000E+00
69		0.04	0.000	0.020	0.1204	0.0000	.0000E+00	.0000E+00
70		0.05	0.000	0.020	0.1215	0.0000	.0000E+00	.0000E+00
71		0.00	0.000	0.011	0.1211	0.0000	.0000E+00	.0000E+00
72		0.00	0.000	0.011	0.1207	0.0000	.0000E+00	.0000E+00
73		0.00	0.000	0.011	0.1203	0.0000	.0000E+00	.0000E+00
74		0.00	0.000	0.011	0.1199	0.0000	.0000E+00	.0000E+00
75		0.00	0.000	0.011	0.1195	0.0000	.0000E+00	.0000E+00
76		0.00	0.000	0.011	0.1191	0.0000	.0000E+00	.0000E+00
77		0.00	0.000	0.009	0.1188	0.0000	.0000E+00	.0000E+00
78		0.00	0.000	0.009	0.1185	0.0000	.0000E+00	.0000E+00
79		0.00	0.000	0.009	0.1181	0.0000	.0000E+00	.0000E+00
80		0.00	0.000	0.009	0.1178	0.0000	.0000E+00	.0000E+00
81		0.00	0.000	0.009	0.1175	0.0000	.0000E+00	.0000E+00
82		0.00	0.000	0.009	0.1172	0.0000	.0000E+00	.0000E+00
83		0.00	0.000	0.009	0.1168	0.0000	.0000E+00	.0000E+00
84		0.00	0.000	0.009	0.1165	0.0000	.0000E+00	.0000E+00
85		0.00	0.000	0.009	0.1162	0.0000	.0000E+00	.0000E+00
86		0.00	0.000	0.009	0.1159	0.0000	.0000E+00	.0000E+00
87		0.00	0.000	0.009	0.1156	0.0000	.0000E+00	.0000E+00
88		0.51	0.000	0.019	0.1331	0.0000	.0000E+00	.0000E+00
89		0.00	0.000	0.010	0.1327	0.0000	.0000E+00	.0000E+00
90		0.00	0.000	0.009	0.1324	0.0000	.0000E+00	.0000E+00
91		0.00	0.000	0.009	0.1321	0.0000	.0000E+00	.0000E+00
92		0.00	0.000	0.009	0.1318	0.0000	.0000E+00	.0000E+00
93		0.00	0.000	0.009	0.1314	0.0000	.0000E+00	.0000E+00
94		0.03	0.000	0.018	0.1318	0.0000	.0000E+00	.0000E+00
95		0.00	0.000	0.009	0.1315	0.0000	.0000E+00	.0000E+00
96		0.00	0.000	0.010	0.1312	0.0000	.0000E+00	.0000E+00
97		0.00	0.000	0.009	0.1309	0.0000	.0000E+00	.0000E+00
98		0.00	0.000	0.009	0.1305	0.0000	.0000E+00	.0000E+00
99		0.00	0.000	0.009	0.1302	0.0000	.0000E+00	.0000E+00
100		0.00	0.000	0.009	0.1299	0.0000	.0000E+00	.0000E+00
101		0.00	0.000	0.009	0.1296	0.0000	.0000E+00	.0000E+00
102		0.00	0.000	0.010	0.1292	0.0000	.0000E+00	.0000E+00
103		0.00	0.000	0.009	0.1289	0.0000	.0000E+00	.0000E+00

104	0.00	0.000	0.009	0.1285	0.0000	.0000E+00	.0000E+00
105	0.00	0.000	0.010	0.1282	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.010	0.1279	0.0000	.0000E+00	.0000E+00
107	0.00	0.000	0.010	0.1275	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.010	0.1271	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.010	0.1268	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.010	0.1264	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.011	0.1260	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.011	0.1256	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.011	0.1253	0.0000	.0000E+00	.0000E+00
114	0.00	0.000	0.011	0.1249	0.0000	.0000E+00	.0000E+00
115	0.00	0.000	0.011	0.1245	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.011	0.1241	0.0000	.0000E+00	.0000E+00
117	0.00	0.000	0.012	0.1236	0.0000	.0000E+00	.0000E+00
118	0.00	0.000	0.012	0.1232	0.0000	.0000E+00	.0000E+00
119	0.00	0.000	0.012	0.1228	0.0000	.0000E+00	.0000E+00
120	0.06	0.000	0.022	0.1241	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.014	0.1236	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.015	0.1231	0.0000	.0000E+00	.0000E+00
123	0.00	0.000	0.015	0.1226	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.015	0.1220	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.016	0.1215	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.016	0.1209	0.0000	.0000E+00	.0000E+00
127	0.00	0.000	0.016	0.1203	0.0000	.0000E+00	.0000E+00
128	0.00	0.000	0.015	0.1198	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.013	0.1193	0.0000	.0000E+00	.0000E+00
130	0.00	0.000	0.014	0.1188	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.014	0.1183	0.0000	.0000E+00	.1072E-05
132	0.10	0.000	0.026	0.1210	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.018	0.1203	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.018	0.1197	0.0000	.0000E+00	.0000E+00
135	0.03	0.000	0.029	0.1197	0.0000	.0000E+00	.0000E+00
136	0.00	0.000	0.019	0.1190	0.0000	.0000E+00	.0000E+00
137	0.00	0.000	0.020	0.1183	0.0000	.0000E+00	.0000E+00
138	0.00	0.000	0.021	0.1176	0.0000	.0000E+00	.0000E+00
139	0.13	0.000	0.034	0.1210	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.020	0.1203	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.021	0.1195	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.022	0.1187	0.0000	.0000E+00	.0000E+00
143	0.30	0.000	0.036	0.1281	0.0000	.0000E+00	.0000E+00
144	0.15	0.000	0.036	0.1322	0.0000	.0000E+00	.0000E+00
145	0.10	0.000	0.261	0.1265	0.0000	.0000E+00	.0000E+00
146	0.00	0.000	0.027	0.1255	0.0000	.0000E+00	.0000E+00
147	0.00	0.000	0.026	0.1246	0.0000	.0000E+00	.0000E+00
148	0.00	0.000	0.026	0.1237	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.024	0.1228	0.0000	.0000E+00	.0000E+00
150	0.00	0.000	0.024	0.1220	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.024	0.1211	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.025	0.1202	0.0000	.0000E+00	.0000E+00
153	0.00	0.000	0.028	0.1192	0.0000	.0000E+00	.0000E+00
154	0.00	0.000	0.026	0.1183	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.027	0.1173	0.0000	.0000E+00	.0000E+00
156	0.00	0.000	0.028	0.1163	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.030	0.1152	0.0000	.0000E+00	.0000E+00
158	0.35	0.000	0.045	0.1261	0.0000	.0000E+00	.0000E+00
159	0.03	0.000	0.208	0.1198	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.200	0.1126	0.0000	.0000E+00	.0000E+00
161	0.00	0.000	0.148	0.1074	0.0000	.0000E+00	.0000E+00
162	0.00	0.000	0.109	0.1035	0.0000	.0000E+00	.0000E+00
163	0.00	0.000	0.082	0.1005	0.0000	.0000E+00	.0000E+00
164	0.00	0.000	0.015	0.1000	0.0000	.0000E+00	.0000E+00
165	0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
166	0.04	0.000	0.023	0.1005	0.0000	.0000E+00	.0000E+00

167		0.00	0.000	0.009	0.1002	0.0000	.0000E+00	.0000E+00
168		0.00	0.000	0.007	0.1000	0.0000	.0000E+00	.0000E+00
169		0.00	0.000	0.001	0.1000	0.0000	.0000E+00	.0000E+00
170		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.1120E-05
171		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
173		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
174		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
175		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
176		0.13	0.000	0.023	0.1038	0.0000	.0000E+00	.0000E+00
177		0.00	0.000	0.007	0.1035	0.0000	.0000E+00	.0000E+00
178		1.40	0.000	0.043	0.1520	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.253	0.1429	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.265	0.1334	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.304	0.1226	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.317	0.1113	0.0000	.0000E+00	.0000E+00
183		0.00	0.000	0.262	0.1019	0.0000	.0000E+00	.0000E+00
184		0.00	0.000	0.043	0.1004	0.0000	.0000E+00	.0000E+00
185		0.00	0.000	0.011	0.1000	0.0000	.0000E+00	.0000E+00
186		0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
188		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
189		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
190		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
191		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
192		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
193		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
194		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
195		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
196	*	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
197	*	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
198		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
199	*	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
200		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
201		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
202		0.22	0.000	0.024	0.1069	0.0000	.0000E+00	.0000E+00
203		0.00	0.000	0.036	0.1056	0.0000	.0000E+00	.0000E+00
204		0.04	0.000	0.045	0.1055	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.034	0.1042	0.0000	.0000E+00	.0000E+00
206		0.03	0.000	0.043	0.1038	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.019	0.1031	0.0000	.0000E+00	.0000E+00
208		0.00	0.000	0.023	0.1023	0.0000	.0000E+00	.1094E-05
209		0.00	0.000	0.015	0.1018	0.0000	.0000E+00	.1093E-05
210		0.29	0.000	0.032	0.1110	0.0000	.0000E+00	.0000E+00
211		0.00	0.000	0.168	0.1049	0.0000	.0000E+00	.1104E-05
212		0.00	0.000	0.098	0.1014	0.0000	.0000E+00	.0000E+00
213		0.00	0.000	0.031	0.1003	0.0000	.0000E+00	.0000E+00
214	*	0.00	0.000	0.009	0.1000	0.0000	.0000E+00	.0000E+00
215		0.04	0.000	0.022	0.1007	0.0000	.0000E+00	.0000E+00
216		0.63	0.000	0.037	0.1219	0.0000	.0000E+00	.0000E+00
217		0.00	0.000	0.080	0.1190	0.0000	.0000E+00	.0000E+00
218	*	0.00	0.000	0.111	0.1151	0.0000	.0000E+00	.0000E+00
219		0.00	0.000	0.112	0.1111	0.0000	.0000E+00	.0000E+00
220	*	0.00	0.000	0.110	0.1071	0.0000	.0000E+00	.0000E+00
221		0.60	0.000	0.100	0.1250	0.0000	.0000E+00	.0000E+00
222		0.00	0.000	0.229	0.1168	0.0000	.0000E+00	.0000E+00
223		0.30	0.000	0.265	0.1181	0.0000	.0000E+00	.0000E+00
224		0.00	0.000	0.111	0.1141	0.0000	.0000E+00	.1107E-05
225	*	0.00	0.000	0.110	0.1101	0.0000	.0000E+00	.1083E-05
226		0.00	0.000	0.196	0.1031	0.0000	.0000E+00	.0000E+00
227		0.00	0.000	0.070	0.1006	0.0000	.0000E+00	.0000E+00
228		0.00	0.000	0.015	0.1001	0.0000	.0000E+00	.0000E+00
229		0.00	0.000	0.004	0.1000	0.0000	.0000E+00	.0000E+00

230		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
231		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
232		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
234		0.01	0.000	0.010	0.0999	0.0000	.0000E+00	.0000E+00
235		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
236		1.90	0.036	0.059	0.1644	0.0000	.0000E+00	.0000E+00
237		0.00	0.000	0.226	0.1563	0.0000	.0000E+00	.0000E+00
238		0.15	0.000	0.261	0.1524	0.0000	.0000E+00	.0000E+00
239		0.00	0.000	0.239	0.1438	0.0000	.0000E+00	.0000E+00
240		0.00	0.000	0.238	0.1353	0.0000	.0000E+00	.0000E+00
241		0.00	0.000	0.206	0.1280	0.0000	.0000E+00	.0000E+00
242		0.00	0.000	0.181	0.1215	0.0000	.0000E+00	.0000E+00
243		0.00	0.000	0.224	0.1135	0.0000	.0000E+00	.0000E+00
244		0.00	0.000	0.257	0.1043	0.0000	.0000E+00	.0000E+00
245	*	0.00	0.000	0.088	0.1012	0.0000	.0000E+00	.0000E+00
246	*	0.00	0.000	0.007	0.1010	0.0000	.0000E+00	.0000E+00
247		0.05	0.000	0.054	0.1008	0.0000	.0000E+00	.0000E+00
248		0.00	0.000	0.017	0.1002	0.0000	.0000E+00	.0000E+00
249		0.00	0.000	0.006	0.1000	0.0000	.0000E+00	.0000E+00
250		0.00	0.000	0.001	0.1000	0.0000	.0000E+00	.0000E+00
251		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.1129E-05
252		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
253		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
254		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
255		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
256		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
257		0.22	0.000	0.028	0.1068	0.0000	.0000E+00	.0000E+00
258		0.00	0.000	0.034	0.1056	0.0000	.0000E+00	.0000E+00
259		0.00	0.000	0.039	0.1042	0.0000	.0000E+00	.0000E+00
260		0.00	0.000	0.047	0.1025	0.0000	.0000E+00	.0000E+00
261		0.02	0.000	0.035	0.1020	0.0000	.0000E+00	.0000E+00
262	*	0.00	0.000	0.000	0.1020	0.0000	.0000E+00	.0000E+00
263		0.00	0.000	0.010	0.1016	0.0000	.0000E+00	.0000E+00
264		0.00	0.000	0.012	0.1012	0.0000	.0000E+00	.0000E+00
265		0.00	0.000	0.010	0.1008	0.0000	.0000E+00	.0000E+00
266		0.00	0.000	0.010	0.1004	0.0000	.0000E+00	.0000E+00
267		0.00	0.000	0.010	0.1001	0.0000	.0000E+00	.1136E-05
268		0.15	0.000	0.029	0.1044	0.0000	.0000E+00	.0000E+00
269		0.00	0.000	0.005	0.1043	0.0000	.0000E+00	.1561E-05
270		0.00	0.000	0.021	0.1035	0.0000	.0000E+00	.0000E+00
271		0.00	0.000	0.027	0.1025	0.0000	.0000E+00	.0000E+00
272		0.12	0.000	0.031	0.1057	0.0000	.0000E+00	.0000E+00
273		0.00	0.000	0.062	0.1035	0.0000	.0000E+00	.0000E+00
274		0.00	0.000	0.025	0.1026	0.0000	.0000E+00	.0000E+00
275		0.00	0.000	0.014	0.1021	0.0000	.0000E+00	.0000E+00
276		0.00	0.000	0.010	0.1017	0.0000	.0000E+00	.1091E-05
277		0.00	0.000	0.007	0.1015	0.0000	.0000E+00	.0000E+00
278		0.00	0.000	0.007	0.1013	0.0000	.0000E+00	.0000E+00
279		0.00	0.000	0.006	0.1010	0.0000	.0000E+00	.0000E+00
280		0.00	0.000	0.006	0.1008	0.0000	.0000E+00	.1092E-05
281		0.00	0.000	0.006	0.1006	0.0000	.0000E+00	.1136E-05
282		0.00	0.000	0.006	0.1004	0.0000	.0000E+00	.1124E-05
283		0.00	0.000	0.006	0.1002	0.0000	.0000E+00	.1977E-05
284		0.00	0.000	0.006	0.1000	0.0000	.0000E+00	.0000E+00
285		0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
286		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
287		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
288		0.09	0.000	0.024	0.1023	0.0000	.0000E+00	.0000E+00
289		0.00	0.000	0.002	0.1022	0.0000	.0000E+00	.0000E+00
290		0.00	0.000	0.005	0.1020	0.0000	.0000E+00	.0000E+00
291	*	0.00	0.000	0.000	0.1020	0.0000	.0000E+00	.0000E+00
292		0.00	0.000	0.005	0.1018	0.0000	.0000E+00	.0000E+00

293		0.00	0.000	0.004	0.1017	0.0000	.0000E+00	.0000E+00
294		0.00	0.000	0.004	0.1015	0.0000	.0000E+00	.0000E+00
295		0.00	0.000	0.004	0.1014	0.0000	.0000E+00	.0000E+00
296		0.17	0.000	0.026	0.1065	0.0000	.0000E+00	.0000E+00
297		0.00	0.000	0.060	0.1044	0.0000	.0000E+00	.1531E-05
298		0.00	0.000	0.072	0.1018	0.0000	.0000E+00	.0000E+00
299		0.00	0.000	0.014	0.1013	0.0000	.0000E+00	.0000E+00
300		0.00	0.000	0.006	0.1011	0.0000	.0000E+00	.0000E+00
301		0.00	0.000	0.004	0.1010	0.0000	.0000E+00	.0000E+00
302		0.00	0.000	0.004	0.1008	0.0000	.0000E+00	.0000E+00
303		0.00	0.000	0.003	0.1007	0.0000	.0000E+00	.1136E-05
304		0.00	0.000	0.003	0.1006	0.0000	.0000E+00	.1110E-05
305		0.35	0.000	0.025	0.1122	0.0000	.0000E+00	.2110E-05
306		0.00	0.000	0.055	0.1102	0.0000	.0000E+00	.0000E+00
307		0.00	0.000	0.065	0.1079	0.0000	.0000E+00	.0000E+00
308		0.00	0.000	0.073	0.1053	0.0000	.0000E+00	.0000E+00
309		0.11	0.000	0.105	0.1055	0.0000	.0000E+00	.0000E+00
310		0.14	0.000	0.083	0.1075	0.0000	.0000E+00	.0000E+00
311		0.00	0.000	0.059	0.1054	0.0000	.0000E+00	.0000E+00
312		0.00	0.000	0.066	0.1030	0.0000	.0000E+00	.0000E+00
313		0.00	0.000	0.035	0.1018	0.0000	.0000E+00	.0000E+00
314		0.00	0.000	0.023	0.1009	0.0000	.0000E+00	.0000E+00
315		0.00	0.000	0.015	0.1004	0.0000	.0000E+00	.0000E+00
316		0.00	0.000	0.009	0.1001	0.0000	.0000E+00	.0000E+00
317		0.00	0.000	0.002	0.1000	0.0000	.0000E+00	.0000E+00
318		0.00	0.000	0.001	0.1000	0.0000	.0000E+00	.0000E+00
319		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
320		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
321		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
322		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
323		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
324		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
325		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
326		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
327		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
328		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
329		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
330		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
331	*	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
332		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
333		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
334		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
335		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
336		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
337		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
338		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
339		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
340		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
341		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
342		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
343		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
344		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
345		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
346		0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
347		0.67	0.000	0.027	0.1229	0.0000	.0000E+00	.0000E+00
348	*	0.45	0.000	0.051	0.1236	0.0000	.0000E+00	.0000E+00
349	*	0.00	0.000	0.052	0.1243	0.0000	.0000E+00	.0000E+00
350	*	0.00	0.000	0.043	0.1250	0.0000	.0000E+00	.0000E+00
351		0.00	0.000	0.074	0.1257	0.0000	.0000E+00	.0000E+00
352		0.11	0.000	0.081	0.1322	0.0000	.0000E+00	.0000E+00
353		0.01	0.000	0.058	0.1305	0.0000	.0000E+00	.0000E+00
354		0.00	0.000	0.051	0.1287	0.0000	.0000E+00	.0000E+00
355		0.00	0.000	0.047	0.1270	0.0000	.0000E+00	.0000E+00

356		0.00	0.000	0.050	0.1252	0.0000	.0000E+00	.0000E+00
357		0.00	0.000	0.063	0.1230	0.0000	.0000E+00	.0000E+00
358		0.00	0.000	0.057	0.1209	0.0000	.0000E+00	.0000E+00
359		0.00	0.000	0.055	0.1190	0.0000	.0000E+00	.0000E+00
360	*	0.50	0.000	0.048	0.1197	0.0000	.0000E+00	.0000E+00
361	*	0.02	0.000	0.030	0.1204	0.0000	.0000E+00	.0000E+00
362	*	0.00	0.000	0.035	0.1211	0.0000	.0000E+00	.0000E+00
363	*	0.00	0.000	0.040	0.1218	0.0000	.0000E+00	.0000E+00
364		0.00	0.000	0.056	0.1225	0.0000	.0000E+00	.0000E+00
365		0.00	0.000	0.064	0.1278	0.0000	.0000E+00	.0000E+00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1987

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.21	0.73	0.60	0.09	0.81	1.95
	0.58	3.63	0.56	0.26	0.60	1.76
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.036	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.821	0.210	0.330	0.321	0.895	1.908
	1.172	3.255	0.841	0.341	0.618	0.981
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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ANNUAL TOTALS FOR YEAR 1987

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.78	1710456.120	100.00
RUNOFF	0.036	5209.863	0.30
EVAPOTRANSPIRATION	11.695	1698082.500	99.28
PERC./LEAKAGE THROUGH LAYER 2	0.000024	3.457	0.00
CHANGE IN WATER STORAGE	0.049	7160.812	0.42
SOIL WATER AT START OF YEAR	4.600	667963.875	
SOIL WATER AT END OF YEAR	4.650	675124.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE 0.0000 -0.554 0.00

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LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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DAILY OUTPUT FOR YEAR 1988

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.00	0.000	0.056	0.1258	0.0000	.0000E+00	.0000E+00
2			0.00	0.000	0.062	0.1236	0.0000	.0000E+00	.0000E+00
3			0.00	0.000	0.050	0.1218	0.0000	.0000E+00	.0000E+00
4			0.00	0.000	0.052	0.1199	0.0000	.0000E+00	.0000E+00
5			0.00	0.000	0.051	0.1181	0.0000	.0000E+00	.0000E+00
6			0.12	0.000	0.080	0.1195	0.0000	.0000E+00	.0000E+00
7			0.00	0.000	0.065	0.1172	0.0000	.0000E+00	.0000E+00
8			0.00	0.000	0.065	0.1149	0.0000	.0000E+00	.0000E+00
9			0.00	0.000	0.066	0.1125	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.055	0.1106	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.052	0.1087	0.0000	.0000E+00	.0000E+00
12			0.00	0.000	0.071	0.1062	0.0000	.0000E+00	.0000E+00
13			0.00	0.000	0.063	0.1039	0.0000	.0000E+00	.0000E+00
14			0.00	0.000	0.070	0.1014	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.030	0.1003	0.0000	.0000E+00	.0000E+00
16			0.00	0.000	0.002	0.1003	0.0000	.0000E+00	.0000E+00
17			0.00	0.000	0.001	0.1002	0.0000	.0000E+00	.0000E+00
18			0.08	0.000	0.024	0.1022	0.0000	.0000E+00	.0000E+00
19			0.00	0.000	0.005	0.1020	0.0000	.0000E+00	.0000E+00
20	*		0.02	0.000	0.030	0.1017	0.0000	.0000E+00	.0000E+00
21	*		0.00	0.000	0.009	0.1014	0.0000	.0000E+00	.0000E+00
22			0.00	0.000	0.009	0.1010	0.0000	.0000E+00	.0000E+00
23	*		0.00	0.000	0.008	0.1008	0.0000	.0000E+00	.0000E+00
24			0.00	0.000	0.008	0.1005	0.0000	.0000E+00	.0000E+00
25	*		0.00	0.000	0.007	0.1002	0.0000	.0000E+00	.0000E+00
26			0.00	0.000	0.003	0.1001	0.0000	.0000E+00	.0000E+00
27			0.00	0.000	0.001	0.1001	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.001	0.1001	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
32			0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
33			0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
34			0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
35			0.02	0.000	0.014	0.1003	0.0000	.0000E+00	.0000E+00
36			1.21	0.000	0.029	0.1425	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.059	0.1404	0.0000	.0000E+00	.0000E+00
38			0.00	0.000	0.074	0.1377	0.0000	.0000E+00	.0000E+00
39			0.00	0.000	0.070	0.1352	0.0000	.0000E+00	.0000E+00
40			0.00	0.000	0.084	0.1323	0.0000	.0000E+00	.0000E+00
41			0.00	0.000	0.081	0.1293	0.0000	.0000E+00	.0000E+00

42	0.00	0.000	0.087	0.1262	0.0000	.0000E+00	.0000E+00
43	0.00	0.000	0.090	0.1230	0.0000	.0000E+00	.0000E+00
44	0.00	0.000	0.095	0.1196	0.0000	.0000E+00	.0000E+00
45	0.00	0.000	0.096	0.1162	0.0000	.0000E+00	.0000E+00
46	0.00	0.000	0.085	0.1132	0.0000	.0000E+00	.0000E+00
47	0.00	0.000	0.097	0.1097	0.0000	.0000E+00	.0000E+00
48	0.00	0.000	0.107	0.1059	0.0000	.0000E+00	.0000E+00
49	0.14	0.000	0.110	0.1069	0.0000	.0000E+00	.0000E+00
50	0.00	0.000	0.072	0.1044	0.0000	.0000E+00	.0000E+00
51	0.00	0.000	0.045	0.1027	0.0000	.0000E+00	.0000E+00
52	0.00	0.000	0.018	0.1021	0.0000	.0000E+00	.0000E+00
53	0.00	0.000	0.021	0.1013	0.0000	.0000E+00	.0000E+00
54	0.00	0.000	0.014	0.1009	0.0000	.0000E+00	.0000E+00
55	0.00	0.000	0.013	0.1004	0.0000	.0000E+00	.0000E+00
56	0.00	0.000	0.004	0.1003	0.0000	.0000E+00	.0000E+00
57	0.00	0.000	0.001	0.1002	0.0000	.0000E+00	.0000E+00
58	0.00	0.000	0.001	0.1002	0.0000	.0000E+00	.0000E+00
59	0.00	0.000	0.000	0.1002	0.0000	.0000E+00	.0000E+00
60	0.00	0.000	0.000	0.1002	0.0000	.0000E+00	.0000E+00
61	0.00	0.000	0.000	0.1002	0.0000	.0000E+00	.0000E+00
62	0.00	0.000	0.000	0.1002	0.0000	.0000E+00	.0000E+00
63	0.10	0.000	0.021	0.1030	0.0000	.0000E+00	.0000E+00
64	0.00	0.000	0.003	0.1029	0.0000	.0000E+00	.0000E+00
65	0.00	0.000	0.009	0.1026	0.0000	.0000E+00	.0000E+00
66	0.00	0.000	0.007	0.1023	0.0000	.0000E+00	.0000E+00
67	0.00	0.000	0.007	0.1021	0.0000	.0000E+00	.0000E+00
68	0.00	0.000	0.006	0.1019	0.0000	.0000E+00	.0000E+00
69	0.00	0.000	0.006	0.1017	0.0000	.0000E+00	.0000E+00
70	0.00	0.000	0.005	0.1015	0.0000	.0000E+00	.0000E+00
71	0.00	0.000	0.005	0.1013	0.0000	.0000E+00	.0000E+00
72	0.00	0.000	0.005	0.1011	0.0000	.0000E+00	.0000E+00
73	0.00	0.000	0.005	0.1009	0.0000	.0000E+00	.0000E+00
74	0.00	0.000	0.005	0.1007	0.0000	.0000E+00	.0000E+00
75	0.00	0.000	0.005	0.1006	0.0000	.0000E+00	.0000E+00
76	0.00	0.000	0.005	0.1004	0.0000	.0000E+00	.0000E+00
77	0.00	0.000	0.005	0.1002	0.0000	.0000E+00	.0000E+00
78	0.00	0.000	0.002	0.1002	0.0000	.0000E+00	.0000E+00
79	0.00	0.000	0.001	0.1001	0.0000	.0000E+00	.0000E+00
80	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
81	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
82	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
83	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
84	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
85	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
86	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
87	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
88	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
89	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
90	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
91	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
92	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
93	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
94	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
95	0.00	0.000	0.000	0.1001	0.0000	.0000E+00	.0000E+00
96	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
97	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
98	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
99	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
100	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
101	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
102	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
103	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
104	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00

105	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.000	0.1000	0.0000	.0000E+00	.0000E+00
107	0.04	0.000	0.017	0.1008	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.002	0.1007	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.003	0.1006	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.003	0.1005	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.003	0.1004	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.003	0.1003	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.003	0.1002	0.0000	.0000E+00	.0000E+00
114	0.00	0.000	0.003	0.1001	0.0000	.0000E+00	.3418E-05
115	0.00	0.000	0.003	0.1000	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.3357E-05
117	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
118	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.3364E-05
119	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
120	0.04	0.000	0.017	0.1008	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.001	0.1007	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.003	0.1006	0.0000	.0000E+00	.0000E+00
123	0.00	0.000	0.003	0.1005	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.003	0.1004	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.003	0.1003	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.003	0.1002	0.0000	.0000E+00	.1094E-05
127	0.00	0.000	0.003	0.1001	0.0000	.0000E+00	.3420E-05
128	0.00	0.000	0.003	0.1000	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.1103E-05
130	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
132	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
135	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
136	0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
137	0.13	0.000	0.018	0.1039	0.0000	.0000E+00	.0000E+00
138	0.00	0.000	0.001	0.1039	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.006	0.1037	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.006	0.1034	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.006	0.1032	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.007	0.1030	0.0000	.0000E+00	.0000E+00
143	0.00	0.000	0.008	0.1027	0.0000	.0000E+00	.0000E+00
144	0.00	0.000	0.008	0.1024	0.0000	.0000E+00	.0000E+00
145	0.00	0.000	0.009	0.1021	0.0000	.0000E+00	.0000E+00
146	0.05	0.000	0.022	0.1031	0.0000	.0000E+00	.0000E+00
147	0.00	0.000	0.002	0.1030	0.0000	.0000E+00	.0000E+00
148	0.00	0.000	0.006	0.1028	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.007	0.1025	0.0000	.0000E+00	.0000E+00
150	0.00	0.000	0.006	0.1023	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.004	0.1022	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.004	0.1020	0.0000	.0000E+00	.0000E+00
153	0.00	0.000	0.003	0.1019	0.0000	.0000E+00	.0000E+00
154	0.00	0.000	0.003	0.1018	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.003	0.1017	0.0000	.0000E+00	.0000E+00
156	0.00	0.000	0.003	0.1016	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.003	0.1015	0.0000	.0000E+00	.1589E-05
158	0.00	0.000	0.003	0.1014	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.003	0.1013	0.0000	.0000E+00	.2012E-05
160	0.00	0.000	0.003	0.1012	0.0000	.0000E+00	.1128E-05
161	0.00	0.000	0.003	0.1011	0.0000	.0000E+00	.2075E-05
162	0.00	0.000	0.003	0.1010	0.0000	.0000E+00	.0000E+00
163	0.15	0.000	0.020	0.1056	0.0000	.0000E+00	.2150E-05
164	0.00	0.000	0.084	0.1026	0.0000	.0000E+00	.1124E-05
165	0.00	0.000	0.009	0.1023	0.0000	.0000E+00	.2173E-05
166	0.00	0.000	0.010	0.1020	0.0000	.0000E+00	.0000E+00
167	0.76	0.000	0.027	0.1281	0.0000	.0000E+00	.0000E+00

168		0.00	0.000	0.152	0.1227	0.0000	.0000E+00	.0000E+00
169		0.00	0.000	0.218	0.1149	0.0000	.0000E+00	.0000E+00
170		0.00	0.000	0.237	0.1065	0.0000	.0000E+00	.0000E+00
171		0.00	0.000	0.157	0.1009	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.020	0.1002	0.0000	.0000E+00	.0000E+00
173		0.00	0.000	0.005	0.1000	0.0000	.0000E+00	.0000E+00
174		0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
175		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
176		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
177		0.33	0.000	0.023	0.1109	0.0000	.0000E+00	.0000E+00
178		0.00	0.000	0.146	0.1057	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.125	0.1012	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.027	0.1002	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.007	0.1000	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.002	0.0999	0.0000	.0000E+00	.0000E+00
183		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.0000E+00
184		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
185		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
186		0.02	0.000	0.016	0.1001	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.002	0.1000	0.0000	.0000E+00	.2277E-05
188		0.51	0.000	0.034	0.1170	0.0000	.0000E+00	.2270E-05
189		0.00	0.000	0.132	0.1123	0.0000	.0000E+00	.0000E+00
190		0.00	0.000	0.189	0.1055	0.0000	.0000E+00	.0000E+00
191	*	0.38	0.000	0.082	0.1062	0.0000	.0000E+00	.0000E+00
192		0.07	0.000	0.281	0.1086	0.0000	.0000E+00	.0000E+00
193		0.00	0.000	0.136	0.1038	0.0000	.0000E+00	.0000E+00
194		0.00	0.000	0.078	0.1010	0.0000	.0000E+00	.0000E+00
195		0.00	0.000	0.024	0.1001	0.0000	.0000E+00	.0000E+00
196		0.00	0.000	0.004	0.1000	0.0000	.0000E+00	.0000E+00
197		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.1127E-05
198		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
199		0.31	0.000	0.024	0.1102	0.0000	.0000E+00	.0000E+00
200		0.00	0.000	0.146	0.1050	0.0000	.0000E+00	.0000E+00
201		0.15	0.000	0.053	0.1084	0.0000	.0000E+00	.0000E+00
202		0.00	0.000	0.167	0.1024	0.0000	.0000E+00	.0000E+00
203		0.00	0.000	0.035	0.1012	0.0000	.0000E+00	.0000E+00
204		0.00	0.000	0.019	0.1005	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.010	0.1001	0.0000	.0000E+00	.0000E+00
206		0.00	0.000	0.004	0.1000	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.001	0.1000	0.0000	.0000E+00	.0000E+00
208		0.00	0.000	0.001	0.0999	0.0000	.0000E+00	.1102E-05
209		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.1886E-05
210		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
211		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
212		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
213		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
214		0.00	0.000	0.000	0.0999	0.0000	.0000E+00	.0000E+00
215		0.05	0.000	0.020	0.1010	0.0000	.0000E+00	.0000E+00
216		0.10	0.000	0.022	0.1038	0.0000	.0000E+00	.0000E+00
217		0.98	0.000	0.033	0.1376	0.0000	.0000E+00	.0000E+00
218		0.00	0.000	0.128	0.1330	0.0000	.0000E+00	.0000E+00
219		0.83	0.000	0.172	0.1565	0.0000	.0000E+00	.0000E+00
220		0.57	0.000	0.243	0.1682	0.0000	.0000E+00	.0000E+00
221		2.25	0.273	0.146	0.2336	0.0000	.0000E+00	.0000E+00
222		0.00	0.000	0.203	0.2264	0.0000	.0000E+00	.0000E+00
223		0.00	0.000	0.232	0.2181	0.0000	.0000E+00	.0000E+00
224		0.35	0.000	0.206	0.2232	0.0000	.0000E+00	.0000E+00
225		0.00	0.000	0.195	0.2163	0.0000	.0000E+00	.0000E+00
226	*	0.00	0.000	0.117	0.2121	0.0000	.0000E+00	.0000E+00
227		0.25	0.000	0.253	0.2120	0.0000	.0000E+00	.0000E+00
228		1.22	0.003	0.262	0.2461	0.0000	.0000E+00	.0000E+00
229	*	1.22	0.000	0.071	0.2468	0.0000	.0000E+00	.0000E+00
230		0.13	0.028	0.100	0.2872	0.0000	.0000E+00	.0000E+00

231		0.00	0.000	0.205	0.2798	0.0000	.0000E+00	.0000E+00
232		0.00	0.000	0.244	0.2711	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.242	0.2608	0.0000	.0000E+00	.0000E+00
234		0.00	0.000	0.206	0.2496	0.0000	.0000E+00	.0000E+00
235		0.00	0.000	0.221	0.2383	0.0000	.0000E+00	.0000E+00
236	*	0.46	0.000	0.072	0.2355	0.0000	.0000E+00	.0000E+00
237		0.00	0.000	0.073	0.2331	0.0000	.0000E+00	.0000E+00
238		0.00	0.000	0.277	0.2300	0.0000	.0000E+00	.0000E+00
239		0.59	0.000	0.261	0.2393	0.0000	.0000E+00	.0000E+00
240		0.20	0.000	0.215	0.2364	0.0000	.0000E+00	.0000E+00
241		0.20	0.000	0.213	0.2347	0.0000	.0000E+00	.0000E+00
242		0.38	0.000	0.197	0.2400	0.0000	.0000E+00	.0000E+00
243		0.00	0.000	0.206	0.2313	0.0000	.0000E+00	.0000E+00
244		0.00	0.000	0.221	0.2220	0.0000	.0000E+00	.0000E+00
245		0.00	0.000	0.215	0.2132	0.0000	.0000E+00	.0000E+00
246		0.10	0.000	0.199	0.2085	0.0000	.0000E+00	.0000E+00
247		0.00	0.000	0.185	0.2006	0.0000	.0000E+00	.0000E+00
248		0.00	0.000	0.085	0.1963	0.0000	.0000E+00	.0000E+00
249		0.00	0.000	0.066	0.1929	0.0000	.0000E+00	.0000E+00
250		0.00	0.000	0.055	0.1900	0.0000	.0000E+00	.2570E-03
251		0.00	0.000	0.049	0.1874	0.0000	.0000E+00	.4898E-02
252		0.00	0.000	0.045	0.1850	0.0000	.0000E+00	.9901E-02
253		0.00	0.000	0.041	0.1829	0.0000	.0000E+00	.1343E-01
254		0.00	0.000	0.039	0.1809	0.0000	.0000E+00	.1578E-01
255		0.00	0.000	0.036	0.1790	0.0000	.0000E+00	.1719E-01
256		0.00	0.000	0.035	0.1773	0.0000	.0000E+00	.1795E-01
257		0.00	0.000	0.033	0.1756	0.0000	.0000E+00	.1822E-01
258		0.00	0.000	0.031	0.1741	0.0000	.0000E+00	.1818E-01
259		0.00	0.000	0.029	0.1726	0.0000	.0000E+00	.1793E-01
260		0.00	0.000	0.028	0.1712	0.0000	.0000E+00	.1755E-01
261		0.00	0.000	0.027	0.1699	0.0000	.0000E+00	.1708E-01
262		0.00	0.000	0.026	0.1686	0.0000	.0000E+00	.1657E-01
263		0.00	0.000	0.025	0.1673	0.0000	.0000E+00	.1383E-01
264		0.00	0.000	0.024	0.1660	0.0000	.0000E+00	.1366E-01
265		0.77	0.000	0.039	0.1918	0.0000	.0000E+00	.1451E-01
266		0.00	0.000	0.023	0.1906	0.0000	.0000E+00	.1485E-01
267		0.06	0.000	0.037	0.1911	0.0000	.0000E+00	.1486E-01
268		0.00	0.000	0.022	0.1901	0.0000	.0000E+00	.1466E-01
269		0.00	0.000	0.021	0.1891	0.0000	.0000E+00	.1433E-01
270		0.00	0.000	0.021	0.1881	0.0000	.0000E+00	.1392E-01
271		0.00	0.000	0.020	0.1872	0.0000	.0000E+00	.1347E-01
272		0.00	0.000	0.020	0.1863	0.0000	.0000E+00	.1300E-01
273		0.00	0.000	0.019	0.1854	0.0000	.0000E+00	.1253E-01
274		0.00	0.000	0.019	0.1846	0.0000	.0000E+00	.1207E-01
275		0.00	0.000	0.018	0.1837	0.0000	.0000E+00	.1163E-01
276		0.00	0.000	0.018	0.1829	0.0000	.0000E+00	.1119E-01
277		0.00	0.000	0.018	0.1821	0.0000	.0000E+00	.1078E-01
278		0.00	0.000	0.017	0.1815	0.0000	.0000E+00	.1381E-01
279		0.00	0.000	0.017	0.1809	0.0000	.0000E+00	.1293E-01
280		0.00	0.000	0.017	0.1803	0.0000	.0000E+00	.1195E-01
281		0.00	0.000	0.017	0.1797	0.0000	.0000E+00	.1110E-01
282		0.00	0.000	0.016	0.1791	0.0000	.0000E+00	.1036E-01
283		0.05	0.000	0.029	0.1799	0.0000	.0000E+00	.9704E-02
284		0.06	0.000	0.029	0.1810	0.0000	.0000E+00	.9126E-02
285		0.00	0.000	0.016	0.1804	0.0000	.0000E+00	.8609E-02
286		0.00	0.000	0.015	0.1799	0.0000	.0000E+00	.8146E-02
287		0.00	0.000	0.015	0.1793	0.0000	.0000E+00	.6762E-02
288		0.00	0.000	0.015	0.1787	0.0000	.0000E+00	.6271E-02
289		0.00	0.000	0.015	0.1782	0.0000	.0000E+00	.6413E-02
290		0.00	0.000	0.015	0.1775	0.0000	.0000E+00	.3696E-02
291		0.00	0.000	0.015	0.1769	0.0000	.0000E+00	.5316E-02
292		0.00	0.000	0.014	0.1764	0.0000	.0000E+00	.6769E-02
293		0.00	0.000	0.014	0.1759	0.0000	.0000E+00	.6473E-02

294	0.00	0.000	0.014	0.1754	0.0000	.0000E+00	.6201E-02
295	0.12	0.000	0.026	0.1788	0.0000	.0000E+00	.5950E-02
296	0.00	0.000	0.014	0.1783	0.0000	.0000E+00	.5717E-02
297	0.00	0.000	0.014	0.1778	0.0000	.0000E+00	.5502E-02
298	0.00	0.000	0.014	0.1773	0.0000	.0000E+00	.5301E-02
299	0.00	0.000	0.014	0.1767	0.0000	.0000E+00	.3415E-02
300	0.00	0.000	0.014	0.1762	0.0000	.0000E+00	.3899E-02
301	0.00	0.000	0.013	0.1757	0.0000	.0000E+00	.3167E-02
302	0.00	0.000	0.013	0.1751	0.0000	.0000E+00	.2247E-02
303	0.00	0.000	0.013	0.1746	0.0000	.0000E+00	.4938E-02
304	0.00	0.000	0.013	0.1741	0.0000	.0000E+00	.4774E-02
305	0.00	0.000	0.013	0.1737	0.0000	.0000E+00	.4620E-02
306	0.00	0.000	0.013	0.1732	0.0000	.0000E+00	.4476E-02
307	0.00	0.000	0.013	0.1727	0.0000	.0000E+00	.4339E-02
308	0.00	0.000	0.013	0.1723	0.0000	.0000E+00	.4211E-02
309	0.00	0.000	0.013	0.1718	0.0000	.0000E+00	.2744E-02
310	0.00	0.000	0.013	0.1714	0.0000	.0000E+00	.0000E+00
311	0.00	0.000	0.013	0.1709	0.0000	.0000E+00	.0000E+00
312	0.00	0.000	0.013	0.1705	0.0000	.0000E+00	.0000E+00
313	0.00	0.000	0.013	0.1700	0.0000	.0000E+00	.0000E+00
314	0.00	0.000	0.013	0.1695	0.0000	.0000E+00	.0000E+00
315	0.00	0.000	0.012	0.1691	0.0000	.0000E+00	.0000E+00
316	0.00	0.000	0.012	0.1687	0.0000	.0000E+00	.0000E+00
317	0.00	0.000	0.012	0.1683	0.0000	.0000E+00	.0000E+00
318	0.00	0.000	0.011	0.1679	0.0000	.0000E+00	.0000E+00
319	0.00	0.000	0.011	0.1675	0.0000	.0000E+00	.0000E+00
320	0.00	0.000	0.011	0.1670	0.0000	.0000E+00	.0000E+00
321	0.00	0.000	0.011	0.1666	0.0000	.0000E+00	.0000E+00
322	0.00	0.000	0.011	0.1662	0.0000	.0000E+00	.0000E+00
323	0.00	0.000	0.011	0.1659	0.0000	.0000E+00	.0000E+00
324	0.00	0.000	0.011	0.1655	0.0000	.0000E+00	.0000E+00
325	0.00	0.000	0.011	0.1651	0.0000	.0000E+00	.0000E+00
326	0.00	0.000	0.011	0.1647	0.0000	.0000E+00	.0000E+00
327	0.00	0.000	0.011	0.1643	0.0000	.0000E+00	.0000E+00
328	0.00	0.000	0.010	0.1639	0.0000	.0000E+00	.0000E+00
329	0.00	0.000	0.011	0.1635	0.0000	.0000E+00	.0000E+00
330	0.00	0.000	0.011	0.1632	0.0000	.0000E+00	.0000E+00
331	0.00	0.000	0.011	0.1628	0.0000	.0000E+00	.0000E+00
332	0.00	0.000	0.010	0.1624	0.0000	.0000E+00	.0000E+00
333	0.00	0.000	0.010	0.1620	0.0000	.0000E+00	.0000E+00
334	0.00	0.000	0.010	0.1617	0.0000	.0000E+00	.0000E+00
335	0.00	0.000	0.010	0.1613	0.0000	.0000E+00	.0000E+00
336	0.00	0.000	0.010	0.1609	0.0000	.0000E+00	.0000E+00
337	0.00	0.000	0.010	0.1606	0.0000	.0000E+00	.0000E+00
338	0.00	0.000	0.010	0.1602	0.0000	.0000E+00	.0000E+00
339	0.00	0.000	0.010	0.1599	0.0000	.0000E+00	.0000E+00
340	0.00	0.000	0.010	0.1595	0.0000	.0000E+00	.0000E+00
341	0.00	0.000	0.010	0.1591	0.0000	.0000E+00	.0000E+00
342	0.00	0.000	0.010	0.1588	0.0000	.0000E+00	.0000E+00
343	0.00	0.000	0.010	0.1584	0.0000	.0000E+00	.0000E+00
344	0.68	0.000	0.016	0.1822	0.0000	.0000E+00	.0000E+00
345	0.00	0.000	0.010	0.1818	0.0000	.0000E+00	.0000E+00
346	0.00	0.000	0.010	0.1815	0.0000	.0000E+00	.0000E+00
347	0.00	0.000	0.010	0.1811	0.0000	.0000E+00	.0000E+00
348	0.00	0.000	0.010	0.1808	0.0000	.0000E+00	.0000E+00
349	0.00	0.000	0.010	0.1804	0.0000	.0000E+00	.0000E+00
350	0.00	0.000	0.010	0.1801	0.0000	.0000E+00	.0000E+00
351	0.00	0.000	0.009	0.1798	0.0000	.0000E+00	.0000E+00
352	0.00	0.000	0.009	0.1794	0.0000	.0000E+00	.0000E+00
353	0.00	0.000	0.009	0.1791	0.0000	.0000E+00	.0000E+00
354	0.54	0.000	0.015	0.1978	0.0000	.0000E+00	.0000E+00
355	0.00	0.000	0.082	0.1949	0.0000	.0000E+00	.0000E+00
356	0.00	0.000	0.087	0.1918	0.0000	.0000E+00	.0000E+00

357		0.00	0.000	0.085	0.1888	0.0000	.0000E+00	.0000E+00
358		0.00	0.000	0.080	0.1859	0.0000	.0000E+00	.0000E+00
359		0.00	0.000	0.062	0.1837	0.0000	.0000E+00	.0000E+00
360		0.00	0.000	0.052	0.1818	0.0000	.0000E+00	.0000E+00
361		0.00	0.000	0.046	0.1802	0.0000	.0000E+00	.0000E+00
362	*	0.00	0.000	0.041	0.1787	0.0000	.0000E+00	.0000E+00
363	*	0.00	0.000	0.038	0.1774	0.0000	.0000E+00	.0000E+00
364	*	0.00	0.000	0.035	0.1761	0.0000	.0000E+00	.0000E+00
365	*	0.00	0.000	0.033	0.1749	0.0000	.0000E+00	.0000E+00
366	*	0.00	0.000	0.031	0.1738	0.0000	.0000E+00	.0000E+00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1988

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.22	1.37	0.10	0.08	0.18	1.24
	1.44	9.78	0.93	0.23	0.00	1.22
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.304	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.995	1.367	0.103	0.062	0.142	1.299
	1.441	5.256	1.514	0.505	0.346	0.870
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LAYER 2	0.0000	0.0000	0.3506	0.2268	0.0158	0.0000

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ANNUAL TOTALS FOR YEAR 1988

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.79	2437908.500	100.00
RUNOFF	0.304	44068.602	1.81
EVAPOTRANSPIRATION	13.901	2018386.370	82.79
PERC./LEAKAGE THROUGH LAYER 2	0.593196	86132.078	3.53
CHANGE IN WATER STORAGE	1.993	289321.500	11.87
SOIL WATER AT START OF YEAR	4.650	675124.687	
SOIL WATER AT END OF YEAR	6.642	964446.187	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE 0.0000 -0.208 0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1984 THROUGH 1988

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.40	0.62	0.34	0.20	0.54	1.87
	1.29	4.16	0.99	1.52	0.96	1.48
STD. DEVIATIONS	0.49	0.50	0.18	0.35	0.29	1.16
	0.49	3.22	0.63	1.63	1.24	0.98
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.002
	0.000	0.068	0.000	0.007	0.001	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.004
	0.000	0.133	0.000	0.016	0.003	0.000
EVAPOTRANSPIRATION						
TOTALS	0.909	0.442	0.247	0.282	0.643	1.887
	1.393	3.167	1.197	1.361	1.025	1.233
STD. DEVIATIONS	0.607	0.538	0.091	0.200	0.389	1.141
	0.176	1.368	0.671	1.113	0.786	0.772
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0701	0.0454	0.0032	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.1568	0.1014	0.0071	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1984 THROUGH 1988

	INCHES		CU. FEET	PERCENT
PRECIPITATION	14.38	(2.073)	2087685.7	100.00
RUNOFF	0.078	(0.1267)	11374.87	0.545
EVAPOTRANSPIRATION	13.787	(1.8291)	2001890.75	95.890

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)                **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:    C:\HELP3\WTSMODEL\WS.D4
TEMPERATURE DATA FILE:      C:\HELP3\WTSMODEL\WS.D7
SOLAR RADIATION DATA FILE:  C:\HELP3\WTSMODEL\WS.D13
EVAPOTRANSPIRATION DATA:    C:\HELP3\WTSMODEL\WS.D11
SOIL AND DESIGN DATA FILE:  C:\HELP3\WTSMODEL\WS.D10
OUTPUT DATA FILE:           C:\HELP3\WTSMODEL\WSP.OUT


TIME:  16: 4     DATE:  12/18/2008


******************************************************************************

     TITLE:  WHITE SANDS MISSILE RANGE PRESCRIPTIVE COVER

******************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                   LAYER  1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                         MATERIAL TEXTURE NUMBER   9
          THICKNESS                   =      6.00   INCHES
          POROSITY                    =      0.5010 VOL/VOL
          FIELD CAPACITY              =      0.2840 VOL/VOL
          WILTING POINT               =      0.1350 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.1720 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.190000006000E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  1.60
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                   LAYER  2
                                   --------
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            TYPE 1 - VERTICAL PERCOLATION LAYER
                MATERIAL TEXTURE NUMBER   0
  THICKNESS                    =     18.00   INCHES
  POROSITY                     =      0.4190 VOL/VOL
  FIELD CAPACITY               =      0.3070 VOL/VOL
  WILTING POINT                =      0.1800 VOL/VOL
  INITIAL SOIL WATER CONTENT   =      0.2120 VOL/VOL
  EFFECTIVE SAT. HYD. COND.    =  0.999999975000E-05 CM/SEC
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           GENERAL DESIGN AND EVAPORATIVE ZONE DATA
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 NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
          SOIL DATA BASE USING SOIL TEXTURE # 9 WITH A
          POOR STAND OF GRASS, A SURFACE SLOPE OF  5.%
          AND A SLOPE LENGTH OF  750. FEET.

SCS RUNOFF CURVE NUMBER             =     87.00
FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
AREA PROJECTED ON HORIZONTAL PLANE  =     40.000  ACRES
EVAPORATIVE ZONE DEPTH              =     24.0    INCHES
INITIAL WATER IN EVAPORATIVE ZONE   =      4.848  INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE  =     10.548  INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE  =      4.050  INCHES
INITIAL SNOW WATER                  =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =      4.848  INCHES
TOTAL INITIAL WATER                 =      4.848  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
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            EVAPOTRANSPIRATION AND WEATHER DATA
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 NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
          EL PASO               TEXAS

     STATION LATITUDE                        =  32.22 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   0.80
     START OF GROWING SEASON (JULIAN DATE)   =     66
     END OF GROWING SEASON (JULIAN DATE)     =    315
     EVAPORATIVE ZONE DEPTH                  =  24.0  INCHES
     AVERAGE ANNUAL WIND SPEED               =   9.20 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  40.00 %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  27.00 %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  46.00 %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  48.00 %


 NOTE:  PRECIPITATION DATA FOR     White Sands Natl MonNew Mexico
          WAS ENTERED FROM A EARTH INFO CLIMATEDATA.


 NOTE:  TEMPERATURE DATA FOR     White Sand Natl     Mon New Mexico
          WAS ENTERED FROM A EARTH INFO CLIMATEDATA.
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NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR EL PASO TEXAS
AND STATION LATITUDE = 32.22 DEGREES

LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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DAILY OUTPUT FOR YEAR 1984

DAY	AIR -	SOIL -	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.00	0.000	0.077	0.1988	0.0000	.0000E+00	.0000E+00
2			0.00	0.000	0.079	0.1955	0.0000	.0000E+00	.0000E+00
3			0.02	0.000	0.092	0.1925	0.0000	.0000E+00	.0000E+00
4			0.00	0.000	0.072	0.1895	0.0000	.0000E+00	.0000E+00
5			0.00	0.000	0.075	0.1864	0.0000	.0000E+00	.0000E+00
6			0.00	0.000	0.086	0.1828	0.0000	.0000E+00	.0000E+00
7			0.00	0.000	0.086	0.1792	0.0000	.0000E+00	.0000E+00
8			0.29	0.000	0.098	0.1872	0.0000	.0000E+00	.0000E+00
9			0.00	0.000	0.089	0.1835	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.085	0.1800	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.076	0.1766	0.0000	.0000E+00	.6464E-02
12			0.00	0.000	0.076	0.1734	0.0000	.0000E+00	.0000E+00
13			0.00	0.000	0.063	0.1708	0.0000	.0000E+00	.0000E+00
14			0.00	0.000	0.022	0.1699	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.012	0.1694	0.0000	.0000E+00	.0000E+00
16			0.00	0.000	0.008	0.1690	0.0000	.0000E+00	.0000E+00
17			0.00	0.000	0.005	0.1688	0.0000	.0000E+00	.0000E+00
18			0.00	0.000	0.002	0.1688	0.0000	.0000E+00	.3025E-07
19			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
20			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
21	*		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
22			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
23			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
24			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
25			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
26			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
27			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
32			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
33			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
34			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
35			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
36			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
38			0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00

39	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
40	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
41	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
42	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
43	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
44	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
45	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
46	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
47	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
48	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
49	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
50	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
51	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
52	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
53	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
54	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
55	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
56	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
57	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
58	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
59	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
60	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
61	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
62	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
63	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
64	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
65	0.32	0.000	0.013	0.1815	0.0000	.0000E+00	.0000E+00
66	0.00	0.000	0.006	0.1813	0.0000	.0000E+00	.0000E+00
67	0.00	0.000	0.006	0.1811	0.0000	.0000E+00	.0000E+00
68	0.00	0.000	0.005	0.1808	0.0000	.0000E+00	.0000E+00
69	0.00	0.000	0.006	0.1806	0.0000	.0000E+00	.0000E+00
70	0.00	0.000	0.007	0.1803	0.0000	.0000E+00	.0000E+00
71	0.00	0.000	0.007	0.1800	0.0000	.0000E+00	.0000E+00
72	0.00	0.000	0.008	0.1797	0.0000	.0000E+00	.0000E+00
73	0.00	0.000	0.008	0.1794	0.0000	.0000E+00	.0000E+00
74	0.00	0.000	0.008	0.1790	0.0000	.0000E+00	.0000E+00
75	0.00	0.000	0.008	0.1787	0.0000	.0000E+00	.0000E+00
76	0.00	0.000	0.008	0.1784	0.0000	.0000E+00	.0000E+00
77	0.00	0.000	0.008	0.1780	0.0000	.0000E+00	.0000E+00
78	0.00	0.000	0.008	0.1777	0.0000	.0000E+00	.0000E+00
79	0.00	0.000	0.008	0.1774	0.0000	.0000E+00	.0000E+00
80	0.00	0.000	0.008	0.1770	0.0000	.0000E+00	.0000E+00
81	0.00	0.000	0.008	0.1767	0.0000	.0000E+00	.0000E+00
82	0.00	0.000	0.008	0.1763	0.0000	.0000E+00	.0000E+00
83	0.00	0.000	0.008	0.1760	0.0000	.0000E+00	.0000E+00
84	0.00	0.000	0.008	0.1757	0.0000	.0000E+00	.0000E+00
85	0.00	0.000	0.008	0.1753	0.0000	.0000E+00	.0000E+00
86	0.00	0.000	0.008	0.1750	0.0000	.0000E+00	.0000E+00
87	0.00	0.000	0.008	0.1747	0.0000	.0000E+00	.2075E-06
88	0.00	0.000	0.008	0.1743	0.0000	.0000E+00	.0000E+00
89	0.00	0.000	0.008	0.1740	0.0000	.0000E+00	.0000E+00
90	0.00	0.000	0.008	0.1737	0.0000	.0000E+00	.0000E+00
91	0.00	0.000	0.008	0.1734	0.0000	.0000E+00	.0000E+00
92	0.00	0.000	0.008	0.1730	0.0000	.0000E+00	.0000E+00
93	0.00	0.000	0.008	0.1727	0.0000	.0000E+00	.0000E+00
94	0.00	0.000	0.008	0.1724	0.0000	.0000E+00	.0000E+00
95	0.00	0.000	0.008	0.1720	0.0000	.0000E+00	.0000E+00
96	0.00	0.000	0.008	0.1717	0.0000	.0000E+00	.0000E+00
97	0.00	0.000	0.008	0.1714	0.0000	.0000E+00	.0000E+00
98	0.00	0.000	0.008	0.1711	0.0000	.0000E+00	.0000E+00
99	0.00	0.000	0.008	0.1707	0.0000	.0000E+00	.0000E+00
100	0.00	0.000	0.008	0.1704	0.0000	.0000E+00	.0000E+00
101	0.00	0.000	0.008	0.1701	0.0000	.0000E+00	.0000E+00

102	0.00	0.000	0.008	0.1697	0.0000	.0000E+00	.0000E+00
103	0.00	0.000	0.008	0.1694	0.0000	.0000E+00	.0000E+00
104	0.00	0.000	0.007	0.1691	0.0000	.0000E+00	.0000E+00
105	0.00	0.000	0.008	0.1688	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
107	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
114	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
115	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
117	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
118	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
119	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
120	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
123	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
127	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
128	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
130	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
132	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
135	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
136	0.11	0.000	0.013	0.1728	0.0000	.0000E+00	.0000E+00
137	0.72	0.000	0.017	0.2021	0.0000	.0000E+00	.0000E+00
138	0.03	0.000	0.016	0.2027	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.008	0.2023	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.008	0.2020	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.008	0.2017	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.008	0.2014	0.0000	.0000E+00	.0000E+00
143	0.00	0.000	0.008	0.2010	0.0000	.0000E+00	.0000E+00
144	0.00	0.000	0.008	0.2007	0.0000	.0000E+00	.0000E+00
145	0.00	0.000	0.008	0.2003	0.0000	.0000E+00	.0000E+00
146	0.00	0.000	0.008	0.2000	0.0000	.0000E+00	.0000E+00
147	0.00	0.000	0.008	0.1996	0.0000	.0000E+00	.0000E+00
148	0.00	0.000	0.009	0.1993	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.009	0.1989	0.0000	.0000E+00	.0000E+00
150	0.00	0.000	0.009	0.1985	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.009	0.1982	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.009	0.1978	0.0000	.0000E+00	.0000E+00
153	0.00	0.000	0.009	0.1974	0.0000	.0000E+00	.0000E+00
154	1.64	0.176	0.022	0.2575	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.201	0.2491	0.0000	.0000E+00	.2252E-07
156	0.00	0.000	0.211	0.2403	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.170	0.2332	0.0000	.0000E+00	.0000E+00
158	0.00	0.000	0.081	0.2298	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.064	0.2272	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.055	0.2249	0.0000	.0000E+00	.0000E+00
161	0.00	0.000	0.049	0.2228	0.0000	.0000E+00	.0000E+00
162	0.00	0.000	0.046	0.2209	0.0000	.0000E+00	.0000E+00
163	0.00	0.000	0.044	0.2191	0.0000	.0000E+00	.0000E+00
164	0.00	0.000	0.038	0.2175	0.0000	.0000E+00	.0000E+00

165		0.08	0.000	0.053	0.2186	0.0000	.0000E+00	.0000E+00
166		0.00	0.000	0.038	0.2170	0.0000	.0000E+00	.0000E+00
167		0.89	0.008	0.050	0.2517	0.0000	.0000E+00	.0000E+00
168		0.30	0.000	0.250	0.2538	0.0000	.0000E+00	.6743E-07
169		0.01	0.000	0.226	0.2448	0.0000	.0000E+00	.0000E+00
170		0.00	0.000	0.202	0.2364	0.0000	.0000E+00	.0000E+00
171		0.82	0.013	0.102	0.2657	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.300	0.2532	0.0000	.0000E+00	.3769E-03
173		0.00	0.000	0.296	0.2408	0.0000	.0000E+00	.0000E+00
174		0.00	0.000	0.196	0.2327	0.0000	.0000E+00	.0000E+00
175		0.00	0.000	0.089	0.2289	0.0000	.0000E+00	.0000E+00
176		0.08	0.000	0.086	0.2287	0.0000	.0000E+00	.0000E+00
177		0.00	0.000	0.064	0.2260	0.0000	.0000E+00	.0000E+00
178		0.00	0.000	0.060	0.2235	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.047	0.2215	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.052	0.2194	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.051	0.2172	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.050	0.2152	0.0000	.0000E+00	.0000E+00
183		0.00	0.000	0.049	0.2131	0.0000	.0000E+00	.0000E+00
184		0.00	0.000	0.046	0.2112	0.0000	.0000E+00	.0000E+00
185		0.00	0.000	0.040	0.2095	0.0000	.0000E+00	.0000E+00
186		0.00	0.000	0.044	0.2077	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.047	0.2057	0.0000	.0000E+00	.0000E+00
188		0.00	0.000	0.046	0.2038	0.0000	.0000E+00	.0000E+00
189		0.00	0.000	0.044	0.2020	0.0000	.0000E+00	.0000E+00
190		0.00	0.000	0.046	0.2000	0.0000	.0000E+00	.0000E+00
191		0.00	0.000	0.050	0.1980	0.0000	.0000E+00	.0000E+00
192		0.00	0.000	0.035	0.1965	0.0000	.0000E+00	.0000E+00
193		0.68	0.000	0.064	0.2222	0.0000	.0000E+00	.0000E+00
194	*	0.00	0.000	0.033	0.2208	0.0000	.0000E+00	.0000E+00
195		0.00	0.000	0.048	0.2188	0.0000	.0000E+00	.0000E+00
196		0.00	0.000	0.049	0.2168	0.0000	.0000E+00	.0000E+00
197		0.00	0.000	0.050	0.2147	0.0000	.0000E+00	.0000E+00
198		0.00	0.000	0.056	0.2124	0.0000	.0000E+00	.0000E+00
199		0.00	0.000	0.048	0.2104	0.0000	.0000E+00	.0000E+00
200		0.47	0.000	0.063	0.2274	0.0000	.0000E+00	.0000E+00
201		0.00	0.000	0.055	0.2251	0.0000	.0000E+00	.0000E+00
202		0.00	0.000	0.052	0.2229	0.0000	.0000E+00	.0000E+00
203		0.15	0.000	0.072	0.2262	0.0000	.0000E+00	.0000E+00
204		0.00	0.000	0.266	0.2151	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.059	0.2126	0.0000	.0000E+00	.0000E+00
206		0.14	0.000	0.080	0.2151	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.060	0.2126	0.0000	.0000E+00	.0000E+00
208		0.00	0.000	0.055	0.2103	0.0000	.0000E+00	.0000E+00
209		0.14	0.000	0.074	0.2131	0.0000	.0000E+00	.0000E+00
210		0.00	0.000	0.067	0.2103	0.0000	.0000E+00	.0000E+00
211		0.00	0.000	0.065	0.2076	0.0000	.0000E+00	.0000E+00
212		0.00	0.000	0.070	0.2047	0.0000	.0000E+00	.0000E+00
213		0.00	0.000	0.073	0.2016	0.0000	.0000E+00	.0000E+00
214	*	0.00	0.000	0.041	0.1999	0.0000	.0000E+00	.0000E+00
215		0.19	0.000	0.088	0.2042	0.0000	.0000E+00	.0000E+00
216	*	0.13	0.000	0.120	0.2046	0.0000	.0000E+00	.0000E+00
217	*	0.09	0.000	0.113	0.2036	0.0000	.0000E+00	.0000E+00
218		0.00	0.000	0.234	0.1939	0.0000	.0000E+00	.0000E+00
219		0.00	0.000	0.231	0.1843	0.0000	.0000E+00	.0000E+00
220		0.10	0.000	0.113	0.1837	0.0000	.0000E+00	.0000E+00
221		0.00	0.000	0.094	0.1798	0.0000	.0000E+00	.0000E+00
222	*	0.25	0.000	0.069	0.1806	0.0000	.0000E+00	.0000E+00
223		0.59	0.000	0.000	0.2057	0.0000	.0000E+00	.0000E+00
224		0.02	0.000	0.193	0.2047	0.0000	.0000E+00	.0000E+00
225		0.00	0.000	0.202	0.1963	0.0000	.0000E+00	.0000E+00
226		0.13	0.000	0.151	0.1954	0.0000	.0000E+00	.0000E+00
227	*	0.00	0.000	0.089	0.1917	0.0000	.0000E+00	.0000E+00

228	*	0.00	0.000	0.092	0.1879	0.0000	.0000E+00	.0000E+00
229	*	0.00	0.000	0.067	0.1851	0.0000	.0000E+00	.0000E+00
230		0.00	0.000	0.077	0.1819	0.0000	.0000E+00	.0000E+00
231		0.00	0.000	0.073	0.1789	0.0000	.0000E+00	.3902E-07
232		0.00	0.000	0.067	0.1761	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.059	0.1736	0.0000	.0000E+00	.0000E+00
234		0.00	0.000	0.082	0.1702	0.0000	.0000E+00	.0000E+00
235		0.00	0.000	0.031	0.1689	0.0000	.0000E+00	.0000E+00
236		0.21	0.000	0.033	0.1763	0.0000	.0000E+00	.0000E+00
237		0.27	0.000	0.055	0.1852	0.0000	.0000E+00	.0000E+00
238		0.67	0.000	0.068	0.2103	0.0000	.0000E+00	.0000E+00
239		0.19	0.000	0.158	0.2117	0.0000	.0000E+00	.0000E+00
240		0.00	0.000	0.164	0.2048	0.0000	.0000E+00	.0000E+00
241		0.00	0.000	0.192	0.1968	0.0000	.0000E+00	.0000E+00
242		0.00	0.000	0.199	0.1885	0.0000	.0000E+00	.0000E+00
243		0.10	0.000	0.170	0.1856	0.0000	.0000E+00	.0000E+00
244		0.00	0.000	0.115	0.1808	0.0000	.0000E+00	.0000E+00
245		0.00	0.000	0.107	0.1764	0.0000	.0000E+00	.0000E+00
246		0.00	0.000	0.083	0.1729	0.0000	.0000E+00	.0000E+00
247		0.06	0.000	0.095	0.1714	0.0000	.0000E+00	.3243E-03
248		0.00	0.000	0.020	0.1706	0.0000	.0000E+00	.1322E-03
249		0.00	0.000	0.017	0.1699	0.0000	.0000E+00	.0000E+00
250		0.00	0.000	0.013	0.1694	0.0000	.0000E+00	.0000E+00
251		0.00	0.000	0.011	0.1689	0.0000	.0000E+00	.0000E+00
252		0.00	0.000	0.002	0.1688	0.0000	.0000E+00	.0000E+00
253		0.00	0.000	0.001	0.1688	0.0000	.0000E+00	.0000E+00
254		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
255		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
256		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
257		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
258		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
259		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
260		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
261		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
262		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
263		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
264		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
265		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
266		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
267		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
268		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
269		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
270		0.12	0.000	0.027	0.1726	0.0000	.0000E+00	.0000E+00
271		0.06	0.000	0.025	0.1741	0.0000	.0000E+00	.0000E+00
272		0.00	0.000	0.010	0.1736	0.0000	.0000E+00	.0000E+00
273		0.00	0.000	0.009	0.1733	0.0000	.0000E+00	.0000E+00
274		0.00	0.000	0.009	0.1729	0.0000	.0000E+00	.0000E+00
275		0.00	0.000	0.011	0.1724	0.0000	.0000E+00	.0000E+00
276		0.00	0.000	0.012	0.1719	0.0000	.0000E+00	.0000E+00
277		0.30	0.000	0.038	0.1829	0.0000	.0000E+00	.0000E+00
278		0.25	0.000	0.035	0.1918	0.0000	.0000E+00	.0000E+00
279		0.00	0.000	0.010	0.1914	0.0000	.0000E+00	.0000E+00
280		0.00	0.000	0.012	0.1909	0.0000	.0000E+00	.0000E+00
281		0.00	0.000	0.012	0.1904	0.0000	.0000E+00	.0000E+00
282		0.00	0.000	0.011	0.1899	0.0000	.0000E+00	.0000E+00
283		0.00	0.000	0.011	0.1895	0.0000	.0000E+00	.0000E+00
284		0.00	0.000	0.011	0.1890	0.0000	.0000E+00	.0000E+00
285		0.10	0.000	0.036	0.1917	0.0000	.0000E+00	.0000E+00
286		0.11	0.000	0.038	0.1947	0.0000	.0000E+00	.0000E+00
287		0.00	0.000	0.012	0.1942	0.0000	.0000E+00	.0000E+00
288		0.00	0.000	0.013	0.1937	0.0000	.0000E+00	.0000E+00
289		0.08	0.000	0.035	0.1955	0.0000	.0000E+00	.0000E+00
290		0.00	0.000	0.012	0.1950	0.0000	.0000E+00	.0000E+00

291		0.00	0.000	0.011	0.1946	0.0000	.0000E+00	.0000E+00
292		0.12	0.000	0.035	0.1981	0.0000	.0000E+00	.0000E+00
293		0.00	0.000	0.012	0.1976	0.0000	.0000E+00	.0000E+00
294		0.04	0.000	0.031	0.1980	0.0000	.0000E+00	.0000E+00
295		0.14	0.000	0.035	0.2024	0.0000	.0000E+00	.0000E+00
296		0.06	0.000	0.034	0.2035	0.0000	.0000E+00	.0000E+00
297		0.27	0.000	0.035	0.2133	0.0000	.0000E+00	.0000E+00
298		0.45	0.000	0.037	0.2305	0.0000	.0000E+00	.0000E+00
299		0.00	0.000	0.036	0.2290	0.0000	.0000E+00	.1376E-04
300		0.11	0.000	0.067	0.2307	0.0000	.0000E+00	.0000E+00
301		0.00	0.000	0.070	0.2278	0.0000	.0000E+00	.0000E+00
302		0.00	0.000	0.056	0.2255	0.0000	.0000E+00	.0000E+00
303		0.00	0.000	0.066	0.2228	0.0000	.0000E+00	.0000E+00
304		0.00	0.000	0.061	0.2202	0.0000	.0000E+00	.0000E+00
305		0.00	0.000	0.066	0.2174	0.0000	.0000E+00	.0000E+00
306		0.00	0.000	0.068	0.2146	0.0000	.0000E+00	.0000E+00
307		0.00	0.000	0.052	0.2124	0.0000	.0000E+00	.0000E+00
308		0.00	0.000	0.044	0.2106	0.0000	.0000E+00	.0000E+00
309		0.00	0.000	0.039	0.2090	0.0000	.0000E+00	.2626E-05
310		0.00	0.000	0.035	0.2075	0.0000	.0000E+00	.0000E+00
311		0.00	0.000	0.032	0.2062	0.0000	.0000E+00	.0000E+00
312		0.00	0.000	0.030	0.2049	0.0000	.0000E+00	.0000E+00
313		0.00	0.000	0.030	0.2037	0.0000	.0000E+00	.0000E+00
314		0.00	0.000	0.030	0.2024	0.0000	.0000E+00	.0000E+00
315	*	0.00	0.000	0.000	0.2024	0.0000	.0000E+00	.0000E+00
316		0.00	0.000	0.028	0.2012	0.0000	.0000E+00	.0000E+00
317		0.00	0.000	0.027	0.2001	0.0000	.0000E+00	.0000E+00
318		0.00	0.000	0.026	0.1991	0.0000	.0000E+00	.0000E+00
319		0.00	0.000	0.025	0.1980	0.0000	.0000E+00	.0000E+00
320		0.00	0.000	0.024	0.1970	0.0000	.0000E+00	.0000E+00
321		0.00	0.000	0.023	0.1961	0.0000	.0000E+00	.1141E-04
322		0.33	0.000	0.044	0.2080	0.0000	.0000E+00	.0000E+00
323		0.06	0.000	0.042	0.2088	0.0000	.0000E+00	.0000E+00
324		0.04	0.000	0.039	0.2088	0.0000	.0000E+00	.0000E+00
325		0.07	0.000	0.041	0.2100	0.0000	.0000E+00	.4023E-05
326		0.00	0.000	0.020	0.2092	0.0000	.0000E+00	.1408E-05
327		0.00	0.000	0.020	0.2083	0.0000	.0000E+00	.0000E+00
328		0.00	0.000	0.019	0.2075	0.0000	.0000E+00	.0000E+00
329		0.61	0.000	0.040	0.2313	0.0000	.0000E+00	.0000E+00
330		0.02	0.000	0.063	0.2295	0.0000	.0000E+00	.0000E+00
331		0.00	0.000	0.053	0.2273	0.0000	.0000E+00	.0000E+00
332		0.00	0.000	0.052	0.2251	0.0000	.0000E+00	.0000E+00
333		0.00	0.000	0.047	0.2232	0.0000	.0000E+00	.0000E+00
334		0.00	0.000	0.056	0.2208	0.0000	.0000E+00	.3899E-03
335		0.00	0.000	0.047	0.2189	0.0000	.0000E+00	.0000E+00
336		0.00	0.000	0.044	0.2171	0.0000	.0000E+00	.0000E+00
337		0.00	0.000	0.039	0.2155	0.0000	.0000E+00	.0000E+00
338		0.00	0.000	0.035	0.2140	0.0000	.0000E+00	.0000E+00
339		0.51	0.000	0.053	0.2330	0.0000	.0000E+00	.0000E+00
340		0.00	0.000	0.045	0.2312	0.0000	.0000E+00	.0000E+00
341		0.00	0.000	0.048	0.2292	0.0000	.0000E+00	.0000E+00
342		0.00	0.000	0.051	0.2271	0.0000	.0000E+00	.0000E+00
343		0.03	0.000	0.071	0.2253	0.0000	.0000E+00	.0000E+00
344		0.00	0.000	0.053	0.2231	0.0000	.0000E+00	.2294E-03
345		0.00	0.000	0.044	0.2213	0.0000	.0000E+00	.0000E+00
346		0.00	0.000	0.039	0.2197	0.0000	.0000E+00	.0000E+00
347		0.26	0.000	0.056	0.2282	0.0000	.0000E+00	.0000E+00
348		0.60	0.000	0.053	0.2509	0.0000	.0000E+00	.0000E+00
349		0.60	0.003	0.075	0.2727	0.0000	.0000E+00	.0000E+00
350		0.28	0.000	0.073	0.2813	0.0000	.0000E+00	.0000E+00
351		0.00	0.000	0.053	0.2791	0.0000	.0000E+00	.0000E+00
352		0.00	0.000	0.049	0.2771	0.0000	.0000E+00	.0000E+00
353		0.00	0.000	0.049	0.2750	0.0000	.0000E+00	.0000E+00

354	0.08	0.000	0.072	0.2754	0.0000	.0000E+00	.0000E+00
355	0.00	0.000	0.053	0.2731	0.0000	.0000E+00	.0000E+00
356	0.00	0.000	0.056	0.2708	0.0000	.0000E+00	.0000E+00
357	0.00	0.000	0.050	0.2688	0.0000	.0000E+00	.0000E+00
358	0.00	0.000	0.049	0.2667	0.0000	.0000E+00	.0000E+00
359	0.00	0.000	0.054	0.2645	0.0000	.0000E+00	.0000E+00
360	0.00	0.000	0.056	0.2621	0.0000	.0000E+00	.0000E+00
361	0.00	0.000	0.060	0.2596	0.0000	.0000E+00	.0000E+00
362	0.00	0.000	0.051	0.2575	0.0000	.0000E+00	.0000E+00
363	0.41	0.000	0.095	0.2706	0.0000	.0000E+00	.0000E+00
364	0.00	0.000	0.067	0.2679	0.0000	.0000E+00	.0000E+00
365	0.00	0.000	0.060	0.2654	0.0000	.0000E+00	.0000E+00
366	0.00	0.000	0.050	0.2633	0.0000	.0000E+00	.0000E+00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1984

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.31	0.00	0.32	0.00	0.86	3.82
	1.58	2.94	0.24	2.03	1.13	2.77
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.197
	0.000	0.000	0.000	0.000	0.000	0.003
EVAPOTRANSPIRATION	1.102	0.000	0.210	0.110	0.163	3.205
	1.904	3.439	0.431	0.960	1.095	1.702
PERCOLATION/LEAKAGE THROUGH	0.0065	0.0000	0.0000	0.0000	0.0000	0.0004
LAYER 2	0.0000	0.0000	0.0005	0.0000	0.0004	0.0002

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ANNUAL TOTALS FOR YEAR 1984

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.00	2323200.500	100.00
RUNOFF	0.200	29062.937	1.25
EVAPOTRANSPIRATION	14.321	2079468.250	89.51
PERC./LEAKAGE THROUGH LAYER 2	0.007950	1154.363	0.05
CHANGE IN WATER STORAGE	1.470	213513.906	9.19
SOIL WATER AT START OF YEAR	4.848	703929.625	
SOIL WATER AT END OF YEAR	6.318	917443.500	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	1.150	0.00

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LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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DAILY OUTPUT FOR YEAR 1985

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.00	0.000	0.059	0.2608	0.0000	.0000E+00	.0000E+00
2	*		0.00	0.000	0.043	0.2590	0.0000	.0000E+00	.0000E+00
3	*		0.00	0.000	0.042	0.2573	0.0000	.0000E+00	.0000E+00
4			0.00	0.000	0.052	0.2551	0.0000	.0000E+00	.0000E+00
5			0.00	0.000	0.054	0.2529	0.0000	.0000E+00	.0000E+00
6			0.00	0.000	0.058	0.2504	0.0000	.0000E+00	.0000E+00
7			0.00	0.000	0.058	0.2480	0.0000	.0000E+00	.0000E+00
8			0.00	0.000	0.071	0.2451	0.0000	.0000E+00	.0000E+00
9			0.00	0.000	0.066	0.2423	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.063	0.2397	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.055	0.2374	0.0000	.0000E+00	.0000E+00
12			0.03	0.000	0.070	0.2357	0.0000	.0000E+00	.0000E+00
13	*		0.36	0.000	0.059	0.2366	0.0000	.0000E+00	.0000E+00
14	*		0.04	0.000	0.048	0.2374	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.084	0.2382	0.0000	.0000E+00	.0000E+00
16			0.28	0.000	0.030	0.2548	0.0000	.0000E+00	.0000E+00
17			0.00	0.000	0.053	0.2526	0.0000	.0000E+00	.0000E+00
18			0.00	0.000	0.065	0.2499	0.0000	.0000E+00	.0000E+00
19			0.00	0.000	0.072	0.2469	0.0000	.0000E+00	.0000E+00
20			0.00	0.000	0.068	0.2441	0.0000	.0000E+00	.0000E+00
21	*		0.00	0.000	0.049	0.2421	0.0000	.0000E+00	.2340E-03
22	*		0.00	0.000	0.055	0.2398	0.0000	.0000E+00	.0000E+00
23			0.00	0.000	0.067	0.2370	0.0000	.0000E+00	.0000E+00
24			0.09	0.000	0.084	0.2372	0.0000	.0000E+00	.0000E+00
25			0.02	0.000	0.084	0.2345	0.0000	.0000E+00	.5888E-03
26			0.17	0.000	0.089	0.2379	0.0000	.0000E+00	.0000E+00
27			0.27	0.000	0.088	0.2455	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.082	0.2420	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.074	0.2389	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.078	0.2357	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.063	0.2331	0.0000	.0000E+00	.0000E+00
32	*		0.01	0.000	0.010	0.2331	0.0000	.0000E+00	.0000E+00
33	*		0.00	0.000	0.048	0.2311	0.0000	.0000E+00	.0000E+00
34	*		0.00	0.000	0.058	0.2287	0.0000	.0000E+00	.0000E+00
35			0.17	0.000	0.073	0.2327	0.0000	.0000E+00	.0000E+00
36			0.00	0.000	0.045	0.2309	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.042	0.2291	0.0000	.0000E+00	.0000E+00
38			0.00	0.000	0.039	0.2275	0.0000	.0000E+00	.0000E+00

39	0.00	0.000	0.036	0.2260	0.0000	.0000E+00	.0000E+00
40	0.00	0.000	0.034	0.2245	0.0000	.0000E+00	.0000E+00
41	0.00	0.000	0.032	0.2232	0.0000	.0000E+00	.0000E+00
42	0.00	0.000	0.031	0.2219	0.0000	.0000E+00	.0000E+00
43	0.00	0.000	0.029	0.2207	0.0000	.0000E+00	.0000E+00
44	0.00	0.000	0.028	0.2195	0.0000	.0000E+00	.0000E+00
45	0.00	0.000	0.027	0.2184	0.0000	.0000E+00	.0000E+00
46	0.00	0.000	0.026	0.2173	0.0000	.0000E+00	.0000E+00
47	0.00	0.000	0.025	0.2163	0.0000	.0000E+00	.0000E+00
48	0.00	0.000	0.024	0.2153	0.0000	.0000E+00	.0000E+00
49	0.00	0.000	0.023	0.2143	0.0000	.0000E+00	.0000E+00
50	0.00	0.000	0.022	0.2134	0.0000	.0000E+00	.0000E+00
51	0.00	0.000	0.022	0.2125	0.0000	.0000E+00	.0000E+00
52	0.00	0.000	0.021	0.2116	0.0000	.0000E+00	.0000E+00
53	0.00	0.000	0.018	0.2108	0.0000	.0000E+00	.0000E+00
54	0.21	0.000	0.042	0.2178	0.0000	.0000E+00	.0000E+00
55	0.00	0.000	0.020	0.2170	0.0000	.0000E+00	.0000E+00
56	0.00	0.000	0.019	0.2162	0.0000	.0000E+00	.0000E+00
57	0.00	0.000	0.019	0.2154	0.0000	.0000E+00	.0000E+00
58	0.00	0.000	0.019	0.2146	0.0000	.0000E+00	.0000E+00
59	0.03	0.000	0.035	0.2144	0.0000	.0000E+00	.0000E+00
60	0.00	0.000	0.018	0.2137	0.0000	.0000E+00	.0000E+00
61	0.00	0.000	0.018	0.2130	0.0000	.0000E+00	.0000E+00
62	0.00	0.000	0.018	0.2122	0.0000	.0000E+00	.0000E+00
63	0.00	0.000	0.018	0.2115	0.0000	.0000E+00	.0000E+00
64	0.00	0.000	0.017	0.2108	0.0000	.0000E+00	.0000E+00
65	0.00	0.000	0.017	0.2100	0.0000	.0000E+00	.0000E+00
66	0.00	0.000	0.017	0.2093	0.0000	.0000E+00	.0000E+00
67	0.00	0.000	0.017	0.2086	0.0000	.0000E+00	.0000E+00
68	0.00	0.000	0.017	0.2080	0.0000	.0000E+00	.0000E+00
69	0.00	0.000	0.016	0.2073	0.0000	.0000E+00	.0000E+00
70	0.00	0.000	0.016	0.2066	0.0000	.0000E+00	.0000E+00
71	0.00	0.000	0.016	0.2059	0.0000	.0000E+00	.0000E+00
72	0.00	0.000	0.016	0.2053	0.0000	.0000E+00	.0000E+00
73	0.00	0.000	0.016	0.2046	0.0000	.0000E+00	.0000E+00
74	0.16	0.000	0.037	0.2098	0.0000	.0000E+00	.0000E+00
75	0.00	0.000	0.015	0.2091	0.0000	.0000E+00	.0000E+00
76	0.00	0.000	0.015	0.2085	0.0000	.0000E+00	.0000E+00
77	0.00	0.000	0.015	0.2079	0.0000	.0000E+00	.0000E+00
78	0.08	0.000	0.036	0.2097	0.0000	.0000E+00	.0000E+00
79	0.10	0.000	0.036	0.2124	0.0000	.0000E+00	.0000E+00
80	0.00	0.000	0.015	0.2118	0.0000	.0000E+00	.0000E+00
81	0.00	0.000	0.015	0.2112	0.0000	.0000E+00	.0000E+00
82	0.00	0.000	0.014	0.2106	0.0000	.0000E+00	.0000E+00
83	0.00	0.000	0.014	0.2100	0.0000	.0000E+00	.0000E+00
84	0.00	0.000	0.014	0.2094	0.0000	.0000E+00	.1666E-03
85	0.00	0.000	0.014	0.2088	0.0000	.0000E+00	.4498E-04
86	0.00	0.000	0.014	0.2082	0.0000	.0000E+00	.0000E+00
87	0.00	0.000	0.014	0.2076	0.0000	.0000E+00	.0000E+00
88	0.00	0.000	0.014	0.2070	0.0000	.0000E+00	.0000E+00
89	0.00	0.000	0.014	0.2064	0.0000	.0000E+00	.0000E+00
90	0.00	0.000	0.014	0.2058	0.0000	.0000E+00	.0000E+00
91	0.00	0.000	0.014	0.2052	0.0000	.0000E+00	.0000E+00
92	0.00	0.000	0.014	0.2046	0.0000	.0000E+00	.0000E+00
93	0.00	0.000	0.014	0.2040	0.0000	.0000E+00	.0000E+00
94	0.00	0.000	0.014	0.2034	0.0000	.0000E+00	.0000E+00
95	0.00	0.000	0.015	0.2028	0.0000	.0000E+00	.0000E+00
96	0.00	0.000	0.014	0.2022	0.0000	.0000E+00	.0000E+00
97	0.00	0.000	0.014	0.2016	0.0000	.0000E+00	.0000E+00
98	0.00	0.000	0.015	0.2010	0.0000	.0000E+00	.0000E+00
99	0.00	0.000	0.015	0.2004	0.0000	.0000E+00	.0000E+00
100	0.00	0.000	0.015	0.1998	0.0000	.0000E+00	.0000E+00
101	0.00	0.000	0.015	0.1992	0.0000	.0000E+00	.0000E+00

102	0.00	0.000	0.016	0.1985	0.0000	.0000E+00	.0000E+00
103	0.00	0.000	0.015	0.1979	0.0000	.0000E+00	.0000E+00
104	0.00	0.000	0.016	0.1973	0.0000	.0000E+00	.0000E+00
105	0.00	0.000	0.016	0.1966	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.016	0.1959	0.0000	.0000E+00	.0000E+00
107	0.00	0.000	0.016	0.1953	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.017	0.1946	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.017	0.1939	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.017	0.1932	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.017	0.1925	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.017	0.1918	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.017	0.1911	0.0000	.0000E+00	.0000E+00
114	0.00	0.000	0.016	0.1904	0.0000	.0000E+00	.0000E+00
115	0.00	0.000	0.019	0.1896	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.019	0.1888	0.0000	.0000E+00	.0000E+00
117	0.22	0.000	0.041	0.1963	0.0000	.0000E+00	.0000E+00
118	0.60	0.000	0.040	0.2196	0.0000	.0000E+00	.0000E+00
119	0.00	0.000	0.018	0.2189	0.0000	.0000E+00	.0000E+00
120	0.00	0.000	0.020	0.2180	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.020	0.2172	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.022	0.2163	0.0000	.0000E+00	.0000E+00
123	0.00	0.000	0.021	0.2154	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.022	0.2145	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.024	0.2135	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.024	0.2125	0.0000	.0000E+00	.0000E+00
127	0.00	0.000	0.025	0.2115	0.0000	.0000E+00	.0000E+00
128	0.00	0.000	0.025	0.2104	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.026	0.2094	0.0000	.0000E+00	.0000E+00
130	0.00	0.000	0.029	0.2082	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.025	0.2072	0.0000	.0000E+00	.0000E+00
132	0.00	0.000	0.027	0.2060	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.028	0.2049	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.024	0.2039	0.0000	.0000E+00	.0000E+00
135	0.00	0.000	0.025	0.2028	0.0000	.0000E+00	.0000E+00
136	0.00	0.000	0.032	0.2015	0.0000	.0000E+00	.0000E+00
137	0.45	0.000	0.057	0.2179	0.0000	.0000E+00	.0000E+00
138	0.05	0.000	0.054	0.2177	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.035	0.2162	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.036	0.2147	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.037	0.2132	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.036	0.2117	0.0000	.0000E+00	.0000E+00
143	0.00	0.000	0.040	0.2100	0.0000	.0000E+00	.0000E+00
144	0.00	0.000	0.043	0.2082	0.0000	.0000E+00	.0000E+00
145	0.00	0.000	0.047	0.2063	0.0000	.0000E+00	.0000E+00
146	0.00	0.000	0.047	0.2043	0.0000	.0000E+00	.0000E+00
147	0.00	0.000	0.050	0.2023	0.0000	.0000E+00	.0000E+00
148	0.00	0.000	0.051	0.2001	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.052	0.1980	0.0000	.0000E+00	.0000E+00
150	0.00	0.000	0.049	0.1959	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.055	0.1937	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.059	0.1912	0.0000	.0000E+00	.0000E+00
153	0.00	0.000	0.059	0.1888	0.0000	.0000E+00	.0000E+00
154	0.00	0.000	0.065	0.1860	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.064	0.1834	0.0000	.0000E+00	.0000E+00
156	0.38	0.000	0.091	0.1954	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.191	0.1875	0.0000	.0000E+00	.0000E+00
158	0.00	0.000	0.056	0.1852	0.0000	.0000E+00	.1975E-07
159	0.00	0.000	0.056	0.1828	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.055	0.1805	0.0000	.0000E+00	.0000E+00
161	0.00	0.000	0.053	0.1783	0.0000	.0000E+00	.0000E+00
162	0.00	0.000	0.066	0.1756	0.0000	.0000E+00	.0000E+00
163	0.00	0.000	0.068	0.1727	0.0000	.0000E+00	.0000E+00
164	0.00	0.000	0.069	0.1699	0.0000	.0000E+00	.0000E+00

165		0.00	0.000	0.022	0.1689	0.0000	.0000E+00	.0000E+00
166		0.00	0.000	0.004	0.1688	0.0000	.0000E+00	.0000E+00
167		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.3299E-07
168		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
169		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
170		0.14	0.000	0.036	0.1731	0.0000	.0000E+00	.0000E+00
171		0.00	0.000	0.007	0.1728	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.026	0.1717	0.0000	.0000E+00	.0000E+00
173		0.00	0.000	0.015	0.1711	0.0000	.0000E+00	.0000E+00
174		0.00	0.000	0.017	0.1704	0.0000	.0000E+00	.0000E+00
175		0.00	0.000	0.015	0.1698	0.0000	.0000E+00	.0000E+00
176		0.33	0.000	0.043	0.1817	0.0000	.0000E+00	.0000E+00
177		0.00	0.000	0.098	0.1777	0.0000	.0000E+00	.0000E+00
178		0.00	0.000	0.158	0.1711	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.045	0.1692	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.008	0.1689	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.003	0.1688	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
183		0.22	0.000	0.041	0.1762	0.0000	.0000E+00	.0000E+00
184		0.00	0.000	0.048	0.1742	0.0000	.0000E+00	.0000E+00
185		0.03	0.000	0.075	0.1723	0.0000	.0000E+00	.0000E+00
186		0.00	0.000	0.026	0.1712	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.020	0.1704	0.0000	.0000E+00	.0000E+00
188	*	0.00	0.000	0.014	0.1698	0.0000	.0000E+00	.0000E+00
189	*	0.00	0.000	0.011	0.1693	0.0000	.0000E+00	.0000E+00
190	*	0.00	0.000	0.011	0.1689	0.0000	.0000E+00	.0000E+00
191	*	0.00	0.000	0.003	0.1688	0.0000	.0000E+00	.0000E+00
192		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
193		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
194		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
195	*	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
196		0.23	0.000	0.036	0.1768	0.0000	.0000E+00	.0000E+00
197	*	0.00	0.000	0.024	0.1759	0.0000	.0000E+00	.0000E+00
198	*	0.00	0.000	0.030	0.1746	0.0000	.0000E+00	.0000E+00
199		0.13	0.000	0.082	0.1766	0.0000	.0000E+00	.0000E+00
200		0.05	0.000	0.084	0.1752	0.0000	.0000E+00	.0000E+00
201		0.00	0.000	0.047	0.1732	0.0000	.0000E+00	.0000E+00
202	*	0.00	0.000	0.035	0.1718	0.0000	.0000E+00	.0000E+00
203		0.45	0.000	0.079	0.1872	0.0000	.0000E+00	.9194E-04
204		0.02	0.000	0.052	0.1859	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.051	0.1838	0.0000	.0000E+00	.0000E+00
206		0.00	0.000	0.061	0.1813	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.064	0.1786	0.0000	.0000E+00	.0000E+00
208		0.25	0.000	0.093	0.1851	0.0000	.0000E+00	.0000E+00
209		0.00	0.000	0.069	0.1822	0.0000	.0000E+00	.3979E-07
210		0.08	0.000	0.080	0.1822	0.0000	.0000E+00	.0000E+00
211		0.31	0.000	0.091	0.1914	0.0000	.0000E+00	.0000E+00
212		0.05	0.000	0.131	0.1880	0.0000	.0000E+00	.0000E+00
213		0.00	0.000	0.093	0.1841	0.0000	.0000E+00	.0000E+00
214		0.31	0.000	0.092	0.1932	0.0000	.0000E+00	.0000E+00
215		0.50	0.000	0.156	0.2076	0.0000	.0000E+00	.0000E+00
216		0.03	0.000	0.168	0.2018	0.0000	.0000E+00	.0000E+00
217	*	0.00	0.000	0.086	0.1982	0.0000	.0000E+00	.0000E+00
218		0.00	0.000	0.079	0.1949	0.0000	.0000E+00	.6665E-08
219		0.00	0.000	0.088	0.1913	0.0000	.0000E+00	.0000E+00
220	*	0.00	0.000	0.080	0.1880	0.0000	.0000E+00	.0000E+00
221		0.30	0.000	0.148	0.1943	0.0000	.0000E+00	.0000E+00
222		0.00	0.000	0.085	0.1907	0.0000	.0000E+00	.0000E+00
223		0.31	0.000	0.161	0.1969	0.0000	.0000E+00	.0000E+00
224		0.00	0.000	0.086	0.1934	0.0000	.0000E+00	.0000E+00
225	*	0.00	0.000	0.099	0.1892	0.0000	.0000E+00	.2347E-03
226	*	0.00	0.000	0.082	0.1858	0.0000	.0000E+00	.0000E+00
227		0.00	0.000	0.121	0.1808	0.0000	.0000E+00	.0000E+00

228		0.00	0.000	0.109	0.1762	0.0000	.0000E+00	.0000E+00
229		0.00	0.000	0.077	0.1730	0.0000	.0000E+00	.0000E+00
230	*	1.24	0.000	0.068	0.1738	0.0000	.0000E+00	.0000E+00
231		0.00	0.031	0.097	0.2165	0.0000	.0000E+00	.0000E+00
232		0.00	0.000	0.162	0.2097	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.169	0.2027	0.0000	.0000E+00	.0000E+00
234		0.00	0.000	0.162	0.1959	0.0000	.0000E+00	.0000E+00
235		0.00	0.000	0.210	0.1872	0.0000	.0000E+00	.0000E+00
236		0.00	0.000	0.203	0.1787	0.0000	.0000E+00	.0000E+00
237		0.00	0.000	0.133	0.1732	0.0000	.0000E+00	.0000E+00
238		0.00	0.000	0.095	0.1692	0.0000	.0000E+00	.0000E+00
239		0.00	0.000	0.009	0.1689	0.0000	.0000E+00	.0000E+00
240		0.00	0.000	0.003	0.1688	0.0000	.0000E+00	.0000E+00
241		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
242		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
243		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
244		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
245		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
246		0.16	0.000	0.045	0.1736	0.0000	.0000E+00	.0000E+00
247		0.00	0.000	0.007	0.1733	0.0000	.0000E+00	.0000E+00
248		0.00	0.000	0.031	0.1720	0.0000	.0000E+00	.0000E+00
249	*	0.00	0.000	0.013	0.1714	0.0000	.0000E+00	.0000E+00
250		0.00	0.000	0.014	0.1709	0.0000	.0000E+00	.0000E+00
251		0.00	0.000	0.013	0.1703	0.0000	.0000E+00	.0000E+00
252		0.00	0.000	0.011	0.1699	0.0000	.0000E+00	.0000E+00
253		0.11	0.000	0.043	0.1726	0.0000	.0000E+00	.0000E+00
254		0.00	0.000	0.008	0.1723	0.0000	.0000E+00	.0000E+00
255		0.00	0.000	0.016	0.1717	0.0000	.0000E+00	.0000E+00
256		0.00	0.000	0.011	0.1712	0.0000	.0000E+00	.0000E+00
257		0.04	0.000	0.031	0.1716	0.0000	.0000E+00	.0000E+00
258		0.03	0.000	0.027	0.1717	0.0000	.0000E+00	.0000E+00
259		0.00	0.000	0.003	0.1716	0.0000	.0000E+00	.0000E+00
260		0.00	0.000	0.009	0.1712	0.0000	.0000E+00	.0000E+00
261		0.00	0.000	0.008	0.1709	0.0000	.0000E+00	.0000E+00
262		0.42	0.000	0.053	0.1862	0.0000	.0000E+00	.0000E+00
263		0.50	0.000	0.052	0.2048	0.0000	.0000E+00	.0000E+00
264		0.00	0.000	0.014	0.2043	0.0000	.0000E+00	.0000E+00
265		0.00	0.000	0.020	0.2034	0.0000	.0000E+00	.0000E+00
266	*	0.00	0.000	0.016	0.2028	0.0000	.0000E+00	.0000E+00
267		0.00	0.000	0.019	0.2020	0.0000	.0000E+00	.0000E+00
268		0.00	0.000	0.018	0.2012	0.0000	.0000E+00	.0000E+00
269	*	0.00	0.000	0.000	0.2012	0.0000	.0000E+00	.0000E+00
270		0.00	0.000	0.017	0.2005	0.0000	.0000E+00	.0000E+00
271		0.16	0.000	0.055	0.2049	0.0000	.0000E+00	.0000E+00
272		0.00	0.000	0.019	0.2041	0.0000	.0000E+00	.4394E-07
273		0.00	0.000	0.017	0.2033	0.0000	.0000E+00	.0000E+00
274		0.00	0.000	0.015	0.2027	0.0000	.0000E+00	.0000E+00
275		0.00	0.000	0.014	0.2021	0.0000	.0000E+00	.0000E+00
276		0.00	0.000	0.014	0.2016	0.0000	.0000E+00	.0000E+00
277		0.00	0.000	0.013	0.2010	0.0000	.0000E+00	.0000E+00
278		0.00	0.000	0.013	0.2005	0.0000	.0000E+00	.0000E+00
279		0.00	0.000	0.012	0.2000	0.0000	.0000E+00	.0000E+00
280	*	1.01	0.000	0.057	0.2008	0.0000	.0000E+00	.0000E+00
281		0.00	0.010	0.088	0.2356	0.0000	.0000E+00	.0000E+00
282		0.07	0.000	0.077	0.2353	0.0000	.0000E+00	.0000E+00
283		0.00	0.000	0.080	0.2319	0.0000	.0000E+00	.4886E-07
284		1.06	0.059	0.106	0.2692	0.0000	.0000E+00	.0000E+00
285		0.00	0.000	0.068	0.2664	0.0000	.0000E+00	.1759E-07
286		0.00	0.000	0.078	0.2631	0.0000	.0000E+00	.0000E+00
287		0.00	0.000	0.075	0.2600	0.0000	.0000E+00	.0000E+00
288		0.07	0.000	0.084	0.2594	0.0000	.0000E+00	.0000E+00
289		0.12	0.000	0.098	0.2603	0.0000	.0000E+00	.0000E+00
290		1.77	0.373	0.112	0.3139	0.0000	.0000E+00	.0000E+00

291		0.00	0.000	0.075	0.3107	0.0000	.0000E+00	.0000E+00
292		0.00	0.000	0.057	0.3084	0.0000	.0000E+00	.0000E+00
293		0.00	0.000	0.058	0.3060	0.0000	.0000E+00	.0000E+00
294		0.00	0.000	0.054	0.3037	0.0000	.0000E+00	.0000E+00
295		0.00	0.000	0.049	0.3017	0.0000	.0000E+00	.0000E+00
296		0.00	0.000	0.069	0.2988	0.0000	.0000E+00	.0000E+00
297		0.00	0.000	0.064	0.2961	0.0000	.0000E+00	.0000E+00
298		0.00	0.000	0.064	0.2935	0.0000	.0000E+00	.0000E+00
299		0.00	0.000	0.054	0.2912	0.0000	.0000E+00	.0000E+00
300		0.00	0.000	0.058	0.2888	0.0000	.0000E+00	.0000E+00
301		0.00	0.000	0.063	0.2862	0.0000	.0000E+00	.0000E+00
302		0.03	0.000	0.074	0.2843	0.0000	.0000E+00	.0000E+00
303		0.00	0.000	0.055	0.2820	0.0000	.0000E+00	.0000E+00
304		0.00	0.000	0.062	0.2794	0.0000	.0000E+00	.0000E+00
305		0.00	0.000	0.057	0.2771	0.0000	.0000E+00	.0000E+00
306		0.00	0.000	0.051	0.2749	0.0000	.0000E+00	.0000E+00
307		0.00	0.000	0.056	0.2726	0.0000	.0000E+00	.0000E+00
308		0.00	0.000	0.049	0.2706	0.0000	.0000E+00	.0000E+00
309		0.00	0.000	0.051	0.2684	0.0000	.0000E+00	.0000E+00
310		0.00	0.000	0.070	0.2655	0.0000	.0000E+00	.0000E+00
311		0.00	0.000	0.069	0.2626	0.0000	.0000E+00	.0000E+00
312		0.00	0.000	0.050	0.2605	0.0000	.0000E+00	.0000E+00
313		0.00	0.000	0.057	0.2581	0.0000	.0000E+00	.0000E+00
314		0.00	0.000	0.065	0.2554	0.0000	.0000E+00	.0000E+00
315		0.00	0.000	0.056	0.2531	0.0000	.0000E+00	.0000E+00
316		0.00	0.000	0.047	0.2511	0.0000	.0000E+00	.0000E+00
317		0.00	0.000	0.042	0.2494	0.0000	.0000E+00	.0000E+00
318		0.00	0.000	0.039	0.2477	0.0000	.0000E+00	.0000E+00
319		0.00	0.000	0.036	0.2462	0.0000	.0000E+00	.0000E+00
320		0.00	0.000	0.034	0.2448	0.0000	.0000E+00	.0000E+00
321		0.00	0.000	0.032	0.2435	0.0000	.0000E+00	.0000E+00
322		0.00	0.000	0.031	0.2422	0.0000	.0000E+00	.0000E+00
323		0.00	0.000	0.029	0.2410	0.0000	.0000E+00	.0000E+00
324		0.00	0.000	0.028	0.2398	0.0000	.0000E+00	.0000E+00
325		0.00	0.000	0.027	0.2387	0.0000	.0000E+00	.0000E+00
326		0.00	0.000	0.026	0.2376	0.0000	.0000E+00	.0000E+00
327		0.00	0.000	0.025	0.2366	0.0000	.0000E+00	.0000E+00
328		0.00	0.000	0.024	0.2355	0.0000	.0000E+00	.0000E+00
329		0.00	0.000	0.024	0.2345	0.0000	.0000E+00	.0000E+00
330		0.00	0.000	0.023	0.2336	0.0000	.0000E+00	.0000E+00
331		0.00	0.000	0.022	0.2326	0.0000	.0000E+00	.0000E+00
332		0.00	0.000	0.022	0.2317	0.0000	.0000E+00	.0000E+00
333		0.00	0.000	0.021	0.2308	0.0000	.0000E+00	.0000E+00
334		0.05	0.000	0.039	0.2313	0.0000	.0000E+00	.0000E+00
335		0.00	0.000	0.020	0.2305	0.0000	.0000E+00	.0000E+00
336		0.00	0.000	0.020	0.2296	0.0000	.0000E+00	.0000E+00
337		0.00	0.000	0.020	0.2288	0.0000	.0000E+00	.0000E+00
338		0.00	0.000	0.019	0.2280	0.0000	.0000E+00	.0000E+00
339		0.00	0.000	0.019	0.2272	0.0000	.0000E+00	.0000E+00
340		0.00	0.000	0.019	0.2264	0.0000	.0000E+00	.0000E+00
341		0.00	0.000	0.018	0.2257	0.0000	.0000E+00	.0000E+00
342		0.00	0.000	0.018	0.2249	0.0000	.0000E+00	.0000E+00
343		0.00	0.000	0.018	0.2242	0.0000	.0000E+00	.0000E+00
344		0.00	0.000	0.017	0.2235	0.0000	.0000E+00	.0000E+00
345		0.00	0.000	0.017	0.2228	0.0000	.0000E+00	.0000E+00
346		0.05	0.000	0.032	0.2235	0.0000	.0000E+00	.0000E+00
347		0.00	0.000	0.017	0.2228	0.0000	.0000E+00	.0000E+00
348	*	0.00	0.000	0.016	0.2221	0.0000	.0000E+00	.0000E+00
349		0.00	0.000	0.016	0.2215	0.0000	.0000E+00	.0000E+00
350		0.00	0.000	0.016	0.2208	0.0000	.0000E+00	.0000E+00
351		0.00	0.000	0.016	0.2201	0.0000	.0000E+00	.0000E+00
352		0.00	0.000	0.016	0.2195	0.0000	.0000E+00	.0000E+00
353		0.00	0.000	0.015	0.2189	0.0000	.0000E+00	.0000E+00

354	0.00	0.000	0.015	0.2182	0.0000	.0000E+00	.0000E+00
355	0.00	0.000	0.015	0.2176	0.0000	.0000E+00	.0000E+00
356	0.00	0.000	0.015	0.2170	0.0000	.0000E+00	.0000E+00
357	0.00	0.000	0.015	0.2164	0.0000	.0000E+00	.0000E+00
358	0.00	0.000	0.015	0.2158	0.0000	.0000E+00	.0000E+00
359	0.00	0.000	0.014	0.2152	0.0000	.0000E+00	.0000E+00
360	0.00	0.000	0.014	0.2146	0.0000	.0000E+00	.0000E+00
361	0.00	0.000	0.014	0.2140	0.0000	.0000E+00	.0000E+00
362	0.00	0.000	0.014	0.2134	0.0000	.0000E+00	.0000E+00
363	0.00	0.000	0.014	0.2128	0.0000	.0000E+00	.0000E+00
364	0.00	0.000	0.014	0.2123	0.0000	.0000E+00	.0000E+00
365	0.00	0.000	0.014	0.2117	0.0000	.0000E+00	.0000E+00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1985

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	1.26	0.42	0.34	0.82	0.50	0.85
	1.82	2.69	1.42	4.13	0.05	0.05
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.031	0.000	0.442	0.000	0.000
EVAPOTRANSPIRATION	1.984	0.867	0.547	0.527	1.085	1.448
	1.358	3.121	0.590	1.862	1.205	0.521
PERCOLATION/LEAKAGE THROUGH	0.0008	0.0000	0.0002	0.0000	0.0000	0.0000
LAYER 2	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000

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ANNUAL TOTALS FOR YEAR 1985

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.35	2083619.870	100.00
RUNOFF	0.473	68680.883	3.30
EVAPOTRANSPIRATION	15.113	2194475.500	105.32
PERC./LEAKAGE THROUGH LAYER 2	0.001361	197.637	0.01
CHANGE IN WATER STORAGE	-1.238	-179733.844	-8.63
SOIL WATER AT START OF YEAR	6.318	917443.500	
SOIL WATER AT END OF YEAR	5.081	737709.687	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.343	0.00

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LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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DAILY OUTPUT FOR YEAR 1986

DAY	AIR -	SOIL -	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.01	0.000	0.020	0.2113	0.0000	.0000E+00	.0000E+00
2			0.00	0.000	0.013	0.2107	0.0000	.0000E+00	.0000E+00
3			0.00	0.000	0.013	0.2102	0.0000	.0000E+00	.0000E+00
4			0.00	0.000	0.013	0.2096	0.0000	.0000E+00	.0000E+00
5			0.00	0.000	0.013	0.2091	0.0000	.0000E+00	.0000E+00
6			0.00	0.000	0.013	0.2086	0.0000	.0000E+00	.0000E+00
7			0.01	0.000	0.019	0.2082	0.0000	.0000E+00	.0000E+00
8	*		0.00	0.000	0.013	0.2076	0.0000	.0000E+00	.0000E+00
9	*		0.00	0.000	0.012	0.2071	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.012	0.2066	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.012	0.2061	0.0000	.0000E+00	.0000E+00
12			0.00	0.000	0.012	0.2056	0.0000	.0000E+00	.0000E+00
13			0.00	0.000	0.012	0.2051	0.0000	.0000E+00	.0000E+00
14			0.00	0.000	0.012	0.2046	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.012	0.2041	0.0000	.0000E+00	.0000E+00
16			0.00	0.000	0.012	0.2036	0.0000	.0000E+00	.0000E+00
17			0.00	0.000	0.012	0.2031	0.0000	.0000E+00	.0000E+00
18			0.00	0.000	0.012	0.2026	0.0000	.0000E+00	.0000E+00
19			0.00	0.000	0.012	0.2021	0.0000	.0000E+00	.0000E+00
20			0.00	0.000	0.012	0.2016	0.0000	.0000E+00	.0000E+00
21			0.00	0.000	0.011	0.2012	0.0000	.0000E+00	.0000E+00
22			0.00	0.000	0.011	0.2007	0.0000	.0000E+00	.0000E+00
23			0.00	0.000	0.011	0.2002	0.0000	.0000E+00	.0000E+00
24			0.00	0.000	0.011	0.1997	0.0000	.0000E+00	.0000E+00
25			0.00	0.000	0.011	0.1993	0.0000	.0000E+00	.0000E+00
26			0.00	0.000	0.011	0.1988	0.0000	.0000E+00	.0000E+00
27			0.00	0.000	0.011	0.1983	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.011	0.1979	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.011	0.1974	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.011	0.1970	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.011	0.1965	0.0000	.0000E+00	.0000E+00
32			0.00	0.000	0.011	0.1961	0.0000	.0000E+00	.0000E+00
33			0.02	0.000	0.019	0.1961	0.0000	.0000E+00	.0000E+00
34			0.00	0.000	0.011	0.1957	0.0000	.0000E+00	.0000E+00
35			0.16	0.000	0.019	0.2016	0.0000	.0000E+00	.0000E+00
36			0.04	0.000	0.019	0.2024	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.010	0.2020	0.0000	.0000E+00	.0000E+00
38			0.05	0.000	0.019	0.2033	0.0000	.0000E+00	.0000E+00
39			0.01	0.000	0.016	0.2030	0.0000	.0000E+00	.0000E+00

40	0.05	0.000	0.019	0.2043	0.0000	.0000E+00	.0000E+00
41	0.24	0.000	0.019	0.2136	0.0000	.0000E+00	.0000E+00
42	0.00	0.000	0.010	0.2131	0.0000	.0000E+00	.0000E+00
43	0.00	0.000	0.010	0.2127	0.0000	.0000E+00	.0000E+00
44	0.00	0.000	0.010	0.2123	0.0000	.0000E+00	.0000E+00
45	0.00	0.000	0.010	0.2119	0.0000	.0000E+00	.0000E+00
46	0.00	0.000	0.010	0.2115	0.0000	.0000E+00	.0000E+00
47	0.00	0.000	0.010	0.2111	0.0000	.0000E+00	.0000E+00
48	0.00	0.000	0.010	0.2107	0.0000	.0000E+00	.0000E+00
49	0.00	0.000	0.010	0.2102	0.0000	.0000E+00	.0000E+00
50	0.00	0.000	0.010	0.2098	0.0000	.0000E+00	.0000E+00
51	0.00	0.000	0.010	0.2094	0.0000	.0000E+00	.0000E+00
52	0.00	0.000	0.010	0.2090	0.0000	.0000E+00	.0000E+00
53	0.00	0.000	0.010	0.2086	0.0000	.0000E+00	.0000E+00
54	0.00	0.000	0.010	0.2082	0.0000	.0000E+00	.0000E+00
55	0.00	0.000	0.010	0.2078	0.0000	.0000E+00	.0000E+00
56	0.00	0.000	0.009	0.2074	0.0000	.0000E+00	.0000E+00
57	0.00	0.000	0.009	0.2070	0.0000	.0000E+00	.0000E+00
58	0.00	0.000	0.009	0.2067	0.0000	.0000E+00	.0000E+00
59	0.00	0.000	0.009	0.2063	0.0000	.0000E+00	.0000E+00
60	0.00	0.000	0.009	0.2059	0.0000	.0000E+00	.0000E+00
61	0.00	0.000	0.009	0.2055	0.0000	.0000E+00	.0000E+00
62	0.00	0.000	0.009	0.2051	0.0000	.0000E+00	.0000E+00
63	0.00	0.000	0.009	0.2047	0.0000	.0000E+00	.0000E+00
64	0.00	0.000	0.009	0.2043	0.0000	.0000E+00	.0000E+00
65	0.00	0.000	0.009	0.2040	0.0000	.0000E+00	.0000E+00
66	0.00	0.000	0.009	0.2036	0.0000	.0000E+00	.0000E+00
67	0.00	0.000	0.009	0.2032	0.0000	.0000E+00	.0000E+00
68	0.00	0.000	0.009	0.2028	0.0000	.0000E+00	.0000E+00
69	0.00	0.000	0.009	0.2024	0.0000	.0000E+00	.0000E+00
70	0.07	0.000	0.016	0.2047	0.0000	.0000E+00	.0000E+00
71	0.00	0.000	0.009	0.2043	0.0000	.0000E+00	.0000E+00
72	0.11	0.000	0.016	0.2082	0.0000	.0000E+00	.0000E+00
73	0.13	0.000	0.016	0.2130	0.0000	.0000E+00	.0000E+00
74	0.00	0.000	0.009	0.2126	0.0000	.0000E+00	.0000E+00
75	0.00	0.000	0.009	0.2122	0.0000	.0000E+00	.0000E+00
76	0.00	0.000	0.009	0.2119	0.0000	.0000E+00	.0000E+00
77	0.00	0.000	0.009	0.2115	0.0000	.0000E+00	.0000E+00
78	0.04	0.000	0.016	0.2125	0.0000	.0000E+00	.0000E+00
79	0.00	0.000	0.009	0.2121	0.0000	.0000E+00	.0000E+00
80	0.00	0.000	0.009	0.2118	0.0000	.0000E+00	.0000E+00
81	0.00	0.000	0.009	0.2114	0.0000	.0000E+00	.0000E+00
82	0.00	0.000	0.009	0.2110	0.0000	.0000E+00	.0000E+00
83	0.00	0.000	0.009	0.2106	0.0000	.0000E+00	.0000E+00
84	0.00	0.000	0.009	0.2103	0.0000	.0000E+00	.0000E+00
85	0.00	0.000	0.009	0.2099	0.0000	.0000E+00	.0000E+00
86	0.00	0.000	0.009	0.2095	0.0000	.0000E+00	.0000E+00
87	0.00	0.000	0.009	0.2091	0.0000	.0000E+00	.0000E+00
88	0.00	0.000	0.009	0.2087	0.0000	.0000E+00	.0000E+00
89	0.00	0.000	0.009	0.2083	0.0000	.0000E+00	.0000E+00
90	0.00	0.000	0.009	0.2079	0.0000	.0000E+00	.0000E+00
91	0.00	0.000	0.010	0.2075	0.0000	.0000E+00	.0000E+00
92	0.00	0.000	0.010	0.2071	0.0000	.0000E+00	.0000E+00
93	0.00	0.000	0.010	0.2067	0.0000	.0000E+00	.0000E+00
94	0.00	0.000	0.010	0.2063	0.0000	.0000E+00	.0000E+00
95	0.00	0.000	0.010	0.2059	0.0000	.0000E+00	.0000E+00
96	0.00	0.000	0.010	0.2054	0.0000	.0000E+00	.0000E+00
97	0.00	0.000	0.011	0.2050	0.0000	.0000E+00	.0000E+00
98	0.00	0.000	0.011	0.2045	0.0000	.0000E+00	.0000E+00
99	0.00	0.000	0.011	0.2041	0.0000	.0000E+00	.0000E+00
100	0.00	0.000	0.011	0.2036	0.0000	.0000E+00	.0000E+00
101	0.00	0.000	0.011	0.2032	0.0000	.0000E+00	.0000E+00
102	0.00	0.000	0.012	0.2027	0.0000	.0000E+00	.0000E+00

103	0.00	0.000	0.012	0.2022	0.0000	.0000E+00	.0000E+00
104	0.00	0.000	0.012	0.2017	0.0000	.0000E+00	.0000E+00
105	0.00	0.000	0.013	0.2012	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.013	0.2006	0.0000	.0000E+00	.0000E+00
107	0.00	0.000	0.013	0.2001	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.012	0.1996	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.013	0.1991	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.013	0.1985	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.014	0.1980	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.014	0.1974	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.015	0.1968	0.0000	.0000E+00	.0000E+00
114	0.01	0.000	0.020	0.1963	0.0000	.0000E+00	.0000E+00
115	0.00	0.000	0.015	0.1957	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.016	0.1950	0.0000	.0000E+00	.0000E+00
117	0.00	0.000	0.016	0.1944	0.0000	.0000E+00	.0000E+00
118	0.00	0.000	0.016	0.1937	0.0000	.0000E+00	.0000E+00
119	0.00	0.000	0.017	0.1929	0.0000	.0000E+00	.0000E+00
120	0.00	0.000	0.019	0.1921	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.019	0.1913	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.020	0.1905	0.0000	.0000E+00	.1671E-02
123	0.00	0.000	0.021	0.1896	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.021	0.1887	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.021	0.1878	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.022	0.1869	0.0000	.0000E+00	.0000E+00
127	0.00	0.000	0.024	0.1859	0.0000	.0000E+00	.0000E+00
128	0.00	0.000	0.023	0.1849	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.022	0.1840	0.0000	.0000E+00	.0000E+00
130	0.00	0.000	0.023	0.1831	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.024	0.1820	0.0000	.0000E+00	.0000E+00
132	0.00	0.000	0.025	0.1810	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.026	0.1799	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.024	0.1789	0.0000	.0000E+00	.0000E+00
135	0.00	0.000	0.030	0.1777	0.0000	.0000E+00	.0000E+00
136	0.00	0.000	0.032	0.1763	0.0000	.0000E+00	.0000E+00
137	0.03	0.000	0.041	0.1759	0.0000	.0000E+00	.0000E+00
138	0.00	0.000	0.030	0.1746	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.035	0.1731	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.037	0.1716	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.041	0.1699	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.027	0.1688	0.0000	.0000E+00	.0000E+00
143	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.2956E-07
144	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
145	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
146	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
147	0.05	0.000	0.013	0.1703	0.0000	.0000E+00	.0000E+00
148	0.02	0.000	0.012	0.1707	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.004	0.1705	0.0000	.0000E+00	.0000E+00
150	0.27	0.000	0.017	0.1811	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.019	0.1803	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.017	0.1795	0.0000	.0000E+00	.0000E+00
153	0.00	0.000	0.024	0.1786	0.0000	.0000E+00	.0000E+00
154	0.00	0.000	0.029	0.1774	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.032	0.1760	0.0000	.0000E+00	.0000E+00
156	0.00	0.000	0.033	0.1747	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.035	0.1732	0.0000	.0000E+00	.0000E+00
158	0.00	0.000	0.037	0.1716	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.037	0.1701	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.025	0.1690	0.0000	.0000E+00	.0000E+00
161	0.00	0.000	0.005	0.1688	0.0000	.0000E+00	.0000E+00
162	0.00	0.000	0.001	0.1688	0.0000	.0000E+00	.0000E+00
163	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
164	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
165	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00

166		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
167		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
168		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
169		0.12	0.000	0.016	0.1731	0.0000	.0000E+00	.0000E+00
170		0.08	0.000	0.016	0.1758	0.0000	.0000E+00	.0000E+00
171		0.00	0.000	0.024	0.1748	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.027	0.1737	0.0000	.0000E+00	.0000E+00
173		0.00	0.000	0.038	0.1721	0.0000	.0000E+00	.0000E+00
174		0.02	0.000	0.030	0.1717	0.0000	.0000E+00	.0000E+00
175		0.46	0.000	0.035	0.1894	0.0000	.0000E+00	.0000E+00
176		0.48	0.000	0.038	0.2078	0.0000	.0000E+00	.0000E+00
177		0.32	0.000	0.049	0.2191	0.0000	.0000E+00	.0000E+00
178		0.00	0.000	0.041	0.2174	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.043	0.2155	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.043	0.2138	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.057	0.2114	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.052	0.2092	0.0000	.0000E+00	.0000E+00
183		0.00	0.000	0.052	0.2070	0.0000	.0000E+00	.0000E+00
184		0.06	0.000	0.065	0.2068	0.0000	.0000E+00	.0000E+00
185		0.00	0.000	0.058	0.2044	0.0000	.0000E+00	.0000E+00
186		0.00	0.000	0.057	0.2020	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.068	0.1992	0.0000	.0000E+00	.0000E+00
188		0.02	0.000	0.072	0.1970	0.0000	.0000E+00	.0000E+00
189		0.00	0.000	0.064	0.1944	0.0000	.0000E+00	.0000E+00
190		0.03	0.000	0.078	0.1924	0.0000	.0000E+00	.1901E-03
191		0.16	0.000	0.079	0.1958	0.0000	.0000E+00	.0000E+00
192		0.00	0.000	0.070	0.1928	0.0000	.0000E+00	.2031E-03
193		0.00	0.000	0.072	0.1898	0.0000	.0000E+00	.0000E+00
194		0.00	0.000	0.073	0.1868	0.0000	.0000E+00	.8946E-07
195		0.00	0.000	0.033	0.1854	0.0000	.0000E+00	.0000E+00
196		0.00	0.000	0.032	0.1841	0.0000	.0000E+00	.0000E+00
197	*	0.00	0.000	0.029	0.1829	0.0000	.0000E+00	.0000E+00
198	*	0.27	0.000	0.080	0.1837	0.0000	.0000E+00	.0000E+00
199		0.02	0.000	0.245	0.1814	0.0000	.0000E+00	.0000E+00
200		0.00	0.000	0.055	0.1791	0.0000	.0000E+00	.0000E+00
201		0.00	0.000	0.054	0.1769	0.0000	.0000E+00	.0000E+00
202		0.23	0.000	0.086	0.1829	0.0000	.0000E+00	.0000E+00
203		0.26	0.000	0.248	0.1834	0.0000	.0000E+00	.1407E-05
204		0.00	0.000	0.191	0.1754	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.124	0.1702	0.0000	.0000E+00	.0000E+00
206		0.00	0.000	0.027	0.1691	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.007	0.1688	0.0000	.0000E+00	.0000E+00
208		0.00	0.000	0.002	0.1688	0.0000	.0000E+00	.0000E+00
209		0.00	0.000	0.001	0.1688	0.0000	.0000E+00	.0000E+00
210		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
211		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
212		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
213		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
214		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
215		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
216		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
217		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
218		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
219		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
220		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
221		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
222		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
223		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
224		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
225		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
226		0.85	0.002	0.054	0.2018	0.0000	.0000E+00	.0000E+00
227		0.05	0.000	0.047	0.2020	0.0000	.0000E+00	.0000E+00
228		0.00	0.000	0.061	0.1994	0.0000	.0000E+00	.0000E+00

229		0.00	0.000	0.058	0.1970	0.0000	.0000E+00	.0000E+00
230		0.00	0.000	0.059	0.1945	0.0000	.0000E+00	.0000E+00
231		0.00	0.000	0.056	0.1922	0.0000	.0000E+00	.0000E+00
232		0.00	0.000	0.056	0.1899	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.050	0.1878	0.0000	.0000E+00	.0000E+00
234		0.00	0.000	0.049	0.1857	0.0000	.0000E+00	.0000E+00
235		0.37	0.000	0.063	0.1986	0.0000	.0000E+00	.0000E+00
236		0.00	0.000	0.049	0.1965	0.0000	.0000E+00	.0000E+00
237		0.00	0.000	0.044	0.1947	0.0000	.0000E+00	.0000E+00
238		0.00	0.000	0.022	0.1938	0.0000	.0000E+00	.0000E+00
239		0.01	0.000	0.032	0.1928	0.0000	.0000E+00	.0000E+00
240	*	0.00	0.000	0.023	0.1919	0.0000	.0000E+00	.0000E+00
241		0.00	0.000	0.022	0.1910	0.0000	.0000E+00	.0000E+00
242	*	0.46	0.000	0.072	0.1918	0.0000	.0000E+00	.0000E+00
243	*	0.00	0.000	0.068	0.1926	0.0000	.0000E+00	.0000E+00
244		0.00	0.000	0.107	0.1958	0.0000	.0000E+00	.0000E+00
245	*	0.00	0.000	0.102	0.1956	0.0000	.0000E+00	.0000E+00
246		0.00	0.000	0.159	0.1890	0.0000	.0000E+00	.0000E+00
247		0.06	0.000	0.121	0.1865	0.0000	.0000E+00	.0000E+00
248		0.00	0.000	0.079	0.1832	0.0000	.0000E+00	.0000E+00
249		0.11	0.000	0.085	0.1842	0.0000	.0000E+00	.1199E-04
250		0.00	0.000	0.066	0.1815	0.0000	.0000E+00	.0000E+00
251		0.00	0.000	0.055	0.1792	0.0000	.0000E+00	.0000E+00
252		0.00	0.000	0.057	0.1768	0.0000	.0000E+00	.0000E+00
253		0.00	0.000	0.044	0.1749	0.0000	.0000E+00	.0000E+00
254		0.00	0.000	0.035	0.1735	0.0000	.0000E+00	.0000E+00
255		0.12	0.000	0.062	0.1759	0.0000	.0000E+00	.1477E-07
256		0.00	0.000	0.040	0.1743	0.0000	.0000E+00	.0000E+00
257		0.00	0.000	0.024	0.1733	0.0000	.0000E+00	.0000E+00
258		0.50	0.000	0.045	0.1922	0.0000	.0000E+00	.1378E-04
259		0.00	0.000	0.016	0.1916	0.0000	.0000E+00	.0000E+00
260		0.00	0.000	0.024	0.1906	0.0000	.0000E+00	.0000E+00
261		0.00	0.000	0.023	0.1896	0.0000	.0000E+00	.0000E+00
262		0.00	0.000	0.022	0.1887	0.0000	.0000E+00	.0000E+00
263	*	0.00	0.000	0.019	0.1879	0.0000	.0000E+00	.0000E+00
264	*	0.00	0.000	0.018	0.1872	0.0000	.0000E+00	.0000E+00
265		0.00	0.000	0.020	0.1863	0.0000	.0000E+00	.0000E+00
266		0.21	0.000	0.041	0.1934	0.0000	.0000E+00	.0000E+00
267		0.80	0.003	0.043	0.2248	0.0000	.0000E+00	.4943E-07
268		0.00	0.000	0.095	0.2209	0.0000	.0000E+00	.0000E+00
269		0.00	0.000	0.109	0.2163	0.0000	.0000E+00	.0000E+00
270		0.00	0.000	0.131	0.2108	0.0000	.0000E+00	.0000E+00
271		0.00	0.000	0.119	0.2059	0.0000	.0000E+00	.0000E+00
272		0.00	0.000	0.099	0.2018	0.0000	.0000E+00	.0000E+00
273		0.00	0.000	0.107	0.1973	0.0000	.0000E+00	.0000E+00
274		0.00	0.000	0.069	0.1944	0.0000	.0000E+00	.0000E+00
275		0.24	0.000	0.078	0.2011	0.0000	.0000E+00	.1038E-03
276		0.26	0.000	0.069	0.2091	0.0000	.0000E+00	.0000E+00
277		0.00	0.000	0.113	0.2044	0.0000	.0000E+00	.1058E-03
278		0.00	0.000	0.043	0.2026	0.0000	.0000E+00	.0000E+00
279		0.10	0.000	0.061	0.2042	0.0000	.0000E+00	.0000E+00
280		0.00	0.000	0.038	0.2027	0.0000	.0000E+00	.0000E+00
281		0.00	0.000	0.035	0.2012	0.0000	.0000E+00	.0000E+00
282		0.00	0.000	0.032	0.1999	0.0000	.0000E+00	.0000E+00
283		0.10	0.000	0.051	0.2019	0.0000	.0000E+00	.0000E+00
284		0.05	0.000	0.049	0.2020	0.0000	.0000E+00	.0000E+00
285		0.14	0.000	0.050	0.2057	0.0000	.0000E+00	.0000E+00
286		0.00	0.000	0.028	0.2045	0.0000	.0000E+00	.0000E+00
287		0.00	0.000	0.026	0.2034	0.0000	.0000E+00	.0000E+00
288		0.00	0.000	0.024	0.2025	0.0000	.0000E+00	.0000E+00
289		0.05	0.000	0.043	0.2027	0.0000	.0000E+00	.0000E+00
290		0.00	0.000	0.024	0.2017	0.0000	.0000E+00	.0000E+00
291	*	0.00	0.000	0.000	0.2017	0.0000	.0000E+00	.0000E+00

292		0.03	0.000	0.039	0.2014	0.0000	.0000E+00	.0000E+00
293		0.00	0.000	0.018	0.2006	0.0000	.0000E+00	.0000E+00
294		0.00	0.000	0.018	0.1999	0.0000	.0000E+00	.4712E-04
295		0.00	0.000	0.016	0.1992	0.0000	.0000E+00	.0000E+00
296		0.00	0.000	0.015	0.1986	0.0000	.0000E+00	.0000E+00
297		0.00	0.000	0.015	0.1980	0.0000	.0000E+00	.0000E+00
298		0.00	0.000	0.015	0.1974	0.0000	.0000E+00	.0000E+00
299		0.00	0.000	0.014	0.1968	0.0000	.0000E+00	.0000E+00
300		0.00	0.000	0.014	0.1962	0.0000	.0000E+00	.0000E+00
301		0.00	0.000	0.014	0.1956	0.0000	.0000E+00	.0000E+00
302		0.00	0.000	0.014	0.1950	0.0000	.0000E+00	.0000E+00
303		0.00	0.000	0.014	0.1944	0.0000	.0000E+00	.0000E+00
304		0.00	0.000	0.014	0.1938	0.0000	.0000E+00	.0000E+00
305		0.00	0.000	0.014	0.1932	0.0000	.0000E+00	.0000E+00
306		1.13	0.031	0.037	0.2375	0.0000	.0000E+00	.0000E+00
307		1.31	0.178	0.074	0.2816	0.0000	.0000E+00	.0000E+00
308		0.00	0.000	0.072	0.2786	0.0000	.0000E+00	.2352E-07
309		0.00	0.000	0.064	0.2759	0.0000	.0000E+00	.0000E+00
310		0.00	0.000	0.066	0.2732	0.0000	.0000E+00	.0000E+00
311		0.00	0.000	0.074	0.2701	0.0000	.0000E+00	.0000E+00
312		0.00	0.000	0.076	0.2669	0.0000	.0000E+00	.0000E+00
313		0.00	0.000	0.071	0.2639	0.0000	.0000E+00	.0000E+00
314		0.00	0.000	0.074	0.2609	0.0000	.0000E+00	.0000E+00
315		0.00	0.000	0.067	0.2581	0.0000	.0000E+00	.0000E+00
316		0.00	0.000	0.073	0.2550	0.0000	.0000E+00	.0000E+00
317		0.24	0.000	0.094	0.2611	0.0000	.0000E+00	.0000E+00
318		0.00	0.000	0.084	0.2576	0.0000	.0000E+00	.0000E+00
319		0.00	0.000	0.088	0.2540	0.0000	.0000E+00	.0000E+00
320		0.00	0.000	0.088	0.2503	0.0000	.0000E+00	.0000E+00
321		0.00	0.000	0.105	0.2459	0.0000	.0000E+00	.0000E+00
322		0.00	0.000	0.088	0.2423	0.0000	.0000E+00	.6325E-03
323		0.34	0.000	0.102	0.2522	0.0000	.0000E+00	.0000E+00
324		0.00	0.000	0.097	0.2482	0.0000	.0000E+00	.0000E+00
325		0.00	0.000	0.084	0.2447	0.0000	.0000E+00	.0000E+00
326		0.00	0.000	0.085	0.2411	0.0000	.0000E+00	.0000E+00
327		0.00	0.000	0.075	0.2380	0.0000	.0000E+00	.0000E+00
328		0.00	0.000	0.066	0.2353	0.0000	.0000E+00	.0000E+00
329		0.00	0.000	0.067	0.2325	0.0000	.0000E+00	.0000E+00
330		0.00	0.000	0.078	0.2292	0.0000	.0000E+00	.0000E+00
331		0.00	0.000	0.077	0.2260	0.0000	.0000E+00	.0000E+00
332		0.00	0.000	0.063	0.2233	0.0000	.0000E+00	.4493E-03
333		0.00	0.000	0.052	0.2212	0.0000	.0000E+00	.0000E+00
334		0.00	0.000	0.047	0.2192	0.0000	.0000E+00	.0000E+00
335		0.00	0.000	0.042	0.2174	0.0000	.0000E+00	.0000E+00
336		0.00	0.000	0.039	0.2158	0.0000	.0000E+00	.0000E+00
337		0.00	0.000	0.036	0.2143	0.0000	.0000E+00	.0000E+00
338		0.00	0.000	0.034	0.2129	0.0000	.0000E+00	.0000E+00
339		0.00	0.000	0.032	0.2116	0.0000	.0000E+00	.0000E+00
340		0.00	0.000	0.030	0.2103	0.0000	.0000E+00	.0000E+00
341		0.11	0.000	0.045	0.2131	0.0000	.0000E+00	.0000E+00
342		0.52	0.000	0.043	0.2329	0.0000	.0000E+00	.0000E+00
343		0.00	0.000	0.068	0.2301	0.0000	.0000E+00	.0000E+00
344		0.15	0.000	0.042	0.2346	0.0000	.0000E+00	.0000E+00
345	*	0.00	0.000	0.051	0.2324	0.0000	.0000E+00	.0000E+00
346	*	0.00	0.000	0.025	0.2314	0.0000	.0000E+00	.0000E+00
347		0.00	0.000	0.024	0.2304	0.0000	.0000E+00	.0000E+00
348		0.00	0.000	0.024	0.2294	0.0000	.0000E+00	.0000E+00
349		0.00	0.000	0.023	0.2284	0.0000	.0000E+00	.0000E+00
350		0.22	0.000	0.039	0.2360	0.0000	.0000E+00	.0000E+00
351		0.50	0.000	0.089	0.2531	0.0000	.0000E+00	.0000E+00
352		0.00	0.000	0.082	0.2497	0.0000	.0000E+00	.0000E+00
353		0.00	0.000	0.055	0.2474	0.0000	.0000E+00	.0000E+00
354		0.00	0.000	0.055	0.2451	0.0000	.0000E+00	.0000E+00

355	0.00	0.000	0.071	0.2421	0.0000	.0000E+00	.0000E+00
356	0.00	0.000	0.074	0.2391	0.0000	.0000E+00	.0000E+00
357	0.09	0.000	0.079	0.2395	0.0000	.0000E+00	.0000E+00
358	0.00	0.000	0.055	0.2372	0.0000	.0000E+00	.0000E+00
359	0.00	0.000	0.058	0.2348	0.0000	.0000E+00	.0000E+00
360	0.00	0.000	0.058	0.2324	0.0000	.0000E+00	.0000E+00
361	0.00	0.000	0.060	0.2299	0.0000	.0000E+00	.0000E+00
362	0.00	0.000	0.068	0.2271	0.0000	.0000E+00	.0000E+00
363	0.00	0.000	0.063	0.2245	0.0000	.0000E+00	.0000E+00
364	0.00	0.000	0.053	0.2222	0.0000	.0000E+00	.0000E+00
365	0.00	0.000	0.047	0.2203	0.0000	.0000E+00	.4264E-04

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1986

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.02	0.57	0.35	0.01	0.37	1.48
	1.05	1.74	1.80	0.97	3.02	1.59
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.002	0.003	0.000	0.210	0.000
EVAPOTRANSPIRATION	0.384	0.336	0.310	0.389	0.653	0.734
	2.072	0.885	1.966	1.053	2.200	1.564
PERCOLATION/LEAKAGE THROUGH	0.0000	0.0000	0.0000	0.0000	0.0017	0.0000
LAYER 2	0.0004	0.0000	0.0000	0.0003	0.0011	0.0000

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ANNUAL TOTALS FOR YEAR 1986

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.97	1883244.000	100.00
RUNOFF	0.214	31045.662	1.65
EVAPOTRANSPIRATION	12.546	1821722.370	96.73
PERC./LEAKAGE THROUGH LAYER 2	0.003473	504.209	0.03
CHANGE IN WATER STORAGE	0.206	29972.107	1.59
SOIL WATER AT START OF YEAR	5.081	737709.687	
SOIL WATER AT END OF YEAR	5.287	767681.750	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE 0.0000 -0.273 0.00

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LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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DAILY OUTPUT FOR YEAR 1987

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.00	0.000	0.042	0.2185	0.0000	.0000E+00	.1150E-03
2			0.00	0.000	0.039	0.2169	0.0000	.0000E+00	.2702E-03
3			0.00	0.000	0.036	0.2154	0.0000	.0000E+00	.4775E-03
4			0.00	0.000	0.034	0.2139	0.0000	.0000E+00	.6190E-03
5			0.00	0.000	0.032	0.2125	0.0000	.0000E+00	.7154E-03
6			0.00	0.000	0.031	0.2112	0.0000	.0000E+00	.5327E-03
7			0.00	0.000	0.029	0.2100	0.0000	.0000E+00	.5696E-03
8			0.00	0.000	0.028	0.2088	0.0000	.0000E+00	.5930E-03
9			0.00	0.000	0.026	0.2077	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.025	0.2067	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.024	0.2057	0.0000	.0000E+00	.0000E+00
12			0.00	0.000	0.024	0.2047	0.0000	.0000E+00	.0000E+00
13			0.00	0.000	0.023	0.2037	0.0000	.0000E+00	.0000E+00
14			0.00	0.000	0.022	0.2028	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.022	0.2019	0.0000	.0000E+00	.0000E+00
16			0.00	0.000	0.022	0.2009	0.0000	.0000E+00	.0000E+00
17	*		0.21	0.000	0.077	0.2018	0.0000	.0000E+00	.0000E+00
18	*		0.00	0.000	0.057	0.2026	0.0000	.0000E+00	.0000E+00
19	*		0.00	0.000	0.037	0.2026	0.0000	.0000E+00	.0000E+00
20	*		0.00	0.000	0.021	0.2017	0.0000	.0000E+00	.0000E+00
21	*		0.00	0.000	0.020	0.2009	0.0000	.0000E+00	.0000E+00
22	*		0.00	0.000	0.020	0.2000	0.0000	.0000E+00	.0000E+00
23	*		0.00	0.000	0.020	0.1992	0.0000	.0000E+00	.0000E+00
24			0.00	0.000	0.020	0.1984	0.0000	.0000E+00	.0000E+00
25			0.00	0.000	0.019	0.1976	0.0000	.0000E+00	.0000E+00
26			0.00	0.000	0.019	0.1968	0.0000	.0000E+00	.0000E+00
27			0.00	0.000	0.019	0.1960	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.018	0.1953	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.018	0.1945	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.018	0.1938	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.017	0.1931	0.0000	.0000E+00	.0000E+00
32			0.00	0.000	0.017	0.1924	0.0000	.0000E+00	.0000E+00
33			0.00	0.000	0.017	0.1917	0.0000	.0000E+00	.0000E+00
34			0.00	0.000	0.017	0.1910	0.0000	.0000E+00	.0000E+00
35			0.00	0.000	0.016	0.1903	0.0000	.0000E+00	.0000E+00
36			0.00	0.000	0.016	0.1896	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.016	0.1889	0.0000	.0000E+00	.0000E+00
38			0.00	0.000	0.016	0.1883	0.0000	.0000E+00	.0000E+00
39			0.00	0.000	0.015	0.1876	0.0000	.0000E+00	.0000E+00
40			0.00	0.000	0.015	0.1870	0.0000	.0000E+00	.0000E+00

41		0.00	0.000	0.015	0.1864	0.0000	.0000E+00	.0000E+00
42		0.00	0.000	0.015	0.1858	0.0000	.0000E+00	.0000E+00
43		0.00	0.000	0.014	0.1852	0.0000	.0000E+00	.0000E+00
44		0.00	0.000	0.014	0.1846	0.0000	.0000E+00	.0000E+00
45		0.00	0.000	0.014	0.1840	0.0000	.0000E+00	.0000E+00
46		0.00	0.000	0.014	0.1834	0.0000	.0000E+00	.0000E+00
47		0.00	0.000	0.014	0.1829	0.0000	.0000E+00	.0000E+00
48		0.00	0.000	0.014	0.1823	0.0000	.0000E+00	.0000E+00
49		0.28	0.000	0.030	0.1927	0.0000	.0000E+00	.0000E+00
50		0.00	0.000	0.013	0.1922	0.0000	.0000E+00	.0000E+00
51		0.07	0.000	0.029	0.1939	0.0000	.0000E+00	.0000E+00
52		0.38	0.000	0.029	0.2085	0.0000	.0000E+00	.0000E+00
53	*	0.00	0.000	0.013	0.2079	0.0000	.0000E+00	.0000E+00
54		0.00	0.000	0.013	0.2074	0.0000	.0000E+00	.0000E+00
55		0.00	0.000	0.013	0.2068	0.0000	.0000E+00	.0000E+00
56		0.00	0.000	0.013	0.2063	0.0000	.0000E+00	.0000E+00
57		0.00	0.000	0.013	0.2057	0.0000	.0000E+00	.0000E+00
58		0.00	0.000	0.013	0.2052	0.0000	.0000E+00	.0000E+00
59		0.00	0.000	0.013	0.2047	0.0000	.0000E+00	.0000E+00
60		0.00	0.000	0.013	0.2041	0.0000	.0000E+00	.0000E+00
61		0.00	0.000	0.013	0.2036	0.0000	.0000E+00	.0000E+00
62		0.00	0.000	0.012	0.2031	0.0000	.0000E+00	.0000E+00
63		0.00	0.000	0.012	0.2026	0.0000	.0000E+00	.0000E+00
64		0.00	0.000	0.012	0.2021	0.0000	.0000E+00	.0000E+00
65		0.00	0.000	0.012	0.2016	0.0000	.0000E+00	.0000E+00
66		0.00	0.000	0.012	0.2011	0.0000	.0000E+00	.0000E+00
67		0.00	0.000	0.012	0.2006	0.0000	.0000E+00	.0000E+00
68		0.00	0.000	0.012	0.2001	0.0000	.0000E+00	.0000E+00
69		0.04	0.000	0.027	0.2006	0.0000	.0000E+00	.0000E+00
70		0.05	0.000	0.027	0.2016	0.0000	.0000E+00	.0000E+00
71		0.00	0.000	0.012	0.2011	0.0000	.0000E+00	.0000E+00
72		0.00	0.000	0.012	0.2006	0.0000	.0000E+00	.0000E+00
73		0.00	0.000	0.012	0.2001	0.0000	.0000E+00	.8499E-04
74		0.00	0.000	0.012	0.1996	0.0000	.0000E+00	.6282E-05
75		0.00	0.000	0.012	0.1991	0.0000	.0000E+00	.0000E+00
76		0.00	0.000	0.012	0.1986	0.0000	.0000E+00	.0000E+00
77		0.00	0.000	0.012	0.1981	0.0000	.0000E+00	.0000E+00
78		0.00	0.000	0.012	0.1976	0.0000	.0000E+00	.0000E+00
79		0.00	0.000	0.012	0.1972	0.0000	.0000E+00	.0000E+00
80		0.00	0.000	0.012	0.1967	0.0000	.0000E+00	.0000E+00
81		0.00	0.000	0.012	0.1962	0.0000	.0000E+00	.0000E+00
82		0.00	0.000	0.011	0.1957	0.0000	.0000E+00	.0000E+00
83		0.00	0.000	0.011	0.1952	0.0000	.0000E+00	.0000E+00
84		0.00	0.000	0.011	0.1948	0.0000	.0000E+00	.0000E+00
85		0.00	0.000	0.011	0.1943	0.0000	.0000E+00	.0000E+00
86		0.00	0.000	0.011	0.1938	0.0000	.0000E+00	.0000E+00
87		0.00	0.000	0.011	0.1934	0.0000	.0000E+00	.0000E+00
88		0.51	0.000	0.027	0.2135	0.0000	.0000E+00	.0000E+00
89		0.00	0.000	0.011	0.2130	0.0000	.0000E+00	.0000E+00
90		0.00	0.000	0.011	0.2126	0.0000	.0000E+00	.0000E+00
91		0.00	0.000	0.011	0.2121	0.0000	.0000E+00	.0000E+00
92		0.00	0.000	0.011	0.2116	0.0000	.0000E+00	.0000E+00
93		0.00	0.000	0.011	0.2112	0.0000	.0000E+00	.0000E+00
94		0.03	0.000	0.025	0.2114	0.0000	.0000E+00	.0000E+00
95		0.00	0.000	0.011	0.2109	0.0000	.0000E+00	.0000E+00
96		0.00	0.000	0.011	0.2105	0.0000	.0000E+00	.0000E+00
97		0.00	0.000	0.011	0.2100	0.0000	.0000E+00	.0000E+00
98		0.00	0.000	0.011	0.2095	0.0000	.0000E+00	.0000E+00
99		0.00	0.000	0.011	0.2091	0.0000	.0000E+00	.0000E+00
100		0.00	0.000	0.011	0.2086	0.0000	.0000E+00	.0000E+00
101		0.00	0.000	0.011	0.2081	0.0000	.0000E+00	.0000E+00
102		0.00	0.000	0.012	0.2076	0.0000	.0000E+00	.0000E+00
103		0.00	0.000	0.012	0.2071	0.0000	.0000E+00	.0000E+00

104	0.00	0.000	0.012	0.2066	0.0000	.0000E+00	.0000E+00
105	0.00	0.000	0.012	0.2062	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.012	0.2057	0.0000	.0000E+00	.0000E+00
107	0.00	0.000	0.012	0.2052	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.013	0.2046	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.013	0.2041	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.013	0.2036	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.013	0.2030	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.013	0.2025	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.013	0.2019	0.0000	.0000E+00	.0000E+00
114	0.00	0.000	0.014	0.2014	0.0000	.0000E+00	.0000E+00
115	0.00	0.000	0.013	0.2008	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.014	0.2002	0.0000	.0000E+00	.0000E+00
117	0.00	0.000	0.015	0.1996	0.0000	.0000E+00	.0000E+00
118	0.00	0.000	0.015	0.1990	0.0000	.0000E+00	.0000E+00
119	0.00	0.000	0.015	0.1984	0.0000	.0000E+00	.0000E+00
120	0.06	0.000	0.030	0.1996	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.016	0.1990	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.016	0.1983	0.0000	.0000E+00	.0000E+00
123	0.00	0.000	0.016	0.1976	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.017	0.1969	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.017	0.1962	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.017	0.1955	0.0000	.0000E+00	.0000E+00
127	0.00	0.000	0.018	0.1947	0.0000	.0000E+00	.0000E+00
128	0.00	0.000	0.019	0.1939	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.019	0.1931	0.0000	.0000E+00	.0000E+00
130	0.00	0.000	0.020	0.1923	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.021	0.1914	0.0000	.0000E+00	.0000E+00
132	0.10	0.000	0.039	0.1939	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.024	0.1930	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.024	0.1920	0.0000	.0000E+00	.0000E+00
135	0.03	0.000	0.037	0.1917	0.0000	.0000E+00	.0000E+00
136	0.00	0.000	0.021	0.1908	0.0000	.0000E+00	.4012E-07
137	0.00	0.000	0.022	0.1899	0.0000	.0000E+00	.0000E+00
138	0.00	0.000	0.024	0.1889	0.0000	.0000E+00	.0000E+00
139	0.13	0.000	0.042	0.1926	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.023	0.1916	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.024	0.1906	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.025	0.1896	0.0000	.0000E+00	.0000E+00
143	0.30	0.000	0.045	0.2002	0.0000	.0000E+00	.0000E+00
144	0.15	0.000	0.045	0.2046	0.0000	.0000E+00	.0000E+00
145	0.10	0.000	0.048	0.2068	0.0000	.0000E+00	.0000E+00
146	0.00	0.000	0.033	0.2054	0.0000	.0000E+00	.0000E+00
147	0.00	0.000	0.029	0.2042	0.0000	.0000E+00	.1699E-04
148	0.00	0.000	0.025	0.2032	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.025	0.2021	0.0000	.0000E+00	.0000E+00
150	0.00	0.000	0.026	0.2010	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.027	0.1999	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.027	0.1988	0.0000	.0000E+00	.0000E+00
153	0.00	0.000	0.031	0.1975	0.0000	.0000E+00	.0000E+00
154	0.00	0.000	0.029	0.1963	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.030	0.1951	0.0000	.0000E+00	.0000E+00
156	0.00	0.000	0.031	0.1938	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.032	0.1924	0.0000	.0000E+00	.0000E+00
158	0.35	0.000	0.054	0.2048	0.0000	.0000E+00	.0000E+00
159	0.03	0.000	0.050	0.2039	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.037	0.2024	0.0000	.0000E+00	.0000E+00
161	0.00	0.000	0.038	0.2008	0.0000	.0000E+00	.9369E-07
162	0.00	0.000	0.038	0.1992	0.0000	.0000E+00	.7242E-07
163	0.00	0.000	0.038	0.1976	0.0000	.0000E+00	.0000E+00
164	0.00	0.000	0.040	0.1959	0.0000	.0000E+00	.0000E+00
165	0.00	0.000	0.042	0.1942	0.0000	.0000E+00	.0000E+00
166	0.04	0.000	0.057	0.1935	0.0000	.0000E+00	.0000E+00

167		0.00	0.000	0.055	0.1912	0.0000	.0000E+00	.0000E+00
168		0.00	0.000	0.050	0.1891	0.0000	.0000E+00	.0000E+00
169		0.00	0.000	0.048	0.1871	0.0000	.0000E+00	.0000E+00
170		0.00	0.000	0.048	0.1851	0.0000	.0000E+00	.0000E+00
171		0.00	0.000	0.045	0.1832	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.048	0.1812	0.0000	.0000E+00	.0000E+00
173		0.00	0.000	0.049	0.1792	0.0000	.0000E+00	.0000E+00
174		0.00	0.000	0.063	0.1765	0.0000	.0000E+00	.0000E+00
175		0.00	0.000	0.061	0.1740	0.0000	.0000E+00	.0000E+00
176		0.13	0.000	0.096	0.1754	0.0000	.0000E+00	.0000E+00
177		0.00	0.000	0.057	0.1730	0.0000	.0000E+00	.0000E+00
178		1.40	0.092	0.058	0.2251	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.204	0.2167	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.211	0.2078	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.254	0.1972	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.264	0.1863	0.0000	.0000E+00	.0000E+00
183		0.00	0.000	0.234	0.1765	0.0000	.0000E+00	.0000E+00
184		0.00	0.000	0.171	0.1694	0.0000	.0000E+00	.1060E-06
185		0.00	0.000	0.011	0.1689	0.0000	.0000E+00	.0000E+00
186		0.00	0.000	0.004	0.1688	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
188		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
189		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
190		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
191		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
192		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
193		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
194		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
195		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
196	*	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
197	*	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
198		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
199	*	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
200		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
201		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
202		0.22	0.000	0.035	0.1765	0.0000	.0000E+00	.0000E+00
203		0.00	0.000	0.043	0.1747	0.0000	.0000E+00	.0000E+00
204		0.04	0.000	0.056	0.1740	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.038	0.1725	0.0000	.0000E+00	.0000E+00
206		0.03	0.000	0.040	0.1720	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.009	0.1717	0.0000	.0000E+00	.0000E+00
208		0.00	0.000	0.019	0.1709	0.0000	.0000E+00	.0000E+00
209		0.00	0.000	0.017	0.1701	0.0000	.0000E+00	.0000E+00
210		0.29	0.000	0.042	0.1805	0.0000	.0000E+00	.0000E+00
211		0.00	0.000	0.045	0.1786	0.0000	.0000E+00	.1642E-13
212		0.00	0.000	0.049	0.1766	0.0000	.0000E+00	.0000E+00
213		0.00	0.000	0.037	0.1750	0.0000	.0000E+00	.0000E+00
214	*	0.00	0.000	0.038	0.1734	0.0000	.0000E+00	.0000E+00
215		0.04	0.000	0.054	0.1729	0.0000	.0000E+00	.1886E-05
216		0.63	0.000	0.057	0.1967	0.0000	.0000E+00	.0000E+00
217		0.00	0.000	0.033	0.1953	0.0000	.0000E+00	.0000E+00
218	*	0.00	0.000	0.036	0.1938	0.0000	.0000E+00	.0000E+00
219		0.00	0.000	0.036	0.1924	0.0000	.0000E+00	.0000E+00
220	*	0.00	0.000	0.035	0.1909	0.0000	.0000E+00	.0000E+00
221		0.60	0.000	0.056	0.2136	0.0000	.0000E+00	.0000E+00
222		0.00	0.000	0.193	0.2055	0.0000	.0000E+00	.0000E+00
223		0.30	0.000	0.221	0.2088	0.0000	.0000E+00	.0000E+00
224		0.00	0.000	0.113	0.2041	0.0000	.0000E+00	.0000E+00
225	*	0.00	0.000	0.109	0.1995	0.0000	.0000E+00	.3257E-04
226		0.00	0.000	0.135	0.1939	0.0000	.0000E+00	.0000E+00
227		0.00	0.000	0.108	0.1894	0.0000	.0000E+00	.0000E+00
228		0.00	0.000	0.091	0.1856	0.0000	.0000E+00	.0000E+00
229		0.00	0.000	0.082	0.1822	0.0000	.0000E+00	.0000E+00

230		0.00	0.000	0.077	0.1790	0.0000	.0000E+00	.0000E+00
231		0.00	0.000	0.098	0.1749	0.0000	.0000E+00	.0000E+00
232		0.00	0.000	0.106	0.1704	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.035	0.1690	0.0000	.0000E+00	.0000E+00
234		0.01	0.000	0.015	0.1688	0.0000	.0000E+00	.0000E+00
235		0.00	0.000	0.001	0.1688	0.0000	.0000E+00	.0000E+00
236		1.90	0.256	0.070	0.2344	0.0000	.0000E+00	.0000E+00
237		0.00	0.000	0.177	0.2270	0.0000	.0000E+00	.0000E+00
238		0.15	0.000	0.228	0.2237	0.0000	.0000E+00	.0000E+00
239		0.00	0.000	0.195	0.2156	0.0000	.0000E+00	.0000E+00
240		0.00	0.000	0.199	0.2073	0.0000	.0000E+00	.0000E+00
241		0.00	0.000	0.175	0.2000	0.0000	.0000E+00	.0000E+00
242		0.00	0.000	0.153	0.1936	0.0000	.0000E+00	.0000E+00
243		0.00	0.000	0.169	0.1865	0.0000	.0000E+00	.3234E-03
244		0.00	0.000	0.132	0.1810	0.0000	.0000E+00	.0000E+00
245	*	0.00	0.000	0.069	0.1782	0.0000	.0000E+00	.0000E+00
246	*	0.00	0.000	0.049	0.1761	0.0000	.0000E+00	.0000E+00
247		0.05	0.000	0.126	0.1730	0.0000	.0000E+00	.0000E+00
248		0.00	0.000	0.083	0.1695	0.0000	.0000E+00	.0000E+00
249		0.00	0.000	0.012	0.1690	0.0000	.0000E+00	.0000E+00
250		0.00	0.000	0.006	0.1688	0.0000	.0000E+00	.0000E+00
251		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
252		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
253		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
254		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
255		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
256		0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
257		0.22	0.000	0.039	0.1763	0.0000	.0000E+00	.0000E+00
258		0.00	0.000	0.034	0.1749	0.0000	.0000E+00	.0000E+00
259		0.00	0.000	0.045	0.1730	0.0000	.0000E+00	.0000E+00
260		0.00	0.000	0.044	0.1712	0.0000	.0000E+00	.0000E+00
261		0.02	0.000	0.033	0.1706	0.0000	.0000E+00	.0000E+00
262	*	0.00	0.000	0.000	0.1706	0.0000	.0000E+00	.0000E+00
263		0.00	0.000	0.007	0.1703	0.0000	.0000E+00	.0000E+00
264		0.00	0.000	0.010	0.1699	0.0000	.0000E+00	.0000E+00
265		0.00	0.000	0.010	0.1695	0.0000	.0000E+00	.0000E+00
266		0.00	0.000	0.009	0.1691	0.0000	.0000E+00	.0000E+00
267		0.00	0.000	0.007	0.1688	0.0000	.0000E+00	.0000E+00
268		0.15	0.000	0.038	0.1735	0.0000	.0000E+00	.0000E+00
269		0.00	0.000	0.004	0.1733	0.0000	.0000E+00	.0000E+00
270		0.00	0.000	0.020	0.1725	0.0000	.0000E+00	.0000E+00
271		0.00	0.000	0.021	0.1716	0.0000	.0000E+00	.0000E+00
272		0.12	0.000	0.040	0.1749	0.0000	.0000E+00	.0000E+00
273		0.00	0.000	0.017	0.1742	0.0000	.0000E+00	.0000E+00
274		0.00	0.000	0.016	0.1735	0.0000	.0000E+00	.0000E+00
275		0.00	0.000	0.019	0.1728	0.0000	.0000E+00	.0000E+00
276		0.00	0.000	0.020	0.1719	0.0000	.0000E+00	.0000E+00
277		0.00	0.000	0.018	0.1711	0.0000	.0000E+00	.0000E+00
278		0.00	0.000	0.006	0.1709	0.0000	.0000E+00	.0000E+00
279		0.00	0.000	0.006	0.1706	0.0000	.0000E+00	.0000E+00
280		0.00	0.000	0.005	0.1704	0.0000	.0000E+00	.0000E+00
281		0.00	0.000	0.005	0.1702	0.0000	.0000E+00	.0000E+00
282		0.00	0.000	0.005	0.1700	0.0000	.0000E+00	.0000E+00
283		0.00	0.000	0.005	0.1698	0.0000	.0000E+00	.0000E+00
284		0.00	0.000	0.005	0.1696	0.0000	.0000E+00	.0000E+00
285		0.00	0.000	0.005	0.1694	0.0000	.0000E+00	.0000E+00
286		0.00	0.000	0.004	0.1692	0.0000	.0000E+00	.0000E+00
287		0.00	0.000	0.004	0.1690	0.0000	.0000E+00	.0000E+00
288		0.09	0.000	0.034	0.1714	0.0000	.0000E+00	.0000E+00
289		0.00	0.000	0.003	0.1713	0.0000	.0000E+00	.0000E+00
290		0.00	0.000	0.004	0.1711	0.0000	.0000E+00	.0000E+00
291	*	0.00	0.000	0.000	0.1711	0.0000	.0000E+00	.0000E+00
292		0.00	0.000	0.004	0.1709	0.0000	.0000E+00	.0000E+00

293		0.00	0.000	0.004	0.1707	0.0000	.0000E+00	.0000E+00
294		0.00	0.000	0.003	0.1706	0.0000	.0000E+00	.0000E+00
295		0.00	0.000	0.003	0.1705	0.0000	.0000E+00	.0000E+00
296		0.17	0.000	0.036	0.1760	0.0000	.0000E+00	.0000E+00
297		0.00	0.000	0.008	0.1757	0.0000	.0000E+00	.0000E+00
298		0.00	0.000	0.007	0.1754	0.0000	.0000E+00	.0000E+00
299		0.00	0.000	0.008	0.1751	0.0000	.0000E+00	.0000E+00
300		0.00	0.000	0.009	0.1747	0.0000	.0000E+00	.0000E+00
301		0.00	0.000	0.009	0.1743	0.0000	.0000E+00	.0000E+00
302		0.00	0.000	0.009	0.1740	0.0000	.0000E+00	.0000E+00
303		0.00	0.000	0.009	0.1736	0.0000	.0000E+00	.0000E+00
304		0.00	0.000	0.009	0.1732	0.0000	.0000E+00	.0000E+00
305		0.35	0.000	0.042	0.1860	0.0000	.0000E+00	.0000E+00
306		0.00	0.000	0.007	0.1858	0.0000	.0000E+00	.0000E+00
307		0.00	0.000	0.005	0.1855	0.0000	.0000E+00	.0000E+00
308		0.00	0.000	0.005	0.1853	0.0000	.0000E+00	.0000E+00
309		0.11	0.000	0.039	0.1883	0.0000	.0000E+00	.0000E+00
310		0.14	0.000	0.041	0.1924	0.0000	.0000E+00	.0000E+00
311		0.00	0.000	0.005	0.1922	0.0000	.0000E+00	.0000E+00
312		0.00	0.000	0.008	0.1918	0.0000	.0000E+00	.0000E+00
313		0.00	0.000	0.008	0.1915	0.0000	.0000E+00	.0000E+00
314		0.00	0.000	0.008	0.1912	0.0000	.0000E+00	.0000E+00
315		0.00	0.000	0.008	0.1908	0.0000	.0000E+00	.0000E+00
316		0.00	0.000	0.008	0.1905	0.0000	.0000E+00	.0000E+00
317		0.00	0.000	0.008	0.1902	0.0000	.0000E+00	.0000E+00
318		0.00	0.000	0.008	0.1898	0.0000	.0000E+00	.0000E+00
319		0.00	0.000	0.008	0.1895	0.0000	.0000E+00	.0000E+00
320		0.00	0.000	0.008	0.1892	0.0000	.0000E+00	.0000E+00
321		0.00	0.000	0.008	0.1889	0.0000	.0000E+00	.0000E+00
322		0.00	0.000	0.008	0.1886	0.0000	.0000E+00	.0000E+00
323		0.00	0.000	0.008	0.1882	0.0000	.0000E+00	.0000E+00
324		0.00	0.000	0.008	0.1879	0.0000	.0000E+00	.0000E+00
325		0.00	0.000	0.007	0.1876	0.0000	.0000E+00	.0000E+00
326		0.00	0.000	0.007	0.1873	0.0000	.0000E+00	.0000E+00
327		0.00	0.000	0.007	0.1870	0.0000	.0000E+00	.0000E+00
328		0.00	0.000	0.007	0.1867	0.0000	.0000E+00	.0000E+00
329		0.00	0.000	0.007	0.1864	0.0000	.0000E+00	.0000E+00
330		0.00	0.000	0.007	0.1861	0.0000	.0000E+00	.0000E+00
331	*	0.00	0.000	0.007	0.1858	0.0000	.0000E+00	.0000E+00
332		0.00	0.000	0.007	0.1855	0.0000	.0000E+00	.0000E+00
333		0.00	0.000	0.007	0.1852	0.0000	.0000E+00	.0000E+00
334		0.00	0.000	0.007	0.1849	0.0000	.0000E+00	.0000E+00
335		0.00	0.000	0.007	0.1846	0.0000	.0000E+00	.0000E+00
336		0.00	0.000	0.007	0.1843	0.0000	.0000E+00	.0000E+00
337		0.00	0.000	0.007	0.1840	0.0000	.0000E+00	.0000E+00
338		0.00	0.000	0.007	0.1837	0.0000	.0000E+00	.0000E+00
339		0.00	0.000	0.007	0.1834	0.0000	.0000E+00	.0000E+00
340		0.00	0.000	0.007	0.1832	0.0000	.0000E+00	.0000E+00
341		0.00	0.000	0.007	0.1829	0.0000	.0000E+00	.0000E+00
342		0.00	0.000	0.007	0.1826	0.0000	.0000E+00	.0000E+00
343		0.00	0.000	0.007	0.1823	0.0000	.0000E+00	.0000E+00
344		0.00	0.000	0.007	0.1820	0.0000	.0000E+00	.0000E+00
345		0.00	0.000	0.007	0.1818	0.0000	.0000E+00	.0000E+00
346		0.00	0.000	0.007	0.1815	0.0000	.0000E+00	.0000E+00
347		0.67	0.000	0.034	0.2080	0.0000	.0000E+00	.0000E+00
348	*	0.45	0.000	0.051	0.2088	0.0000	.0000E+00	.0000E+00
349	*	0.00	0.000	0.052	0.2096	0.0000	.0000E+00	.0000E+00
350	*	0.00	0.000	0.043	0.2104	0.0000	.0000E+00	.0000E+00
351		0.00	0.000	0.074	0.2113	0.0000	.0000E+00	.0000E+00
352		0.11	0.000	0.081	0.2188	0.0000	.0000E+00	.0000E+00
353		0.01	0.000	0.041	0.2175	0.0000	.0000E+00	.5096E-07
354		0.00	0.000	0.032	0.2162	0.0000	.0000E+00	.0000E+00
355		0.00	0.000	0.029	0.2150	0.0000	.0000E+00	.0000E+00

356		0.00	0.000	0.038	0.2134	0.0000	.0000E+00	.0000E+00
357		0.00	0.000	0.047	0.2114	0.0000	.0000E+00	.0000E+00
358		0.00	0.000	0.043	0.2096	0.0000	.0000E+00	.0000E+00
359		0.00	0.000	0.039	0.2080	0.0000	.0000E+00	.0000E+00
360	*	0.50	0.000	0.048	0.2089	0.0000	.0000E+00	.0000E+00
361	*	0.02	0.000	0.030	0.2097	0.0000	.0000E+00	.0000E+00
362	*	0.00	0.000	0.035	0.2105	0.0000	.0000E+00	.0000E+00
363	*	0.00	0.000	0.040	0.2113	0.0000	.0000E+00	.0000E+00
364		0.00	0.000	0.056	0.2121	0.0000	.0000E+00	.0000E+00
365		0.00	0.000	0.064	0.2183	0.0000	.0000E+00	.0000E+00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1987

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.21	0.73	0.60	0.09	0.81	1.95
	0.58	3.63	0.56	0.26	0.60	1.76
RUNOFF	0.000	0.000	0.000	0.000	0.000	0.092
	0.000	0.256	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.860	0.452	0.411	0.400	0.803	1.923
	1.077	3.134	0.856	0.283	0.320	0.958
PERCOLATION/LEAKAGE THROUGH	0.0039	0.0000	0.0001	0.0000	0.0000	0.0000
LAYER 2	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000

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ANNUAL TOTALS FOR YEAR 1987

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.78	1710456.120	100.00
RUNOFF	0.347	50409.484	2.95
EVAPOTRANSPIRATION	11.476	1666360.120	97.42
PERC./LEAKAGE THROUGH LAYER 2	0.004359	632.910	0.04
CHANGE IN WATER STORAGE	-0.048	-6945.831	-0.41
SOIL WATER AT START OF YEAR	5.287	767681.750	
SOIL WATER AT END OF YEAR	5.239	760735.937	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE 0.0000 -0.645 0.00

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LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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DAILY OUTPUT FOR YEAR 1988

DAY	AIR	SOIL	RAIN IN.	RUNOFF IN.	ET IN.	E. ZONE WATER IN./IN.	HEAD #1 IN.	DRAIN #1 IN.	LEAK #1 IN.
1			0.00	0.000	0.035	0.2169	0.0000	.0000E+00	.2252E-07
2			0.00	0.000	0.036	0.2154	0.0000	.0000E+00	.0000E+00
3			0.00	0.000	0.033	0.2140	0.0000	.0000E+00	.0000E+00
4			0.00	0.000	0.031	0.2127	0.0000	.0000E+00	.0000E+00
5			0.00	0.000	0.031	0.2114	0.0000	.0000E+00	.0000E+00
6			0.12	0.000	0.054	0.2141	0.0000	.0000E+00	.5145E-04
7			0.00	0.000	0.024	0.2131	0.0000	.0000E+00	.0000E+00
8			0.00	0.000	0.023	0.2122	0.0000	.0000E+00	.0000E+00
9			0.00	0.000	0.025	0.2111	0.0000	.0000E+00	.0000E+00
10			0.00	0.000	0.024	0.2101	0.0000	.0000E+00	.0000E+00
11			0.00	0.000	0.022	0.2092	0.0000	.0000E+00	.0000E+00
12			0.00	0.000	0.021	0.2083	0.0000	.0000E+00	.0000E+00
13			0.00	0.000	0.020	0.2075	0.0000	.0000E+00	.0000E+00
14			0.00	0.000	0.019	0.2067	0.0000	.0000E+00	.0000E+00
15			0.00	0.000	0.018	0.2060	0.0000	.0000E+00	.0000E+00
16			0.00	0.000	0.018	0.2052	0.0000	.0000E+00	.0000E+00
17			0.00	0.000	0.018	0.2045	0.0000	.0000E+00	.0000E+00
18			0.08	0.000	0.043	0.2060	0.0000	.0000E+00	.0000E+00
19			0.00	0.000	0.017	0.2053	0.0000	.0000E+00	.0000E+00
20	*		0.02	0.000	0.036	0.2046	0.0000	.0000E+00	.0000E+00
21	*		0.00	0.000	0.016	0.2040	0.0000	.0000E+00	.0000E+00
22			0.00	0.000	0.016	0.2033	0.0000	.0000E+00	.0000E+00
23	*		0.00	0.000	0.016	0.2027	0.0000	.0000E+00	.0000E+00
24			0.00	0.000	0.015	0.2020	0.0000	.0000E+00	.0000E+00
25	*		0.00	0.000	0.015	0.2014	0.0000	.0000E+00	.0000E+00
26			0.00	0.000	0.015	0.2008	0.0000	.0000E+00	.0000E+00
27			0.00	0.000	0.015	0.2002	0.0000	.0000E+00	.0000E+00
28			0.00	0.000	0.015	0.1996	0.0000	.0000E+00	.0000E+00
29			0.00	0.000	0.015	0.1989	0.0000	.0000E+00	.0000E+00
30			0.00	0.000	0.015	0.1983	0.0000	.0000E+00	.0000E+00
31			0.00	0.000	0.015	0.1977	0.0000	.0000E+00	.0000E+00
32			0.00	0.000	0.015	0.1970	0.0000	.0000E+00	.0000E+00
33			0.00	0.000	0.014	0.1964	0.0000	.0000E+00	.0000E+00
34			0.00	0.000	0.014	0.1959	0.0000	.0000E+00	.0000E+00
35			0.02	0.000	0.028	0.1955	0.0000	.0000E+00	.3496E-05
36			1.21	0.050	0.040	0.2422	0.0000	.0000E+00	.0000E+00
37			0.00	0.000	0.046	0.2403	0.0000	.0000E+00	.1627E-04
38			0.00	0.000	0.058	0.2378	0.0000	.0000E+00	.0000E+00
39			0.00	0.000	0.054	0.2356	0.0000	.0000E+00	.0000E+00
40			0.00	0.000	0.060	0.2331	0.0000	.0000E+00	.0000E+00
41			0.00	0.000	0.057	0.2307	0.0000	.0000E+00	.0000E+00

42	0.00	0.000	0.066	0.2279	0.0000	.0000E+00	.0000E+00
43	0.00	0.000	0.068	0.2251	0.0000	.0000E+00	.0000E+00
44	0.00	0.000	0.072	0.2221	0.0000	.0000E+00	.0000E+00
45	0.00	0.000	0.071	0.2191	0.0000	.0000E+00	.0000E+00
46	0.00	0.000	0.058	0.2167	0.0000	.0000E+00	.0000E+00
47	0.00	0.000	0.050	0.2147	0.0000	.0000E+00	.0000E+00
48	0.00	0.000	0.043	0.2129	0.0000	.0000E+00	.9419E-04
49	0.14	0.000	0.066	0.2159	0.0000	.0000E+00	.0000E+00
50	0.00	0.000	0.036	0.2144	0.0000	.0000E+00	.1050E-03
51	0.00	0.000	0.033	0.2131	0.0000	.0000E+00	.0000E+00
52	0.00	0.000	0.033	0.2117	0.0000	.0000E+00	.0000E+00
53	0.00	0.000	0.031	0.2104	0.0000	.0000E+00	.2224E-04
54	0.00	0.000	0.028	0.2092	0.0000	.0000E+00	.0000E+00
55	0.00	0.000	0.027	0.2081	0.0000	.0000E+00	.0000E+00
56	0.00	0.000	0.026	0.2070	0.0000	.0000E+00	.0000E+00
57	0.00	0.000	0.025	0.2060	0.0000	.0000E+00	.0000E+00
58	0.00	0.000	0.024	0.2050	0.0000	.0000E+00	.0000E+00
59	0.00	0.000	0.023	0.2041	0.0000	.0000E+00	.0000E+00
60	0.00	0.000	0.022	0.2031	0.0000	.0000E+00	.0000E+00
61	0.00	0.000	0.022	0.2022	0.0000	.0000E+00	.0000E+00
62	0.00	0.000	0.021	0.2013	0.0000	.0000E+00	.0000E+00
63	0.10	0.000	0.047	0.2036	0.0000	.0000E+00	.0000E+00
64	0.00	0.000	0.021	0.2027	0.0000	.0000E+00	.0000E+00
65	0.00	0.000	0.021	0.2018	0.0000	.0000E+00	.0000E+00
66	0.00	0.000	0.020	0.2010	0.0000	.0000E+00	.0000E+00
67	0.00	0.000	0.020	0.2001	0.0000	.0000E+00	.0000E+00
68	0.00	0.000	0.020	0.1993	0.0000	.0000E+00	.0000E+00
69	0.00	0.000	0.020	0.1985	0.0000	.0000E+00	.0000E+00
70	0.00	0.000	0.019	0.1977	0.0000	.0000E+00	.0000E+00
71	0.00	0.000	0.017	0.1970	0.0000	.0000E+00	.2390E-07
72	0.00	0.000	0.017	0.1963	0.0000	.0000E+00	.0000E+00
73	0.00	0.000	0.017	0.1956	0.0000	.0000E+00	.0000E+00
74	0.00	0.000	0.017	0.1949	0.0000	.0000E+00	.0000E+00
75	0.00	0.000	0.016	0.1942	0.0000	.0000E+00	.0000E+00
76	0.00	0.000	0.016	0.1935	0.0000	.0000E+00	.0000E+00
77	0.00	0.000	0.016	0.1929	0.0000	.0000E+00	.0000E+00
78	0.00	0.000	0.016	0.1922	0.0000	.0000E+00	.0000E+00
79	0.00	0.000	0.015	0.1916	0.0000	.0000E+00	.0000E+00
80	0.00	0.000	0.015	0.1909	0.0000	.0000E+00	.0000E+00
81	0.00	0.000	0.015	0.1903	0.0000	.0000E+00	.0000E+00
82	0.00	0.000	0.015	0.1897	0.0000	.0000E+00	.0000E+00
83	0.00	0.000	0.016	0.1890	0.0000	.0000E+00	.0000E+00
84	0.00	0.000	0.016	0.1884	0.0000	.0000E+00	.0000E+00
85	0.00	0.000	0.016	0.1877	0.0000	.0000E+00	.0000E+00
86	0.00	0.000	0.015	0.1871	0.0000	.0000E+00	.0000E+00
87	0.00	0.000	0.016	0.1864	0.0000	.0000E+00	.0000E+00
88	0.00	0.000	0.014	0.1859	0.0000	.0000E+00	.0000E+00
89	0.00	0.000	0.015	0.1852	0.0000	.0000E+00	.0000E+00
90	0.00	0.000	0.014	0.1847	0.0000	.0000E+00	.0000E+00
91	0.00	0.000	0.014	0.1841	0.0000	.0000E+00	.0000E+00
92	0.00	0.000	0.014	0.1835	0.0000	.0000E+00	.0000E+00
93	0.00	0.000	0.014	0.1829	0.0000	.0000E+00	.0000E+00
94	0.00	0.000	0.014	0.1823	0.0000	.0000E+00	.0000E+00
95	0.00	0.000	0.014	0.1817	0.0000	.0000E+00	.0000E+00
96	0.00	0.000	0.014	0.1811	0.0000	.0000E+00	.0000E+00
97	0.00	0.000	0.014	0.1805	0.0000	.0000E+00	.0000E+00
98	0.00	0.000	0.014	0.1799	0.0000	.0000E+00	.0000E+00
99	0.00	0.000	0.014	0.1793	0.0000	.0000E+00	.0000E+00
100	0.00	0.000	0.015	0.1787	0.0000	.0000E+00	.0000E+00
101	0.00	0.000	0.014	0.1781	0.0000	.0000E+00	.0000E+00
102	0.00	0.000	0.014	0.1776	0.0000	.0000E+00	.0000E+00
103	0.00	0.000	0.014	0.1770	0.0000	.0000E+00	.0000E+00
104	0.00	0.000	0.015	0.1764	0.0000	.0000E+00	.0000E+00

105	0.00	0.000	0.015	0.1757	0.0000	.0000E+00	.0000E+00
106	0.00	0.000	0.015	0.1751	0.0000	.0000E+00	.0000E+00
107	0.04	0.000	0.036	0.1753	0.0000	.0000E+00	.0000E+00
108	0.00	0.000	0.014	0.1747	0.0000	.0000E+00	.0000E+00
109	0.00	0.000	0.014	0.1741	0.0000	.0000E+00	.0000E+00
110	0.00	0.000	0.015	0.1735	0.0000	.0000E+00	.0000E+00
111	0.00	0.000	0.016	0.1728	0.0000	.0000E+00	.0000E+00
112	0.00	0.000	0.016	0.1722	0.0000	.0000E+00	.0000E+00
113	0.00	0.000	0.016	0.1715	0.0000	.0000E+00	.0000E+00
114	0.00	0.000	0.016	0.1708	0.0000	.0000E+00	.0000E+00
115	0.00	0.000	0.016	0.1701	0.0000	.0000E+00	.0000E+00
116	0.00	0.000	0.017	0.1695	0.0000	.0000E+00	.0000E+00
117	0.00	0.000	0.014	0.1689	0.0000	.0000E+00	.0000E+00
118	0.00	0.000	0.003	0.1688	0.0000	.0000E+00	.0000E+00
119	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
120	0.04	0.000	0.023	0.1695	0.0000	.0000E+00	.0000E+00
121	0.00	0.000	0.002	0.1694	0.0000	.0000E+00	.0000E+00
122	0.00	0.000	0.003	0.1693	0.0000	.0000E+00	.0000E+00
123	0.00	0.000	0.003	0.1691	0.0000	.0000E+00	.0000E+00
124	0.00	0.000	0.003	0.1690	0.0000	.0000E+00	.0000E+00
125	0.00	0.000	0.003	0.1689	0.0000	.0000E+00	.0000E+00
126	0.00	0.000	0.003	0.1688	0.0000	.0000E+00	.0000E+00
127	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
128	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
129	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
130	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
131	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
132	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
133	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
134	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
135	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
136	0.00	0.000	0.000	0.1688	0.0000	.0000E+00	.0000E+00
137	0.13	0.000	0.030	0.1729	0.0000	.0000E+00	.0000E+00
138	0.00	0.000	0.002	0.1729	0.0000	.0000E+00	.0000E+00
139	0.00	0.000	0.008	0.1725	0.0000	.0000E+00	.0000E+00
140	0.00	0.000	0.008	0.1722	0.0000	.0000E+00	.0000E+00
141	0.00	0.000	0.009	0.1719	0.0000	.0000E+00	.0000E+00
142	0.00	0.000	0.010	0.1714	0.0000	.0000E+00	.0000E+00
143	0.00	0.000	0.005	0.1712	0.0000	.0000E+00	.0000E+00
144	0.00	0.000	0.004	0.1711	0.0000	.0000E+00	.0000E+00
145	0.00	0.000	0.004	0.1709	0.0000	.0000E+00	.0000E+00
146	0.05	0.000	0.026	0.1719	0.0000	.0000E+00	.0000E+00
147	0.00	0.000	0.003	0.1718	0.0000	.0000E+00	.0000E+00
148	0.00	0.000	0.006	0.1715	0.0000	.0000E+00	.0000E+00
149	0.00	0.000	0.005	0.1713	0.0000	.0000E+00	.0000E+00
150	0.00	0.000	0.004	0.1711	0.0000	.0000E+00	.0000E+00
151	0.00	0.000	0.004	0.1710	0.0000	.0000E+00	.0000E+00
152	0.00	0.000	0.004	0.1708	0.0000	.0000E+00	.0000E+00
153	0.00	0.000	0.003	0.1707	0.0000	.0000E+00	.0000E+00
154	0.00	0.000	0.004	0.1705	0.0000	.0000E+00	.0000E+00
155	0.00	0.000	0.004	0.1704	0.0000	.0000E+00	.0000E+00
156	0.00	0.000	0.004	0.1702	0.0000	.0000E+00	.0000E+00
157	0.00	0.000	0.004	0.1701	0.0000	.0000E+00	.0000E+00
158	0.00	0.000	0.004	0.1699	0.0000	.0000E+00	.0000E+00
159	0.00	0.000	0.004	0.1698	0.0000	.0000E+00	.0000E+00
160	0.00	0.000	0.004	0.1696	0.0000	.0000E+00	.0000E+00
161	0.00	0.000	0.003	0.1695	0.0000	.0000E+00	.0000E+00
162	0.00	0.000	0.003	0.1693	0.0000	.0000E+00	.0000E+00
163	0.15	0.000	0.031	0.1743	0.0000	.0000E+00	.0000E+00
164	0.00	0.000	0.003	0.1742	0.0000	.0000E+00	.0000E+00
165	0.00	0.000	0.009	0.1738	0.0000	.0000E+00	.0000E+00
166	0.00	0.000	0.009	0.1734	0.0000	.0000E+00	.0000E+00
167	0.76	0.000	0.040	0.2034	0.0000	.0000E+00	.0000E+00

168		0.00	0.000	0.009	0.2030	0.0000	.0000E+00	.0000E+00
169		0.00	0.000	0.015	0.2024	0.0000	.0000E+00	.0000E+00
170		0.00	0.000	0.016	0.2017	0.0000	.0000E+00	.0000E+00
171		0.00	0.000	0.016	0.2011	0.0000	.0000E+00	.0000E+00
172		0.00	0.000	0.016	0.2004	0.0000	.0000E+00	.0000E+00
173		0.00	0.000	0.017	0.1997	0.0000	.0000E+00	.0000E+00
174		0.00	0.000	0.018	0.1989	0.0000	.0000E+00	.0000E+00
175		0.00	0.000	0.017	0.1982	0.0000	.0000E+00	.0000E+00
176		0.00	0.000	0.017	0.1975	0.0000	.0000E+00	.0000E+00
177		0.33	0.000	0.046	0.2094	0.0000	.0000E+00	.0000E+00
178		0.00	0.000	0.021	0.2085	0.0000	.0000E+00	.0000E+00
179		0.00	0.000	0.021	0.2076	0.0000	.0000E+00	.0000E+00
180		0.00	0.000	0.020	0.2068	0.0000	.0000E+00	.0000E+00
181		0.00	0.000	0.020	0.2059	0.0000	.0000E+00	.0000E+00
182		0.00	0.000	0.021	0.2051	0.0000	.0000E+00	.0000E+00
183		0.00	0.000	0.020	0.2042	0.0000	.0000E+00	.0000E+00
184		0.00	0.000	0.018	0.2035	0.0000	.0000E+00	.0000E+00
185		0.00	0.000	0.021	0.2026	0.0000	.0000E+00	.0000E+00
186		0.02	0.000	0.035	0.2020	0.0000	.0000E+00	.0000E+00
187		0.00	0.000	0.022	0.2010	0.0000	.0000E+00	.0000E+00
188		0.51	0.000	0.052	0.2201	0.0000	.0000E+00	.0000E+00
189		0.00	0.000	0.027	0.2190	0.0000	.0000E+00	.0000E+00
190		0.00	0.000	0.025	0.2179	0.0000	.0000E+00	.0000E+00
191	*	0.38	0.000	0.082	0.2188	0.0000	.0000E+00	.0000E+00
192		0.07	0.000	0.281	0.2216	0.0000	.0000E+00	.0000E+00
193		0.00	0.000	0.028	0.2204	0.0000	.0000E+00	.0000E+00
194		0.00	0.000	0.034	0.2189	0.0000	.0000E+00	.3995E-07
195		0.00	0.000	0.032	0.2176	0.0000	.0000E+00	.0000E+00
196		0.00	0.000	0.035	0.2161	0.0000	.0000E+00	.0000E+00
197		0.00	0.000	0.035	0.2147	0.0000	.0000E+00	.0000E+00
198		0.00	0.000	0.037	0.2131	0.0000	.0000E+00	.0000E+00
199		0.31	0.000	0.068	0.2232	0.0000	.0000E+00	.0000E+00
200		0.00	0.000	0.037	0.2217	0.0000	.0000E+00	.0000E+00
201		0.15	0.000	0.073	0.2249	0.0000	.0000E+00	.0000E+00
202		0.00	0.000	0.182	0.2173	0.0000	.0000E+00	.0000E+00
203		0.00	0.000	0.043	0.2155	0.0000	.0000E+00	.0000E+00
204		0.00	0.000	0.048	0.2135	0.0000	.0000E+00	.0000E+00
205		0.00	0.000	0.048	0.2115	0.0000	.0000E+00	.0000E+00
206		0.00	0.000	0.053	0.2093	0.0000	.0000E+00	.0000E+00
207		0.00	0.000	0.048	0.2073	0.0000	.0000E+00	.0000E+00
208		0.00	0.000	0.047	0.2053	0.0000	.0000E+00	.0000E+00
209		0.00	0.000	0.049	0.2033	0.0000	.0000E+00	.0000E+00
210		0.00	0.000	0.047	0.2013	0.0000	.0000E+00	.0000E+00
211		0.00	0.000	0.049	0.1993	0.0000	.0000E+00	.0000E+00
212		0.00	0.000	0.051	0.1972	0.0000	.0000E+00	.0000E+00
213		0.00	0.000	0.049	0.1951	0.0000	.0000E+00	.0000E+00
214		0.00	0.000	0.049	0.1931	0.0000	.0000E+00	.0000E+00
215		0.05	0.000	0.069	0.1923	0.0000	.0000E+00	.0000E+00
216		0.10	0.000	0.088	0.1928	0.0000	.0000E+00	.0000E+00
217		0.98	0.013	0.086	0.2295	0.0000	.0000E+00	.0000E+00
218		0.00	0.000	0.178	0.2221	0.0000	.0000E+00	.0000E+00
219		0.83	0.013	0.193	0.2480	0.0000	.0000E+00	.0000E+00
220		0.57	0.002	0.249	0.2613	0.0000	.0000E+00	.0000E+00
221		2.25	0.784	0.146	0.3163	0.0000	.0000E+00	.7272E-03
222		0.00	0.000	0.170	0.3092	0.0000	.0000E+00	.0000E+00
223		0.00	0.000	0.208	0.3005	0.0000	.0000E+00	.0000E+00
224		0.35	0.000	0.198	0.3068	0.0000	.0000E+00	.0000E+00
225		0.00	0.000	0.170	0.2998	0.0000	.0000E+00	.0000E+00
226	*	0.00	0.000	0.107	0.2953	0.0000	.0000E+00	.0000E+00
227		0.25	0.000	0.252	0.2952	0.0000	.0000E+00	.0000E+00
228		1.22	0.149	0.264	0.3288	0.0000	.0000E+00	.0000E+00
229	*	1.22	0.000	0.071	0.3296	0.0000	.0000E+00	.0000E+00
230		0.13	0.257	0.100	0.3672	0.0000	.0000E+00	.0000E+00

231		0.00	0.000	0.186	0.3593	0.0000	.0000E+00	.3764E-02
232		0.00	0.000	0.227	0.3499	0.0000	.0000E+00	.0000E+00
233		0.00	0.000	0.223	0.3376	0.0000	.0000E+00	.7296E-01
234		0.00	0.000	0.181	0.3251	0.0000	.0000E+00	.1182
235		0.00	0.000	0.193	0.3129	0.0000	.0000E+00	.9845E-01
236	*	0.46	0.000	0.072	0.3108	0.0000	.0000E+00	.7032E-01
237		0.00	0.000	0.073	0.3095	0.0000	.0000E+00	.5830E-01
238		0.00	0.000	0.277	0.3069	0.0000	.0000E+00	.5294E-01
239		0.59	0.000	0.248	0.3192	0.0000	.0000E+00	.4759E-01
240		0.20	0.000	0.200	0.3177	0.0000	.0000E+00	.3554E-01
241		0.20	0.000	0.198	0.3165	0.0000	.0000E+00	.3234E-01
242		0.38	0.000	0.183	0.3236	0.0000	.0000E+00	.2588E-01
243		0.00	0.000	0.167	0.3153	0.0000	.0000E+00	.3146E-01
244		0.00	0.000	0.179	0.3066	0.0000	.0000E+00	.2908E-01
245		0.00	0.000	0.172	0.2984	0.0000	.0000E+00	.2559E-01
246		0.10	0.000	0.172	0.2944	0.0000	.0000E+00	.2258E-01
247		0.00	0.000	0.145	0.2875	0.0000	.0000E+00	.2148E-01
248		0.00	0.000	0.144	0.2805	0.0000	.0000E+00	.2394E-01
249		0.00	0.000	0.130	0.2743	0.0000	.0000E+00	.1822E-01
250		0.00	0.000	0.116	0.2689	0.0000	.0000E+00	.1455E-01
251		0.00	0.000	0.120	0.2633	0.0000	.0000E+00	.1250E-01
252		0.00	0.000	0.127	0.2576	0.0000	.0000E+00	.1112E-01
253		0.00	0.000	0.119	0.2522	0.0000	.0000E+00	.9619E-02
254		0.00	0.000	0.129	0.2465	0.0000	.0000E+00	.8984E-02
255		0.00	0.000	0.121	0.2414	0.0000	.0000E+00	.1116E-02
256		0.00	0.000	0.100	0.2372	0.0000	.0000E+00	.0000E+00
257		0.00	0.000	0.079	0.2339	0.0000	.0000E+00	.0000E+00
258		0.00	0.000	0.067	0.2311	0.0000	.0000E+00	.0000E+00
259		0.00	0.000	0.058	0.2287	0.0000	.0000E+00	.0000E+00
260		0.00	0.000	0.053	0.2265	0.0000	.0000E+00	.0000E+00
261		0.00	0.000	0.049	0.2245	0.0000	.0000E+00	.0000E+00
262		0.00	0.000	0.045	0.2226	0.0000	.0000E+00	.0000E+00
263		0.00	0.000	0.042	0.2209	0.0000	.0000E+00	.0000E+00
264		0.00	0.000	0.039	0.2193	0.0000	.0000E+00	.0000E+00
265		0.77	0.000	0.072	0.2484	0.0000	.0000E+00	.0000E+00
266		0.00	0.000	0.115	0.2435	0.0000	.0000E+00	.0000E+00
267		0.06	0.000	0.062	0.2434	0.0000	.0000E+00	.0000E+00
268		0.00	0.000	0.033	0.2421	0.0000	.0000E+00	.0000E+00
269		0.00	0.000	0.031	0.2408	0.0000	.0000E+00	.0000E+00
270		0.00	0.000	0.029	0.2396	0.0000	.0000E+00	.0000E+00
271		0.00	0.000	0.028	0.2384	0.0000	.0000E+00	.0000E+00
272		0.00	0.000	0.027	0.2373	0.0000	.0000E+00	.0000E+00
273		0.00	0.000	0.026	0.2362	0.0000	.0000E+00	.0000E+00
274		0.00	0.000	0.025	0.2352	0.0000	.0000E+00	.0000E+00
275		0.00	0.000	0.024	0.2342	0.0000	.0000E+00	.0000E+00
276		0.00	0.000	0.023	0.2332	0.0000	.0000E+00	.0000E+00
277		0.00	0.000	0.022	0.2323	0.0000	.0000E+00	.0000E+00
278		0.00	0.000	0.022	0.2314	0.0000	.0000E+00	.0000E+00
279		0.00	0.000	0.021	0.2305	0.0000	.0000E+00	.0000E+00
280		0.00	0.000	0.020	0.2297	0.0000	.0000E+00	.0000E+00
281		0.00	0.000	0.020	0.2289	0.0000	.0000E+00	.0000E+00
282		0.00	0.000	0.019	0.2280	0.0000	.0000E+00	.0000E+00
283		0.05	0.000	0.043	0.2283	0.0000	.0000E+00	.0000E+00
284		0.06	0.000	0.045	0.2290	0.0000	.0000E+00	.0000E+00
285		0.00	0.000	0.018	0.2282	0.0000	.0000E+00	.0000E+00
286		0.00	0.000	0.018	0.2274	0.0000	.0000E+00	.0000E+00
287		0.00	0.000	0.018	0.2267	0.0000	.0000E+00	.7017E-03
288		0.00	0.000	0.017	0.2259	0.0000	.0000E+00	.2168E-02
289		0.00	0.000	0.017	0.2251	0.0000	.0000E+00	.1515E-02
290		0.00	0.000	0.017	0.2244	0.0000	.0000E+00	.0000E+00
291		0.00	0.000	0.017	0.2237	0.0000	.0000E+00	.0000E+00
292		0.00	0.000	0.017	0.2230	0.0000	.0000E+00	.0000E+00
293		0.00	0.000	0.017	0.2223	0.0000	.0000E+00	.0000E+00

294	0.00	0.000	0.017	0.2216	0.0000	.0000E+00	.0000E+00
295	0.12	0.000	0.044	0.2248	0.0000	.0000E+00	.0000E+00
296	0.00	0.000	0.017	0.2241	0.0000	.0000E+00	.0000E+00
297	0.00	0.000	0.017	0.2234	0.0000	.0000E+00	.0000E+00
298	0.00	0.000	0.017	0.2227	0.0000	.0000E+00	.0000E+00
299	0.00	0.000	0.016	0.2219	0.0000	.0000E+00	.1729E-02
300	0.00	0.000	0.017	0.2212	0.0000	.0000E+00	.1611E-02
301	0.00	0.000	0.017	0.2204	0.0000	.0000E+00	.8942E-03
302	0.00	0.000	0.016	0.2197	0.0000	.0000E+00	.1576E-02
303	0.00	0.000	0.016	0.2190	0.0000	.0000E+00	.0000E+00
304	0.00	0.000	0.016	0.2183	0.0000	.0000E+00	.0000E+00
305	0.00	0.000	0.017	0.2176	0.0000	.0000E+00	.0000E+00
306	0.00	0.000	0.016	0.2169	0.0000	.0000E+00	.0000E+00
307	0.00	0.000	0.017	0.2162	0.0000	.0000E+00	.0000E+00
308	0.00	0.000	0.017	0.2155	0.0000	.0000E+00	.0000E+00
309	0.00	0.000	0.017	0.2148	0.0000	.0000E+00	.0000E+00
310	0.00	0.000	0.017	0.2141	0.0000	.0000E+00	.0000E+00
311	0.00	0.000	0.017	0.2134	0.0000	.0000E+00	.0000E+00
312	0.00	0.000	0.017	0.2127	0.0000	.0000E+00	.0000E+00
313	0.00	0.000	0.018	0.2119	0.0000	.0000E+00	.0000E+00
314	0.00	0.000	0.018	0.2112	0.0000	.0000E+00	.0000E+00
315	0.00	0.000	0.017	0.2104	0.0000	.0000E+00	.0000E+00
316	0.00	0.000	0.013	0.2099	0.0000	.0000E+00	.0000E+00
317	0.00	0.000	0.013	0.2094	0.0000	.0000E+00	.0000E+00
318	0.00	0.000	0.013	0.2089	0.0000	.0000E+00	.0000E+00
319	0.00	0.000	0.012	0.2083	0.0000	.0000E+00	.0000E+00
320	0.00	0.000	0.012	0.2078	0.0000	.0000E+00	.0000E+00
321	0.00	0.000	0.012	0.2073	0.0000	.0000E+00	.0000E+00
322	0.00	0.000	0.012	0.2068	0.0000	.0000E+00	.0000E+00
323	0.00	0.000	0.012	0.2063	0.0000	.0000E+00	.0000E+00
324	0.00	0.000	0.012	0.2058	0.0000	.0000E+00	.0000E+00
325	0.00	0.000	0.012	0.2053	0.0000	.0000E+00	.0000E+00
326	0.00	0.000	0.012	0.2048	0.0000	.0000E+00	.0000E+00
327	0.00	0.000	0.012	0.2043	0.0000	.0000E+00	.0000E+00
328	0.00	0.000	0.012	0.2038	0.0000	.0000E+00	.0000E+00
329	0.00	0.000	0.012	0.2034	0.0000	.0000E+00	.0000E+00
330	0.00	0.000	0.011	0.2029	0.0000	.0000E+00	.0000E+00
331	0.00	0.000	0.011	0.2024	0.0000	.0000E+00	.0000E+00
332	0.00	0.000	0.011	0.2019	0.0000	.0000E+00	.0000E+00
333	0.00	0.000	0.011	0.2015	0.0000	.0000E+00	.0000E+00
334	0.00	0.000	0.011	0.2010	0.0000	.0000E+00	.0000E+00
335	0.00	0.000	0.011	0.2005	0.0000	.0000E+00	.0000E+00
336	0.00	0.000	0.011	0.2001	0.0000	.0000E+00	.0000E+00
337	0.00	0.000	0.011	0.1996	0.0000	.0000E+00	.0000E+00
338	0.00	0.000	0.011	0.1992	0.0000	.0000E+00	.0000E+00
339	0.00	0.000	0.011	0.1987	0.0000	.0000E+00	.0000E+00
340	0.00	0.000	0.011	0.1983	0.0000	.0000E+00	.0000E+00
341	0.00	0.000	0.011	0.1978	0.0000	.0000E+00	.0000E+00
342	0.00	0.000	0.011	0.1974	0.0000	.0000E+00	.0000E+00
343	0.00	0.000	0.011	0.1969	0.0000	.0000E+00	.0000E+00
344	0.68	0.000	0.023	0.2243	0.0000	.0000E+00	.0000E+00
345	0.00	0.000	0.010	0.2239	0.0000	.0000E+00	.0000E+00
346	0.00	0.000	0.010	0.2234	0.0000	.0000E+00	.0000E+00
347	0.00	0.000	0.010	0.2230	0.0000	.0000E+00	.0000E+00
348	0.00	0.000	0.010	0.2226	0.0000	.0000E+00	.0000E+00
349	0.00	0.000	0.010	0.2222	0.0000	.0000E+00	.0000E+00
350	0.00	0.000	0.010	0.2217	0.0000	.0000E+00	.0000E+00
351	0.00	0.000	0.010	0.2213	0.0000	.0000E+00	.0000E+00
352	0.00	0.000	0.010	0.2209	0.0000	.0000E+00	.0000E+00
353	0.00	0.000	0.010	0.2205	0.0000	.0000E+00	.0000E+00
354	0.54	0.000	0.021	0.2421	0.0000	.0000E+00	.0000E+00
355	0.00	0.000	0.072	0.2391	0.0000	.0000E+00	.0000E+00
356	0.00	0.000	0.010	0.2387	0.0000	.0000E+00	.0000E+00

357		0.00	0.000	0.010	0.2383	0.0000	.0000E+00	.0000E+00
358		0.00	0.000	0.010	0.2379	0.0000	.0000E+00	.0000E+00
359		0.00	0.000	0.010	0.2375	0.0000	.0000E+00	.0000E+00
360		0.00	0.000	0.010	0.2371	0.0000	.0000E+00	.0000E+00
361		0.00	0.000	0.010	0.2367	0.0000	.0000E+00	.0000E+00
362	*	0.00	0.000	0.010	0.2363	0.0000	.0000E+00	.0000E+00
363	*	0.00	0.000	0.010	0.2359	0.0000	.0000E+00	.0000E+00
364	*	0.00	0.000	0.010	0.2355	0.0000	.0000E+00	.0000E+00
365	*	0.00	0.000	0.010	0.2351	0.0000	.0000E+00	.0000E+00
366	*	0.00	0.000	0.009	0.2347	0.0000	.0000E+00	.0000E+00

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MONTHLY TOTALS (IN INCHES) FOR YEAR 1988

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.22	1.37	0.10	0.08	0.18	1.24
	1.44	9.78	0.93	0.23	0.00	1.22
RUNOFF	0.000	0.050	0.000	0.000	0.000	0.000
	0.000	1.218	0.000	0.000	0.000	0.000
EVAPOTRANSPIRATION	0.715	1.189	0.558	0.432	0.146	0.418
	1.678	5.209	2.474	0.641	0.410	0.401
PERCOLATION/LEAKAGE THROUGH	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
LAYER 2	0.0000	0.6775	0.1697	0.0102	0.0000	0.0000

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ANNUAL TOTALS FOR YEAR 1988

	INCHES	CU. FEET	PERCENT
PRECIPITATION	16.79	2437908.500	100.00
RUNOFF	1.268	184126.969	7.55
EVAPOTRANSPIRATION	14.271	2072183.000	85.00
PERC./LEAKAGE THROUGH LAYER 2	0.857718	124540.703	5.11
CHANGE IN WATER STORAGE	0.393	57058.496	2.34
SOIL WATER AT START OF YEAR	5.239	760735.937	
SOIL WATER AT END OF YEAR	5.632	817794.437	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00

ANNUAL WATER BUDGET BALANCE	0.0000	-0.727	0.00

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1984 THROUGH 1988

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.40	0.62	0.34	0.20	0.54	1.87
	1.29	4.16	0.99	1.52	0.96	1.48
STD. DEVIATIONS	0.49	0.50	0.18	0.35	0.29	1.16
	0.49	3.22	0.63	1.63	1.24	0.98
RUNOFF						
TOTALS	0.000	0.010	0.000	0.000	0.000	0.058
	0.000	0.301	0.001	0.088	0.042	0.001
STD. DEVIATIONS	0.000	0.022	0.000	0.000	0.000	0.087
	0.000	0.524	0.001	0.198	0.094	0.001
EVAPOTRANSPIRATION						
TOTALS	1.009	0.569	0.407	0.372	0.570	1.545
	1.618	3.158	1.263	0.960	1.046	1.029
STD. DEVIATIONS	0.604	0.465	0.151	0.156	0.410	1.100
	0.404	1.537	0.905	0.588	0.757	0.591
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0022	0.0000	0.0001	0.0000	0.0003	0.0001
	0.0001	0.1356	0.0340	0.0021	0.0003	0.0001
STD. DEVIATIONS	0.0028	0.0001	0.0001	0.0000	0.0007	0.0002
	0.0002	0.3029	0.0758	0.0045	0.0005	0.0001

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1984 THROUGH 1988

	INCHES		CU. FEET	PERCENT
PRECIPITATION	14.38	(2.073)	2087685.7	100.00
RUNOFF	0.500	(0.4432)	72665.19	3.481
EVAPOTRANSPIRATION	13.546	(1.4889)	1966841.87	94.212

PERCOLATION/LEAKAGE THROUGH LAYER 2	0.17497 (0.38167)	25405.965	1.21694
CHANGE IN WATER STORAGE	0.157 (0.9709)	22772.97	1.091

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PEAK DAILY VALUES FOR YEARS 1984 THROUGH 1988

	(INCHES)	(CU. FT.)
PRECIPITATION	2.25	326700.000
RUNOFF	0.784	113810.9450
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.118181	17159.88480
SNOW WATER	1.22	177189.7340

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3672
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1688

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FINAL WATER STORAGE AT END OF YEAR 1988

LAYER	(INCHES)	(VOL/VOL)
1	1.5622	0.2604
2	4.0700	0.2261
SNOW WATER	0.000	

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APPENDIX E

Monitoring Plan

WSMR Environmental Document ES-EC-TO-015-06-168

REVISED FINAL

RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82, Surface Impoundment (SI)-3)

White Sands Missile Range

May 2008

White Sands Missile Range
Directorate of Public Works - Environment Division
White Sands Missile Range, New Mexico 88002

WHITE SANDS TECHNICAL SERVICES

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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1. REPORT DATE *(DD-MM-YYYY)* May 2008	**2. REPORT TYPE** Revised Final	**3. DATES COVERED** *(From - To)*
4. TITLE AND SUBTITLE RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82, Surface Impoundment (SI)-3)		**5a. CONTRACT NUMBER** W9124Q-04-D-0012 **5b. GRANT NUMBER** **5c. PROGRAM ELEMENT NUMBER**
6. AUTHOR(S) William Little, Senior Engineer, WTS		**5d. PROJECT NUMBER** **5e. TASK NUMBER** 15
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) White Sands Technical Services, LLC P.O. Box 363 WSMR, NM 88002		**5f. WORK UNIT NUMBER** **8. PERFORMING ORGANIZATION REPORT NUMBER** ES-EC-TO-015-06-168
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Department of the Army U.S. Army White Sands Missile Range 100 Headquarters Avenue ATTN: IMWE-WSM-PWEEC (Jose Gallegos) White Sands Missile Range, NM 88002		**10. SPONSOR/MONITOR'S ACRONYM(S)** **11. SPONSORING/MONITORING AGENCY REPORT NUMBER** ES-EC-TO-015-06-168

12. DISTRIBUTION AVAILABILITY STATEMENT

13. SUPPLEMENTARY NOTES

14. ABSTRACT

This RCRA Monitoring Plan addresses the requirements identified in the New Mexico Environment Department (NMED) letter of 24 August 2007 concerning NMED Notice of Disapproval, RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82) at White Sands Missile Range. This letter identified specific actions for WSMR to undertake, including a ground water monitoring program.

15. SUBJECT TERMS

RCRA, WSMR, STP Percolation Ditches, ground water

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
			none	7	Jose Gallegos
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER (*Include area code*)**
unclassified	unclassified	unclassified			575-678-1007

RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82, Surface Impoundment (SI)-3)

Submitted to:

U.S. Army
White Sands Missile Range
Directorate of Public Works - Environment Division
White Sands Missile Range, New Mexico 88002-5048

May 2008

Submitted by:

White Sands Technical Services, LLC
Building 126
White Sands Missile Range, New Mexico 88002

WSMR response to

1. **NMED NOTICE OF DISAPPROVAL, RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82), WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235, WSMR-07-001, 24 August 2007.**
2. **NMED Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001, 18 March 2008.**
3. **NMED E-Mail Message, Monitoring plan clarifications – STP Ditches, T. Diaz, NMED, to José Gallegos, WSMR, 25 March 2008, and 18 April 2008 telephone conversation, C. Frischkorn/J. Gallegos, further clarifying NMED comments.**

Comment Number		NMED Comments		WSMR Response and Discussion
NMED NOTICE OF DISAPPROVAL, RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82), WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235, WSMR-07-001, 24 August 2007				
1		In Section 3.2 (Corrective Measures Studies), the Permittee states "[a] revised Corrective Measures Study (CMS) is currently (2007) in preparation which addresses current conditions, understandings and agency concerns." Solid Waste Management Unit (SWMU) 82 is a regulated unit and therefore a Closure Plan, rather than a CMS, is required to be submitted to NMED. This issue is being addressed in the June 11, 2007 White Sands Missile Range (WSMR) Draft Resource Conservation and Recovery Act (RCRA) Permit.		WSMR will cease preparation of the previously agreed-to revised CMS. Closure Plan issues will be addressed during negotiation concerning the draft RCRA Permit.
2		In Section 5.3 (Groundwater Sampling), the Permittee references NMED's Comment 6 of the August 7, 2006 Response Letter (located in Appendix A). In the letter, NMED asks the Permittee to provide an explanation for dissolved oxygen level measurements that appear to be uncharacteristic of possible groundwater conditions at the site. NMED also asks the Permittee to explain how the data was collected and if any data collection problems were encountered. The Permittee has not addressed this Comment in the current Monitoring Plan. The Permittee must address this issue in the revised Monitoring Plan.		At the present time, WSMR has no ready explanation for the apparent anomalies, nor do we have recorded difficulties with data collection. Sampling preparations, collection techniques, and recordkeeping have been double-checked and observed by third parties with no anomalies noted. Examination of the sampling record shows that, while there were anomalies reported during 2005, there have been no obvious problems since. We intend to continue to carefully follow sampling and measurement protocols in order to discover and correct any problems. Care will be taken to insure that field measurements are collected properly (equipment calibration and sampling technique). Sampling and data collection procedures are presented in the cited and provided SOPs, which are appropriate for the site and the assigned tasks. See Section 5.0, pages 3 – 4.
3		In Section 5.3 (Groundwater Sampling), page 5, the Permittee states "WSMR will continue the ongoing groundwater monitoring program, with sampling scheduled to occur on & semi-annual basis, usually in December and June of each Year.. -This Program was initiated in 2005 and is due for re-evaluation in 2010." The groundwater monitoring dates are subject to change based on pending requirements in the June 11, 2007 White Sands Missile Range RCRA Permit Draft. The Permittee must remove the reference to re-evaluation in 2010.		Noted.
4		In Section 5.3 (Groundwater Sampling), page 5, the Permittee states "[c]are will be taken to insure that field measurements are collected properly (equipment calibration and sampling technique)." The Permittee must include descriptions of proposed methods and procedures for sampling and data collection. The Permittee must also include a step test(s) to determine pumping rates at the well(s) proposed for constant discharge aquifer testing (listed in Table 5-1). The Permittee must provide a detailed description of these procedures in the aquifer characterization work plan submittal.		1) The requested information is provided in the supplied SOPs. 2) The proposed aquifer test will be addressed in a separate work plan and executed by the U.S. Geological Survey.

WSMR response to 1. **NMED NOTICE OF DISAPPROVAL, RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82), WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235, WSMR-07-001, 24 August 2007.** 2. **NMED Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001, 18 March 2008.** 3. **NMED E-Mail Message, Monitoring plan clarifications – STP Ditches, T. Diaz, NMED, to José Gallegos, WSMR, 25 March 2008, and 18 April 2008 telephone conversation, C. Frischkorn/J. Gallegos, further clarifying NMED comments.**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
5		In Table 5-2 (Planned Analytical Program), the Permittee lists the proposed analytical methods for the sample analysis. The methods proposed for analysis of Volatile Organic Compounds (VOCs) and cyanide are not the most current according to Environmental Protection Agency (EPA) methods. The most current are Method 8260C for VOCs and Method 9010C for cyanide. Please refer to http://www.epa.gov/sw-846/new-meth.htm and http://www.epa.gov/fedfac/pdf/mra_hbook_5_05.pdf. The Permittee must revise the Monitoring Plan to propose using these updated analytical methods. This correction must also be included in the aquifer characterization work plan.		We acknowledge the new methods, but recognize that the guidance leaves it to our discretion, we will propose using new methods if readily available, and otherwise, current methods will continue to be used.
6		In Section 5.4 (Aquifer Testing), the Permittee references NMED' Comment 2 of the December 8, 2006 (located in Appendix A). In the response letter, NMED requires the Permittee to provide aquifer testing in multiple wells that include, but are not limited to, wells MPL-02, MPL-17 and SMW-03, In the Monitoring Plan the Permittee states "[t]hese wells are too far to allow measurable drawdown in adjacent wells." The Permittee must propose a well or wells that will allow for a multiple-well constant discharge test(s) in the area near SMW-03. The well or wells proposed for this study, along with a description of the detailed proposed aquifer testing, must be included in the aquifer characterization work plan.		Aquifer Testing details will be addressed in the separately provided Aquifer Characterization Work Plan.
7		In the Comment Response table (located in Appendix A) addressing NMED's Comment Response Letter dated August 7, 2006, and NMED's Notice of Deficiency (NOD), dated December 8, 2006, the Permittee states that a work plan is being prepared and will be submitted to NMED. The Permittee must include all proposed aquifer testing details in the aquifer characterization work plan to be submitted to NMED. Monitoring addressed in the Comment Response tables must be included in the revised Monitoring Plan.		By prior agreement with NMED [fonecon 18 April 2007, Gallegos / Frischkorn and follow-up C. Frischkorn e-mail message, 19 April 2007], the provided Monitoring Plan contained the planned aquifer testing program. However, the revised Monitoring Plan will not address aquifer tests. Aquifer testing details will be addressed in the separate Aquifer Characterization Work Plan.
8		The Permittee failed to provide the details for conducting any aquifer tests at the site. As stated in previous comments, the Permittee must submit an aquifer characterization work plan for NMED's approval that provides the details for conducting aquifer tests at a minimum of four wells, including at least one multiple well constant discharge test.		See responses to Comments 4 and 7.

WSMR response to 1. **NMED NOTICE OF DISAPPROVAL, RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82), WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235, WSMR-07-001, 24 August 2007.** 2. **NMED Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001, 18 March 2008.** 3. **NMED E-Mail Message, Monitoring plan clarifications – STP Ditches, T. Diaz, NMED, to José Gallegos, WSMR, 25 March 2008, and 18 April 2008 telephone conversation, C. Frischkorn/J. Gallegos, further clarifying NMED comments.**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
9		In the Comment Response table (located in Appendix A) addressing NMED's Comment Response Letter, dated August 7, 2006, Comment 7, NMED requires that the Permittee provide reliable information to support current aquifer conditions at the site. In response to NMED's comment, the Permittee states "WSMR believes that, properly interpreted, the available data provide a coherent, plausible, and acceptable description of current and past hydrogeologic conditions. These data provide an adequate basis for interpreting and predicting future conditions." In the past, the Permittee has not provided current aquifer data; therefore, based on proposed investigations and results, the Permittee must therefore re-evaluate the data collected during the upcoming well characterization activities and develop a model of current hydrogeologic conditions. Results from this study must be included in the Closure Plan. (See Comment 1)		WSMR will conduct an additional aquifer test (as described in the separate Aquifer Characterization Work Plan) and will consider this new data with data previously collected (e.g., *Considerations of Aquifer Permeability in the Vicinity of the Former Sewage Treatment Plant (STP) Percolation Ditches*, WTS, May 2006) to describe aquifer conditions.
10		In the Comment Response table addressing NMED's NOD dated December 8, 2006 (Appendix A), the Permittee proposes to submit a Work Plan that describes proposed activities in response to NMED's request, as well as a complete CMS. As stated in Comment 1, the Permittee must submit a Closure Plan to NMED, not a CMS. This issue is being addressed in the WSMR Draft RCRA Permit dated, June 11, 2007.		See response to Comment 1.
NMED Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001, 18 March 2008.				
1		NMED has determined that the Permittee did not respond to the comments established in the NOD, but instead addressed a former NOD dated August 7, 2006. NMED hereby rejects the Monitoring Plan.		The ambiguity should be cleared up throughout the current version.
NMED E-Mail Message, Monitoring plan clarifications – STP Ditches, T. Diaz, NMED, to José Gallegos, WSMR, 25 March 2008, and 18 April 2008 telephone conversation, C. Frischkorn/J. Gallegos, further clarifying NMED comments.				
1		Discussion specified certain portions of the Monitoring Plan to be removed.		All such material has been removed.
2		Discussion questioned accuracy of citations for cyanide methods in Table 5-2.		Full method citations have been provided. WSMR has verified that appropriate methods are being employed.

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APPENDIX A NMED Letters and WSMR Responses

APPENDIX B WTS SOPs

LIST OF ACRONYMS

MNA	Monitored Natural Attenuation
MPL	Main Post Landfill
NMED	New Mexico Environment Department
RCRA	Resource Conservation & Recovery Act of 1976
RFI	RCRA Facility Investigation
SOP	Standard Operating Procedures
STP	Sewage Treatment Plant
SWMU	Solid Waste Management Unit
VOCs	Volatile Organic Compounds
WSMR	White Sands Missile Range
WTS	White Sands Technical Services, LLC

RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES WSMR-62 (SWMU 82)

1.0 INTRODUCTION

This RCRA Monitoring Plan addresses the requirements identified in the New Mexico Environment Department (NMED) letter of 24 August 2007, *Notice of Disapproval, RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001.*

The 24 August 2007 letter is a continuation and amplification of a previous NMED letter of 7 August 2006, *NMED Response to the White Sands Missile Range (WSMR) Comment Response Letter Regarding the Evaluation of Monitored Natural Attenuation (MNA) STP Ditches (SWMUs 82 and 83) White Sands Missile Range, EPA ID NO. NM2750211235 HWB-WSMR-99-007.*

The current document has been modified to incorporate the contents of NMED 18 March 2008 letter, *Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001,* and NMED 25 March 2008 E-mail message, *Monitoring plan clarifications – STP Ditches*.

A copy of each of these letters is provided in Appendix A, together with the relevant WSMR response-to-comments document.

SWMUs 82 and 83 were administratively combined as SWMU 82 and designated as Surface Impoundment(SI)-3, per *Final Settlement Agreement No. HRM-00-05(A)*, 4 Dec 2000.

This plan constitutes a monitoring plan, as defined in 20NMAC4.2.7.Y. The Monitoring Plan format has been tailored to focus on the specific actions involved.

2.0 SITE DESCRIPTION

The focus of this study is to address groundwater contamination at the former Sewage Treatment Plant (STP) percolation ditches and effluent impoundment area. From 1958 to 1967, sewage effluent from the STP was initially discharged to a natural surface drainage channel. From 1967 to 1986, the effluent was diverted to one of two parallel drainage ditches. Each of the drainage areas channeled effluent from the STP to impoundment areas which acted as evaporation and percolation beds. For almost thirty years, a significant amount of effluent was reportedly discharged to these areas.

2.1 Location

The immediate area around the former STP discharge ditches is undeveloped, with the Main Post Landfill (MPL) to the northeast and the STP to the west. The Main Post Headquarters and residential areas are located approximately three miles west of the STP ditches. A site map of the immediate area around SWMUs 82 and 83 is provided in Figure 2-1.

2.2 Hydrogeology

The former STP Percolation Ditches are located on the distal portion of the alluvial fan extending eastward from the Organ Mountains. Sediments consist of varying layers of sands and clays to below the zone of interest, becoming somewhat more fine-grained to the east (toward the center of the Tularosa Basin). Depth to groundwater varies from roughly 170 to 250 feet below land surface. Measured potentiometric surface elevations suggest a groundwater flow direction to the southeast. The configuration of the land surface and the water table (based on measurements taken in 1999) is shown in Figure 2-2. As a conceptual model, little change appears to have occurred in the interim.

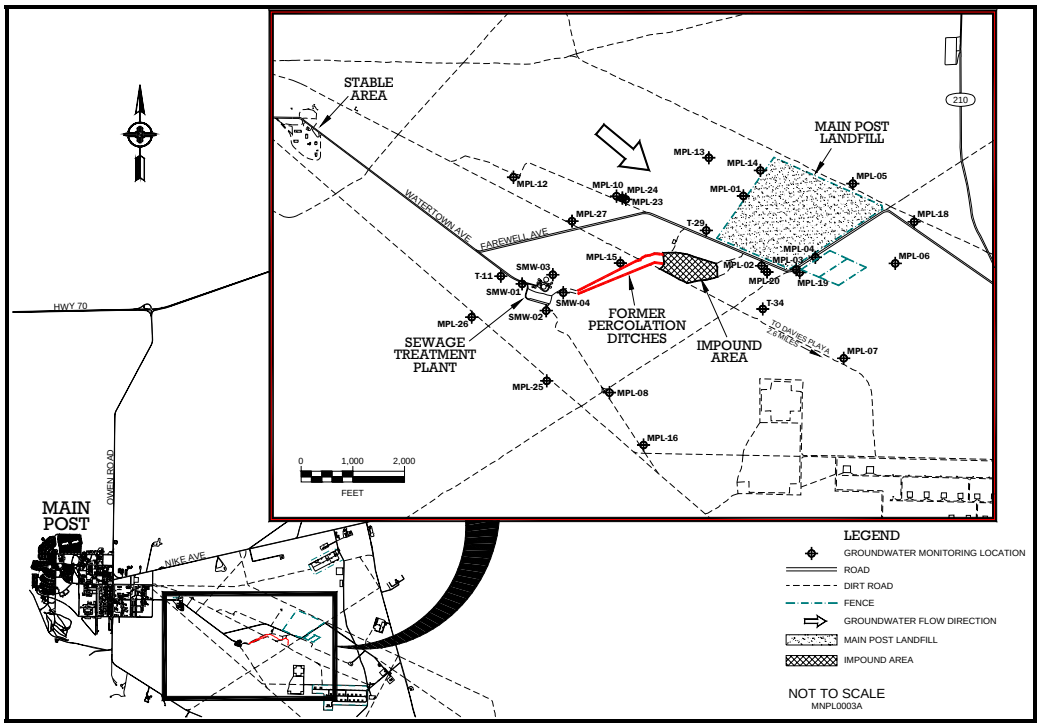

FIGURE 2-1. SWMU 82 SITE MAP.

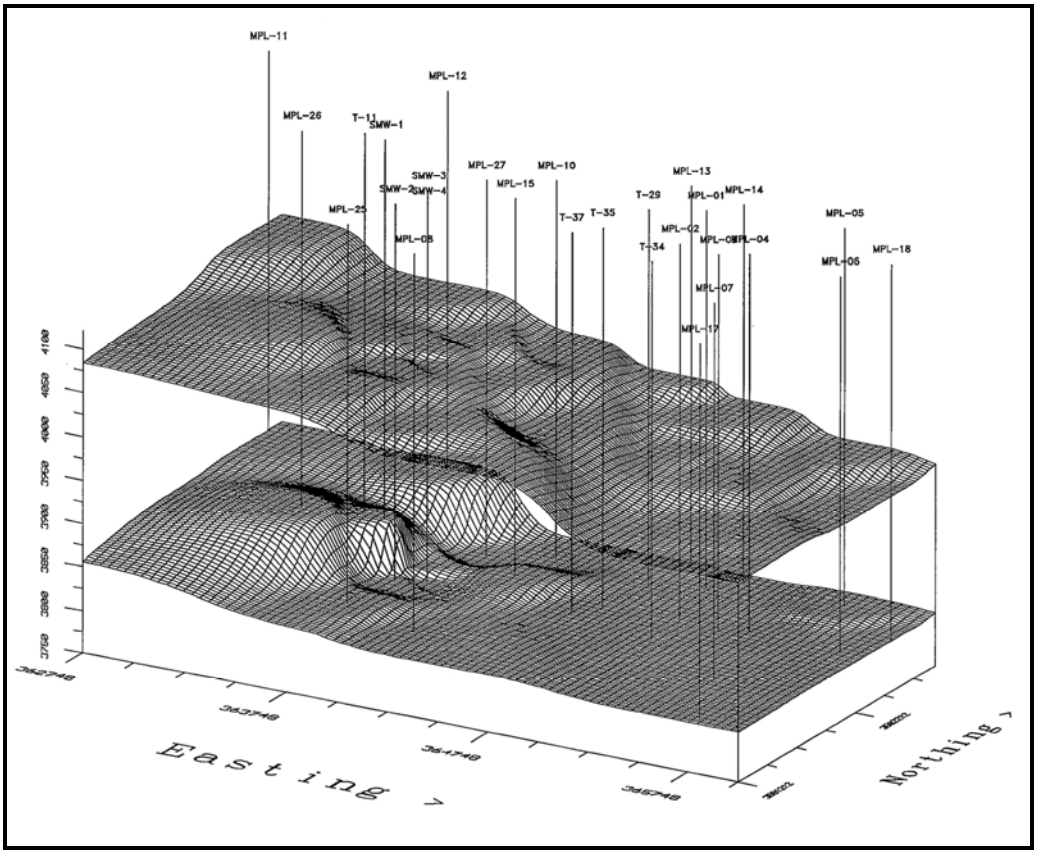

FIGURE 2-2. TOPOGRAPHY OF LAND SURFACE AND WATER TABLE IN THE VICINITY OF THE FORMER STP PERCOLATION DITCHES

3.0 PREVIOUS INVESTIGATIONS

Total cyanide concentrations in groundwater at WSMR were first identified during the groundwater monitoring program at the Main Post Landfill (MPL) in June 1996 (MEVATEC 1997a). Other investigative activities are described below.

3.1 Site Investigations

The former STP Percolation Ditches (SWMU 82) were studied as part of the Phase I (IT Corporation 1992) and Phase II (Sverdrup Environmental, Inc. 1994) RCRA Facility Investigations (RFIs). In response to the Phase I and Phase II RFI soil sampling results, approximately 4,000 cubic yards (3,058 cubic m) of surface soils from the parallel drainage ditches and impoundment areas were excavated from March through April 1997 (Radian 1997). Following the groundwater monitoring program at the MPL, two additional studies were conducted to provide additional information regarding the extent and possible source area of the cyanide groundwater concentrations (MEVATEC 1997b and MEVATEC 1999). Most recently, three additional monitor wells (MPL 28-30) were installed at the request of NMED (WTS 2005).

3.2 Corrective Measures Studies

A Corrective Measures Study (CMS) was published in 2000 (MEVATEC 2000), based on the findings of the previous studies. An addendum to the CMS, expanding on the preferred alternative of Monitored Natural Attenuation (MNA) was published in 2004 (BAE Systems 2004).

4.0 CURRENT CONDITIONS

The current distribution of cyanide is a relict of the former mounding caused by the recharge from the STP Ditches resulting in a greater hydraulic gradient and transport mechanism during their time of use. Once the water supply was cut off, the system slowed to near-static conditions (current conditions). These current conditions are illustrated in Figure 2-2, above, which shows both the low gradient across most of the site as well as the groundwater ridge which bounds the system to the west. The former STP Percolation Ditches are in the east-central portion of the figure, near well T-35.

5.0 SCOPE OF WORK

The monitoring plan scope is described below.

Planned Scope: WSMR will continue the ongoing groundwater monitoring program, with sampling scheduled to occur on a semi-annual basis, usually in December and June of each year. This program was initiated in 2005. The wells to be sampled are shown in Table 5-1, below. The analytical parameters are as shown in Table 5-2, below.

Two sampling events incorporating analyses for volatile organic compounds (VOCs) have been conducted. Since no VOCs have been detected, analysis for them has been deleted from the sampling program.

At the present time, WSMR has no ready explanation for the apparent anomalies in dissolved oxygen values reported, nor do we have recorded difficulties with data collection. Sampling preparations, collection techniques, and recordkeeping have been double-checked and observed by third parties with no anomalies noted. Examination of the sampling record shows that, while there were anomalies reported during 2005, there have been no obvious problems since. We intend to continue to carefully follow sampling and measurement protocols in order to discover and correct any problems. Care will be taken to insure that field measurements are collected properly (equipment calibration and sampling technique).

Sampling and data collection procedures are presented in the cited and provided SOPs, which are appropriate for the site and the assigned tasks. Relevant WTS SOPs (provided in Appendix B) are:

SOP 1 **Field Quality Program**
SOP 1.1 - Chain of Custody
SOP 1.2 - Field Activity Documentation
SOP 2 **Sample Handling, Packing, and Shipping**
SOP 2.1 - Sample Labeling
SOP 2.2 - Sample Numbering
SOP 2.3 - On-Site Sample Storage
SOP 4 **Calibration and Maintenance of Field Instrumentation**
SOP 4.1 - Field Instrument
SOP 5 **Water Level Measurements in Monitoring Wells**
SOP 6 **Field Equipment Decontamination**
SOP 9.3 **Low-Flow Groundwater Sampling**
SOP 13 **Field Quality Control Sampling**
SOP 14 **Management of Investigation-Derived Waste**
SOP 16 **Quality Inspection and Inspection Records**

Monitoring equipment to be used includes various nitrogen gas-powered bladder pumps and controllers for low-flow sampling. Discharge tubing is dedicated to each well, separately bagged and labeled between events. For the shallower wells, pumps with disposable bladders (such as QED Sample-Pro) are used, so that only new parts contact the sample. For the deeper wells (greater than 300'), a high-lift bladder pump is used and decontaminated between wells.

For each sampling event, 26 wells are sampled; three wells are sampled in duplicate; and three wells are sampled in duplicate for laboratory matrix-spike analyses. An equipment blank is collected to document decontamination of the deep-well bladder pump.

TABLE 5-1. PLANNED MONITORING PROGRAM – SEMIANNUAL SAMPLING FREQUENCY

Well ID	Type	Depth Category	Notes
MPL01	Center plume	interface	Required for landfill monitoring program
MPL02	Center plume	interface	Required for landfill monitoring program
MPL03	Center plume	interface	maintain as part of southern nested well group and required for landfill monitoring program
MPL04	Center plume	interface	Required for landfill monitoring program
MPL05	Center plume	interface	maintain as part of northeast nested well group
MPL06	Plume edge	interface	maintain for monitoring potential eastward plume movement
MPL07	Center plume	interface	n/a
MPL10	Center plume	interface	maintain as part of northwest nested well group
MPL13	Plume	interface	n/a
MPL16	Plume edge	interface	n/a
MPL17	Plume edge	interface	maintain for monitoring potential eastward plume movement
MPL18	plume edge	interface	maintain for monitoring potential eastward plume movement
MPL19	center plume	deep-level	maintain as part of southern nested well group

TABLE 5-1. PLANNED MONITORING PROGRAM – SEMIANNUAL SAMPLING FREQUENCY			
Well ID	**Type**	**Depth Category**	**Notes**
MPL20	center plume	mid-level	maintain as part of southern nested well group
MPL21	center plume	deep-level	maintain as part of northeast nested well group
MPL22	center plume	mid-level	maintain as part of northeast nested well group
MPL23	center plume	deep-level	maintain as part of northwest nested well group
MPL24	center plume	mid-level	maintain as part of northwest nested well group
MPL25	plume edge	interface	maintain for monitoring potential southwest plume movement
MPL26	up gradient	interface	Keep sampling as background comparison
MPL28	center plume	interface	New well 2005
MPL29	plume edge	interface	New well 2005
MPL30	plume edge	interface	New well 2005
SMW01	up gradient	mid-level	n/a
SMW04	plume edge	interface	n/a
T40	down gradient	interface	[Existing] Sentinel well down-gradient
Center plume wells within area of plume HISTORICALLY above 0.2 mg/L total cyanide. Plume wells are those consistently within the defined plume, but outside of the 0.2 mg/L isopleth. Plume edge wells are those wells located on or near the 0.0 mg/L total cyanide isopleth.			

TABLE 5-2. PLANNED ANALYTICAL PROGRAM		
PARAMETER	**REFERENCE METHOD**	**METHOD TYPE**
FIELD PARAMETERS		
pH	SM 4500-H^+ B	Field / Probe
Conductivity	SM 2510 B	
Turbidity	SM 2130 B	
Dissolved Oxygen	SM 4500-O G	
Temperature	SM 2550 B	
Oxidation Reduction Potential	SM 2580 B	
ORGANICS		
NONE		
CYANIDE		
Total and amenable	SM 4500-CN C,E and SM 4500-CN^- G	Distillation
Free cyanide	SW846 9213	Electrode
OTHER ANALYSES		
Dissolved ions		
Chloride Fluoride Sulfate	EPA 300.0	Ion chromatography

TABLE 5-2. PLANNED ANALYTICAL PROGRAM			
PARAMETER		**REFERENCE METHOD**	**METHOD TYPE**
Nutrients			
Ammonia (NH_3+NH_4) Nitrate/nitrite (NO_3+NO_2)		EPA 350.1 SM 4500	Colorimetric Cd column
Water quality			
pH Specific conductance Residue, dissolved (TDS) Bicarbonate & carbonate (alkalinity)		EPA 150.1 EPA 120.1 EPA 160.1 EPA 310.1	Electrometric Conductivity meter Gravimetric Titrimetric
TOTAL METALS			
Antimony Arsenic Barium Beryllium Cadmium Chromium Cobalt Copper	Lead Nickel Selenium Silver Thallium Tin Vanadium Zinc	SW846 6010A	Inductively coupled Plasma emission Spectroscopy
Mercury (total)		SW846 7470A	Atomic absorption Cold vapor

6.0 REPORTS OF FINDINGS

The results of the field efforts described above will be reported and incorporated into future documents. The results of the ongoing ground water sampling events will be reported through the existing series of long-term monitoring reports for WSMR.

7.0 SCHEDULE OF IMPLEMENTATION

The groundwater monitoring program described in Section 5.0 has been initiated.

REFERENCES

NMED 2006a. *NMED Response to the White Sands Missile Range (WSMR) Comment Response Letter Regarding the Evaluation of Monitored Natural Attenuation (MNA) STP Ditches (SWMUs 82 and 83) White Sands Missile Range, EPA ID NO. NM2750211235 HWB-WSMR-99-007.* 7 August 2006.

NMED 2007. *Notice of Disapproval, RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001.* 24 August 2007.

NMED 2008a. *Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001, 18 March 2008.*

NMED 2008b. E-mail message, *Monitoring plan clarifications – STP Ditches*, T. Diaz, NMED, to José Gallegos, WSMR, 25 March 2008.

APPENDIX A

NMED Letters and WSMR Responses

State of New Mexico
ENVIRONMENT DEPARTMENT
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303
Telephone (505) 428-2500
Fax (505) 428-2567
www.nmenv.state.nm.us

BILL RICHARDSON
GOVERNOR

RON CURRY
SECRETARY

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

August 7, 2006

Thomas A. Ladd
Director, Environment and Safety Directorate
100 Headquarters Avenue
White Sands Missile Range, New Mexico 88002-5000

RE: NMED RESPONSE TO THE WHITE SANDS MISSLE RANGE (WSMR) COMMENT RESPONSE LETTER REGARDING THE EVALUATION OF MONITORED NATURAL ATTENUATION (MNA) STP DITCHES (SWMUs 82 AND 83) WHITE SANDS MISSLE RANGE, EPA ID NO. NM2750211235 HWB-WSMR-99-007

Dear Mr. Ladd:

The New Mexico Environment Department (NMED) has reviewed the comment response letter referenced above and associated summary data table dated April 27, 2006. NMED has determined that White Sands Missile Range (WSMR) (Permittee) has not collected data critical to demonstrating that monitored natural attenuation (MNA) is an acceptable remediation method for this site. The Permittee must address the following comments in order to support any action other than conducting active remediation to reduce cyanide concentrations in groundwater.

COMMENT 1

The Permitee must survey all existing monitoring wells to a common coordinate system. In addition, all monitoring wells must have a surveyed permanent notch or other permanent mark fixed in the riser to provide reliable measuring points prior to collecting groundwater measurements.

Rid 8/9/06

The horizontal and vertical coordinates of the top of each monitoring well casing and the ground surface at each monitoring well location shall be determined by a registered New Mexico professional land surveyor in accordance with the State Plane Coordinate System (NMSA 1978 47-1-49-56 (Repl. Pamp. 1993)). The surveys must be conducted in accordance with Sections 500.1 through 500.12 of the Regulations and Rules of the Board of Registration for Professional Engineers and Surveyors Minimum Standards for Surveying in New Mexico. Horizontal positions shall be measured to the nearest 0.1-ft, and vertical elevations shall be measured to an accuracy of 0.01-ft. The Permittee must prepare site map(s), certified by a registered New Mexico professional land surveyor, presenting all surveyed locations and elevations including relevant site features and structures for submittal with all associated reports to NMED.

Other site attributes (e.g., soil sample locations, sediment sample locations, springs, outfalls, pertinent structures, monitoring stations, as well as staked out sampling grids), may be located by using the global positioning system (GPS), another NMED-approved surveying system, or by using a registered New Mexico Registered Land Surveyor using the methods described in the paragraph above. If using GPS, horizontal locations must be measured to 0.5 ft. The Permittee must provide NMED a statement of accuracy for survey data upon request.

COMMENT 2

It is evident that there are inconsistencies in groundwater elevation measurements specifically for measurements taken at wells MPL-26 (elevation 3885.25 ft) and MPL-25 (3825.21 ft). These wells are approximately 2000 ft apart with a 60 ft vertical elevation difference; although the hydraulic gradient at the site is estimated to be significantly less than 0.03 ft/ft.

After all wells have been evaluated and resurveyed, groundwater elevation measurements must be collected from all monitoring wells, including those proposed for abandonment, with the exception of the dry wells. All measurements must be obtained within a 48 hour period (refer to Comment 1 for further details). WSMR must also inspect the integrity of all monitoring wells during the survey.

COMMENT 3

In the WSMR Comment Response Table, the Permittee proposed to discontinue monitoring the following wells: MPL08, MPL11, MPL12, MPL14, MPL27, SMW02, and SMW03.

If these wells are still competent, the Permittee must not abandon them. Since there are relatively large distances between wells at this site, these wells must be included in the network of wells to be surveyed and used for the collection of groundwater elevation measurements.

COMMENT 4
The Permittee must collect the following from the appropriate wells and submit results to NMED: dissolved oxygen, oxidation reduction potential, nitrate, total dissolved solids, pH, temperature, conductivity, metals (target analyte list metals only), total cyanide, free cyanide, amendable cyanide and ammonia. During the first sampling event, the Permittee must sample for VOCs. If VOCs are not detected, the Permittee may discontinue sampling for VOCs during subsequent sampling events. The Permittee must propose the wells to be sampled in the Work Plan. The Work Plan must include analysis for all of the constituents listed along with the proposed sampling methods and procedures.

COMMENT 5
The Permittee must perform slug tests on the following wells: MPL-17, SMW-03, and MPL-02. Results from the tests must be submitted to NMED within 90 days after NMEDs approval of the Work Plan requested in this letter. The slug tests at each well must include both falling head and rising head tests.

The Permittee must submit specific data for each test and a description of the testing processes including any slug tests conducted prior to this request. Based on the results of this hydraulic testing, the Permittee must explain why the plume has traveled more than one mile from the source area.

COMMENT 6
In the 2005 Field Water Quality Parameters Tables C-1 to C-3 from the 2005 Groundwater Monitoring Program Report, reported dissolved oxygen levels appear to be somewhat uncharacteristic for the area.

The Permittee must provide an explanation for these dissolved oxygen level measurements. The Permittee must also explain how the data was collected and any data collection problems that were experienced during field activities.

COMMENT 7
NMED has reviewed the historic data referenced in previous reports by the Permittee. This historic data appears to be unreliable, specifically relating to groundwater velocity and the rate of plume migration. NMED requires that the Permittee provide information regarding the current aquifer conditions in the vicinity of the Sewage Treatment Plant (STP) Ditches and associated contaminant migration. (See Comment 5)

COMMENT 8
WSMR must submit engineering drawings of the STP. The drawings must include influent and effluent piping schematics and pipeline maps, as well as structures associated with the site.

Within 120 days of receipt of this letter the Permittee must submit a work plan proposing investigation activities that will address the comments included in this letter. In summary the Work Plan should include the following: procedures for measuring groundwater elevations, survey techniques, sampling methods and procedures, and slug test procedures and techniques. The work plan must also include a response letter that addresses the remainder of the comments in this letter cross-referencing NMED's numbered comments.

If you have any questions concerning this letter, please contact Tammy Diaz of my staff at 505-428-2552.

Sincerely,

for James P. Bearzi
Bureau Chief
Hazardous Waste Bureau

JPB:td

cc: Dave Cobrain, NMED HWB
Tammy Diaz, NMED HWB
C. Frischkorn, NMED HWB
L. King, EPA Region 6 (6PD-N)
Jose Gallegos, WSMR
File: Reading File & WSMR 2006 File

DEPARTMENT OF THE ARMY
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100 Headquarters Avenue
WHITE SANDS MISSILE RANGE, NEW MEXICO 88002-5000

13 OCT 2006

REPLY TO
ATTENTION OF

Office of the Garrison Commander

Mr. James Bearzi
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, New Mexico 87505-6303

Subject: WSMR Response to August 2006 NMED Letter Concerning the Former STP Percolation Ditches (IRP Site WSMR-62; SWMU 82 and 83) and Time Extension Request

Dear Mr. Bearzi:

This letter is in response to your August 7, 2006 letter with subject matter *NMED Response to the White Sands Missile Range (WSMR) Comment Response Letter Regarding the Evaluation of Monitored Natural Attenuation (MNA), STP Ditches (SWMU 82 and 83).* Our responses to individual comments are included in the attached response table (1 print copy). The response table will also be provided to you via email.

WSMR will provide a work plan as requested in your letter. However, due to the current workload presented by the HELSTF Phase III RCRA Facility Investigation, **we request a time extension of an additional 120 days for work plan submittal.** If granted, the work plan would be provided by April 2007. The time extension would allow our staff adequate time to fully address your concerns, obtain funding required for contractual support, and provide a comprehensive and complete plan.

Finally, given the site's complexities, we propose a face-to-face discussion to clarify technical issues and the path forward. The meeting can take place in early December or some other mutually agreeable time.

We look forward to working with your staff in accomplishing a sound, satisfactory and mutually agreeable resolution for this site.

The following certification is provided as required by our permit and according to NMAC 20.4.1.900, incorporating 40 CFR 270.11:

> *"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."*

Copies furnished, with enclosure (1 print copy), to Ms. Cheryl Frischkorn, NMED-HWB; Mr. T.A. Ladd, WSMR; Mr. Chuck Hendrickson, Region VI EPA; Mr. Bill Davis, U.S. Army Environmental Center; and, without enclosure, to Mr. John Kieling, NMED-HWB; and White Sands Technical Services, LLC.

Should you have any questions regarding this matter, please contact Mr. Jose Gallegos of our Environmental Compliance office at (505) 678-1007.

Sincerely,

Gary D. Griebel
Colonel, U.S. Army
Commanding

Enclosure

WSMR response to **NMED RESPONSE TO THE WHITE SANDS MISSILE RANGE (WSMR) COMMENT RESPONSE LETTER REGARDING THE EVALUATION OF MONITORED NATURAL ATTENUATION (MNA) STP DITCHES (SWMUs 82 AND 83) WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235 HWB-WSMR-99-007, 7 August 2006**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
1		The Permittee must survey all existing monitoring wells to a common coordinate system. In addition, all monitoring wells must have a surveyed permanent notch or other permanent mark fixed in the riser to provide reliable measuring points prior to collecting groundwater measurements. The horizontal and vertical coordinates of the top of each monitoring well casing and the ground surface at each monitoring well location shall be determined by a registered New Mexico professional land surveyor in accordance with the State Plane Coordinate System (NMSA 1978 471-49-56 (Repl. Ramp. 1993)). The surveys must be conducted in accordance with Sections 500.1 through 500.12 of the Regulations and Rules of the Board of Registration for Professional Engineers and Surveyors Minimum Standards for Surveying in New Mexico. Horizontal positions shall be measured to the nearest 0.1-ft, and vertical elevations shall be measured to an accuracy of 0.01-ft. The Permittee must prepare site map(s), certified by a registered New Mexico professional land surveyor, presenting all surveyed locations and elevations including relevant site features and structures for submittal with all associated reports to NMED. Other site attributes (e.g., soil sample locations, sediment sample locations, springs, outfalls, pertinent structures, monitoring stations, as well as staked out sampling grids), may be located by using the global positioning system (GPS), another NMED-approved surveying system, or by using a registered New Mexico Registered Land Surveyor using the methods described in the paragraph above. If using GPS, horizontal locations must be measured to 0.5 ft. The Permittee must provide NMED a statement of accuracy for survey data upon request.		WSMR will contract a licensed professional surveyor to acquire the requested well data. The deliverable will be a table of well locations and elevations, prepared to the required accuracy and certified by the licensed professional surveyor. We propose to overlay the survey results on a site map prepared from the WSMR GIS database. This will provide a site map with rich detail while complying with the referenced standards. The WSMR GIS is compliant to the Spatial Data Standards for Facilities, Infrastructure, and the Environment (SDSFIE), version 2.500, promulgated by the US Army Corps of Engineers CADD/GIS Technology Center. The Standards (SDS) provide basic data standards for use with geographic information system (GIS),and similar computerized geospatial data systems. They should provide for locational data equivalent to that provided by the licensed surveyor.

WSMR response to **NMED RESPONSE TO THE WHITE SANDS MISSILE RANGE (WSMR) COMMENT RESPONSE LETTER REGARDING THE EVALUATION OF MONITORED NATURAL ATTENUATION (MNA) STP DITCHES (SWMUs 82 AND 83) WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235 HWB-WSMR-99-007, 7 August 2006**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
2		It is evident that there are inconsistencies in groundwater elevation measurements specifically for measurements taken at wells MPL-26 (elevation 3885.25 ft) and MPL-25 (3825.21 ft). These wells are approximately 2000 ft apart with a 60 ft vertical elevation difference; although the hydraulic gradient at the site is estimated to be significantly less than 0.03 ft/ft. After all wells have been evaluated and resurveyed, groundwater elevation measurements must be collected from all monitoring wells, including those proposed for abandonment, with the exception of the dry wells. All measurements must be obtained within a 48 hour period (refer to Comment I for further details). WSMR must also inspect the integrity of all monitoring wells during the survey.		There are apparent ambiguities with the observations in this well pair. WSMR believes these to be representative of the groundwater ridge between the WSMR well field and the basin, proper. This ridge has been documented and described in previous documents (see separate discussion). These anomalous observations in Wells MPL 25 and 26 should not be an impediment to understanding the cyanide site as a whole. WSMR will plan and conduct a synoptic water level survey. Details will be presented in the work plan. The requirement to inspect the integrity of the wells will require some additional planning. Details of the proposed inspection process will be provided in the forthcoming work plan.
3		In the WSMR Comment Response Table, the Permittee proposed to discontinue monitoring the following wells: MPL08, MPL11, MPL12, MPL14, MPL27, SMW02, and SMW03. If these wells are still competent, the Permittee must not abandon them. Since there are relatively large distances between wells at this site, these wells must be included in the network of wells to be surveyed and used for the collection of groundwater elevation measurements.		Agree. WSMR has no active plans for well abandonment.

WSMR response to **NMED RESPONSE TO THE WHITE SANDS MISSILE RANGE (WSMR) COMMENT RESPONSE LETTER REGARDING THE EVALUATION OF MONITORED NATURAL ATTENUATION (MNA) STP DITCHES (SWMUs 82 AND 83) WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235 HWB-WSMR-99-007, 7 August 2006**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
4		The Permittee must collect the following from the appropriate wells and submit results to NMED: dissolved oxygen, oxidation reduction potential, nitrate, total dissolved solids, pH, temperature, conductivity, metals (target analyte list metals only), total cyanide, free cyanide, amendable cyanide and ammonia. During the first sampling event, the Permittee must sample for VOCs. If VOCs are not detected, the Permittee may discontinue sampling for VOCs during subsequent sampling events. The Permittee must propose the wells to be sampled in the Work Plan. The Work Plan must include analysis for all of the constituents listed along with the proposed sampling methods and procedures.		WSMR has sampled and analyzed the monitor wells associated with the former STP Percolation Ditches for VOCs from 2000 through 2003. No VOCs were detected. Since then, only wells MPL-01 – 04 have been sampled for VOCs, in support of the Main Post Landfill monitoring program. Only acetone (present in the trip blank at similar levels) and bromoform have occurred. Both have been at low levels and are not repeatable. We see no merit in resuming sampling and analysis for VOCs. Details of the continuing groundwater monitoring plan will be presented in the work plan. WSMR plans to use the same wells that have been used in the most recent sampling event. See the table at right. **Well Name** MPL01, MPL02, MPL03, MPL04, MPL05, MPL06, MPL07, MPL10, MPL13, MPL16, MPL17, MPL18, MPL19, MPL20, MPL21, MPL22, MPL23, MPL24, MPL25, MPL26, MPL28, MPL29, MPL30, SMW01, SMW04, T40
5		The Permittee must perform slug tests on the following wells: MPL-17, SMW-03, and MPL-02. Results from the tests must be submitted to NMED within 90 days after NMEDs approval of the Work Plan requested in this letter. The slug tests at each well must include both failing head and rising head tests. The Permittee must submit specific data for each test and a description of the testing processes including any slug tests conducted prior to this request. Based on the results of this hydraulic testing, the Permittee must explain why the plume has traveled more than one mile from the source area		The selected wells were all constructed with substantial artificial sand packs. As discussed in ASTM D5912, slug tests on sand-pack wells are of limited value. WSMR has discussed the implications of aquifer permeability at length in previous documents. The issue of aquifer permeability will be further discussed in the work plan. As has been explained previously, the current distribution of cyanide is a relict of the former mounding caused by the recharge from the STP Ditches resulting in a greater hydraulic gradient and transport mechanism in the past. Once the water supply was cut off, the system slowed to near-static conditions (current conditions). The origin and evolution of the current distribution of cyanide will be more fully explained in the work plan.

WSMR response to **NMED RESPONSE TO THE WHITE SANDS MISSILE RANGE (WSMR) COMMENT RESPONSE LETTER REGARDING THE EVALUATION OF MONITORED NATURAL ATTENUATION (MNA) STP DITCHES (SWMUs 82 AND 83) WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235 HWB-WSMR-99-007, 7 August 2006**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
6		In the 2005 Field Water Quality Parameters Tables C-1 to C-3 from the 2005 Groundwater Monitoring Program Report, reported dissolved oxygen levels appear to be somewhat uncharacteristic for the area. The Permittee must provide an explanation for these dissolved oxygen level measurements. The Permittee must also explain how the data was collected and any data collection problems that were experienced during field activities.		We do not understand the anomalies. Techniques, including calibration, seen to be in order. Somehow, air is being entrained in the pumping system. The issue will be further addressed in the work plan.
7		NMED has reviewed the historic data referenced in previous reports by the Permittee. This historic data appears to be unreliable, specifically relating to groundwater velocity and the rate of plume migration. NMED requires that the Permittee provide information regarding the current aquifer conditions in the vicinity of the Sewage Treatment Plant (STP) Ditches and associated contaminant migration. (See Comment 5)		WSMR believes that, properly interpreted, the available data provide a coherent, plausible, and acceptable description of current and past hydrogeologic conditions. These data provide an adequate basis for interpreting and predicting future conditions. Available information will be organized and discussed in the work plan.
8		WSMR must submit engineering drawings of the STP. The drawings must include influent and effluent piping schematics and pipeline maps, as well as structures associated with the site.		Drawings will be procured from the engineering files and provided in the work plan.
		Within 120 days of receipt of this letter the Permittee must submit a work plan proposing investigation activities that will address the comments included in this letter. In summary the Work Plan should include the following: procedures for measuring groundwater elevations, survey techniques, sampling methods and procedures, and slug test procedures and techniques. The work plan must also include a response letter that addresses the remainder of the comments in this letter cross-referencing NMED's numbered comments.		A Work Plan will be prepared. WSMR is requesting a 120-day delay in delivering the work plan, since the principal investigator for the STP Percolation Ditches is also in charge of the current HELSTF Phase III RFI. The document would be scheduled for delivery on or before 3 April 2007.

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BILL RICHARDSON
GOVERNOR

RON CURRY
SECRETARY

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

December 8, 2006

Thomas A. Ladd
Director, Environment and Safety Directorate
100 Headquarters Avenue
White Sands Missile Range, New Mexico 88002-5000

RE: WHITE SANDS MISSLE RANGE (WSMR)
NOTICE OF DEFICIENCY RESPONSE LETTER REGARDING THE EVALUATION OF MONITORED NATURAL ATTENUATION (MNA) AT STP DITCHES (SWMU 82 AND 83).
WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235
HWB-WSMR-99-007

Dear Mr. Ladd:

The New Mexico Environment Department (NMED) has reviewed White Sands Missile Range's (the Permittee) response to NMED's Notice of Deficiency (NOD) dated October 23, 2006. NMED does not approve monitored natural attenuation (MNA) as an acceptable remediation method for this site at this time. The Permittee must address the following comments:

COMMENT 1

(Permittee Response #4): Reiterating what was stated in NMED's August 7, 2006 letter, the Permittee must collect the following information from the wells located within a two-mile radius of the STP Ditches and submit results to NMED no later than January 30, 2007: dissolved oxygen, oxidation reduction potential, nitrate, total dissolved solids, pH, temperature, conductivity, metals (target analyte list metals only), total cyanide, free cyanide, amendable cyanide, and ammonia. Although the Permittee states that it sees no "merit" in sampling for Volatile Organic Compounds (VOCs), NMED requires that the Permittee sample all of the wells for VOCs. However, if VOCs are not detected, the Permittee may discontinue sampling for

VOCs during subsequent groundwater sampling events. NMED requires up-to-date and current data to assess natural attenuation processes. Initial VOC sampling must therefore be included to characterize current groundwater conditions at the site.

COMMENT 2

(Permittee Response #5): The Permittee has stated that "slug tests on sand-pack wells are of limited value"; NMED concurs with this conclusion. If the Permittee believes that a slug test will not provide adequate data regarding the aquifer characteristics at the site, then the Permittee must select another method for obtaining representative aquifer characteristics (e.g., step test, pump test). These tests must be conducted utilizing multiple wells including but not limited to use of MPL-17, SMW-03 and MPL-02 as pumping wells. The Permittee must identify and describe the chosen test method and wells to be used for each test in the required Work Plan.

COMMENT 3

(Permittee Response #5): The Permittee states that "the current distribution of cyanide is a relict of the former mounding caused by the recharge from the STP ditches…." The Permittee is referencing the Sedillo, 1969 document that discusses the groundwater mound and the plume migration. While the Sedillo study provides useful information, it is not an acceptable reference for current hydrogeologic conditions at the site for the reason that it is a 40 year old document and conditions may have changed. NMED requires that the Permittee address current hydrogeologic conditions for plume migration with current empirical data.

COMMENT 4

(Permittee Response #7): NMED does not concur with the idea that "properly interpreted" data can be inferred from a 1969 reference. The Permittee must collect current data for interpreting hydrogeologic conditions at the site. This information must be included in the required Work Plan to be approved by NMED. See also Comment 3.

The Permittee has requested an extension for the submittal of the Work Plan in the letter dated October 23, 2006. NMED hereby approves the extension. The Permittee must submit a Work Plan that includes actions to comply with the above comments by April 27, 2007. The work plan must also include a response letter that addresses the remainder of the comments in this letter cross-referencing NMED's numbered comments.

Failure to address the comments above will result in NMED's rejection of MNA as a viable remedy for these SWMUs. Moreover, NMED will require the Permittee to select a more aggressive method.

The NMED Hazardous Waste Bureau is in the process of switching to a new phone system. On or about December 7, 2006 the phone number for Ms. Diaz-Martinez will change from the current number (505) 428-2552 to the new number (505) 476-6056. The NMED Hazardous Waste Bureau's main number will be (505) 476-6000. If you have any questions concerning this letter, please contact Tammy Diaz-Martinez of my staff.

Sincerely,

James P. Bearzi
Chief
Hazardous Waste Bureau

JPB:tdm

cc: J. Kieling, NMED HWB
D. Cobrain, NMED HWB
T. Diaz-Martinez, NMED HWB
C. Frischkorn, NMED HWB
L. King, EPA Region 6 (6PD-N)
Jose Gallegos, WSMR
File: WSMR 2006 and Reading File
WSMR-99-007

WSMR response to **WHITE SANDS MISSILE RANGE (WSMR) NOTICE OF DEFICIENCY RESPONSE LETTER REGARDING THE EVALUATION OF MONITORED NATURAL ATTENUATION (MNA) AT STP DITCHES (SWMU 82 AND 83). WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235 HWB-WSMR-99-007, December 8, 2006**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
NMED introductory remarks.		The New Mexico Environment Department (NMED) has reviewed White Sands Missile Range's (the Permittee) response to NMED's Notice of Deficiency (NOD) dated October 23, 2006. NMED does not approve monitored natural attenuation (MNA) as an acceptable remediation method for this site at this time. The Permittee must address the following comments:		As discussed during the December 5, 2006 conference call, WSMR will be preparing two documents: a straightforward RCRA Facility Investigation Work Plan that describes field efforts to be accomplished in direct response to NMED requests; and a complete revision to the 2000 Corrective Measures Study (CMS). Insofar as it is practicable, discussions of issues will be deferred to the CMS. Field work can commence after the Work Plan is approved. The revised CMS is in preparation.
1		**(Permittee Response #4):** Reiterating what was stated in NMED's August 7, 2006 letter, the Permittee must collect the following information from the wells located within a two-mile radius of the STP Ditches and submit results to NMED no later than January 30, 2007: dissolved oxygen, oxidation reduction potential, nitrate, total dissolved solids, pH, temperature, conductivity, metals (target analyte list metals only), total cyanide, free cyanide, amendable cyanide, and ammonia. Although the Permittee states that it sees no "merit" in sampling for Volatile Organic Compounds (VOCs), NMED requires that the Permittee sample all of the wells for VOCs. However, if VOCs are not detected, the Permittee may discontinue sampling for VOCs during subsequent groundwater sampling events. NMED requires up-to-date and current data to assess natural attenuation processes. Initial VOC sampling must therefore be included to characterize current groundwater conditions at the site.		1. Note that VOC data are available (and have been reported to NMED) for 2000 – 2003. Additionally, VOC data for wells MPL01 – 04 have been reported for 2004 and 2005. 2. The requirement to present the data by January 30, 2007 is not supportable. We are initiating the next round of routine sampling (26 wells, new analytical schedule) in mid- to late-January. A request for an extension will be filed to allow the data from the January 2007 sample event to support this requirement. 3. VOCs will be added to analytical schedule, as requested, with the provision that such analyses will be continued only if VOCs are detected.
2		**(Permittee Response #5):** The Permittee has stated that "slug tests on sand-pack wells are of limited value"; NMED concurs with this conclusion. If the Permittee believes that a slug test will not provide adequate data regarding the aquifer characteristics at the site, then the Permittee must select another method for obtaining representative aquifer characteristics (e.g., step test, pump test). These tests must be conducted utilizing multiple wells including but not limited to use of MPL-17, SMW-03 and MPL-02 as pumping wells. The Permittee must identify and describe the chosen test method and wells to be used for each test in the required Work Plan.		1. For MPL-02 and -17, we will substitute single-well pump tests in lieu of the slug tests, but continue to use these wells as identified by NMED. SMW-03 is not productive enough to support a pump test, so a slug test will be performed. 2. All three of these wells are too far from their neighbors to allow measurable drawdown in adjacent wells. 3. Disposal of produced water is an issue. Disposal options will be presented in the Work Plan.

WSMR response to **WHITE SANDS MISSILE RANGE (WSMR) NOTICE OF DEFICIENCY RESPONSE LETTER REGARDING THE EVALUATION OF MONITORED NATURAL ATTENUATION (MNA) AT STP DITCHES (SWMU 82 AND 83). WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235 HWB-WSMR-99-007, December 8, 2006**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
3		**(Permittee Response #5):** The Permittee states that "the current distribution of cyanide is a relict of the former mounding caused by the recharge from the STP ditches...." The Permittee is referencing the Sedillo, 1969 document that discusses the groundwater mound and the plume migration. While the Sedillo study provides useful information, it is not an acceptable reference for current hydrogeologic conditions at the site for the reason that it is a 40 year old document and conditions may have changed. NMED requires that the Permittee address current hydrogeologic conditions for plume migration with current empirical data.		1. The Sedillo (1969) document was cited as a description of initial conditions, Contemporary hydrogeologic conditions across the site were reported in the 2000 CMS; data have been updated with each subsequent sampling event supporting the current conclusion that a relict condition still exists. 2. The synoptic water level measurements to be conducted under the Work Plan will further update the existing site information. 3. Discussion of current conditions and historical data will be deferred to the CMS.
4		**(Permittee Response** #7): NMED does not concur with the idea that "properly interpreted" data can be inferred from a 1969 reference. The Permittee must collect current data for interpreting hydrogeologic conditions at the site. This information must be included in the required Work Plan to be approved by NMED. See also Comment 3.		See response to Comment 3. Discussion of current conditions and historical data will be deferred to the CMS.
		The Perrnittee has requested an extension for the submittal of the Work Plan in the letter dated October 23, 2006. NMED hereby approves the extension. The Pennittee must submit a Work Plan that includes actions to comply with the above comments by April 27, 2007. The work plan· must also include a response letter that addresses the remainder of the comments in this letter cross-referencing NMED's numbered comments.		The Work Plan will be delivered as soon as practicable, but no later than April 27, 2007. Field work will be initiated within 30 days of receipt of Work Plan approval and, contingent upon funding, will be completed 120 days thereafter. Delivery of the CMS is to be determined.
		Failure to address the comments above will result in NMED's rejection of MNA as a viable remedy for these SWMUs. Moreover, NMED will require the Permittee to select a more aggressive method.		Noted.

NEW MEXICO
ENVIRONMENT DEPARTMENT

Hazardous Waste Bureau

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DIANE DENISH
Lieutenant Governor

RON CURRY
Secretary

CINDY PADILLA
Deputy Secretary

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

March 18, 2008

T.A. Ladd
U.S. Army Garrison White Sands
100 Headquarters Avenue (B. 1510)
ATTN: IMSW-WSM-PW
White Sands Missile Range, NM 88002

RE: **REJECTION OF THE REVISED RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82), WHITE SANDS MISSILE RANGE EPA ID NO. NM2750211235 WSMR-07-001**

Dear Mr. Ladd:

The New Mexico Environment Department (NMED) has received the Department of the Army's (the Permittee) *Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82)* (Monitoring Plan), dated February 2008. The revised Monitoring Plan was required by NMED's Notice of Deficiency letter dated August 24, 2007. NMED has determined that the Permittee did not respond to the comments established in the NOD, but instead addressed a former NOD dated August 7, 2006. NMED hereby rejects the Monitoring Plan.

The Permittee must address all comments contained in the August 24, 2007 NOD and submit a revised Monitoring Plan. NMED will re-evaluate the Monitoring Plan once the required information is provided. The Permittee must submit the revised Plan by April 11, 2008.

If you have any questions regarding this letter, please contact Tammy Diaz-Martinez of my staff at (505) 476-6056.

Sincerely,

John E. Kieling
Program Manager
Permits Management Program
Hazardous Waste Bureau

cc: Dave Cobrain, NMED HWB
Tammy Diaz, NMED HWB
C. Frischkorn, NMED HWB
Jose Gallegos, WSMR

File: WSMR 2008 and Reading File
WSMR-07-001

William Little

From: Diaz, Tammy, NMENV [Tammy.Diaz@state.nm.us]
Sent: Tuesday, March 25, 2008 11:28 AM
To: Gallegos, Jose A Mr CIV USA IMCOM; wlittle@ws-tech.com
Cc: Frischkorn, Cheryl, NMENV; Cobrain, Dave, NMENV
Subject: Monitoring plan clarification-STP Ditches

Hello-I just wanted to provide some clarification for the February 2008 Monitoring Plan (MP). There are not many technical comments in the August 24, 2007 NOD that should be addressed in the revised MP; however, the comments that are currently in the MP as listed below are from the August 4, 2006 NOD and are also addressed in the 2008 Work Plan (WP):

Section 5.1 NMED's requirement is a WP type comment and should be removed from the MP, it does not address monitoring at the site. This comment has already been addressed in the 2/2008 Work Plan as well.

Section 5.2 this too is a WP type comment and has already been addressed in the 2/2008 WP, it should be removed from the MP.

Section 5.4 has also been incorporated in the WP and is not part of the MP.

Section 5.3 is from the August 7, 2006 NOD, but should still remain in the current MP, instead as presenting it as a quote from the 8/7/06 NOD, it should be presented as part of the proposed Groundwater Sampling Section, or the Permittee must include a statement that states that the comment is not addressing the 8/24/2007 NOD but the 8/04/2006 rather, for clarification to the readers.

The Permittee did not address Comment 2 from the 8/24/2007 NOD, this should be incorporated in the MP along with the corresponding response that is included in the Comment Response Table located in Appendix A of the 2008 MP.

Basically a Monitoring Plan should include proposed monitoring efforts for planned monitoring. Because the current 2008 MP is the same as the May 2007 Monitoring Plan, the comments that were required to be included in a separate Work Plan still remain in the Monitoring Plan, therefore the Permittee did not address the 8/24/2007 NOD.

The Comment Response Table included in Appendix A of the 2008 MP is in an Appendix and is not part of the actual Monitoring "Plan", typically readers do not refer to Appendices unless directed to, but for monitoring purposes a reader should be able to

pickup a monitoring plan read the body of the text and know what is being proposed for monitoring at a site.

I hope this provides some clarification for what should be included in a monitoring plan. If you have any questions please feel free to contact me. I will be in the office the rest of today, but will be out from March 26 through April 2, I will be back in the office on April 3.

Tammy Diaz-Martinez
Environmental Specialist
RCRA Permits Management Program
Hazardous Waste Bureau
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Santa Fe, NM 87505
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WSMR response to

1. **NMED NOTICE OF DISAPPROVAL, RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82), WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235, WSMR-07-001, 24 August 2007.**
2. **NMED Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001, 18 March 2008.**
3. **NMED E-Mail Message, Monitoring plan clarifications – STP Ditches, T. Diaz, NMED, to José Gallegos, WSMR, 25 March 2008, and 18 April 2008 telephone conversation, C. Frischkorn/J. Gallegos, further clarifying NMED comments.**

Comment Number		NMED Comments		WSMR Response and Discussion
NMED NOTICE OF DISAPPROVAL, RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82), WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235, WSMR-07-001, 24 August 2007				
1		In Section 3.2 (Corrective Measures Studies), the Permittee states "[a] revised Corrective Measures Study (CMS) is currently (2007) in preparation which addresses current conditions, understandings and agency concerns." Solid Waste Management Unit (SWMU) 82 is a regulated unit and therefore a Closure Plan, rather than a CMS, is required to be submitted to NMED. This issue is being addressed in the June 11, 2007 White Sands Missile Range (WSMR) Draft Resource Conservation and Recovery Act (RCRA) Permit.		WSMR will cease preparation of the previously agreed-to revised CMS. Closure Plan issues will be addressed during negotiation concerning the draft RCRA Permit.
2		In Section 5.3 (Groundwater Sampling), the Permittee references NMED's Comment 6 of the August 7, 2006 Response Letter (located in Appendix A). In the letter, NMED asks the Permittee to provide an explanation for dissolved oxygen level measurements that appear to be uncharacteristic of possible groundwater conditions at the site. NMED also asks the Permittee to explain how the data was collected and if any data collection problems were encountered. The Permittee has not addressed this Comment in the current Monitoring Plan. The Permittee must address this issue in the revised Monitoring Plan.		At the present time, WSMR has no ready explanation for the apparent anomalies, nor do we have recorded difficulties with data collection. Sampling preparations, collection techniques, and recordkeeping have been double-checked and observed by third parties with no anomalies noted. Examination of the sampling record shows that, while there were anomalies reported during 2005, there have been no obvious problems since. We intend to continue to carefully follow sampling and measurement protocols in order to discover and correct any problems. Care will be taken to insure that field measurements are collected properly (equipment calibration and sampling technique). Sampling and data collection procedures are presented in the cited and provided SOPs, which are appropriate for the site and the assigned tasks. See Section 5.0, pages 3 – 4.
3		In Section 5.3 (Groundwater Sampling), page 5, the Permittee states "WSMR will continue the ongoing groundwater monitoring program, with sampling scheduled to occur on & semi-annual basis, usually in December and June of each Year.. -This Program was initiated in 2005 and is due for re-evaluation in 2010." The groundwater monitoring dates are subject to change based on pending requirements in the June 11, 2007 White Sands Missile Range RCRA Permit Draft. The Permittee must remove the reference to re-evaluation in 2010.		Noted.
4		In Section 5.3 (Groundwater Sampling), page 5, the Permittee states "[c]are will be taken to insure that field measurements are collected properly (equipment calibration and sampling technique)." The Permittee must include descriptions of proposed methods and procedures for sampling and data collection. The Permittee must also include a step test(s) to determine pumping rates at the well(s) proposed for constant discharge aquifer testing (listed in Table 5-1). The Permittee must provide a detailed description of these procedures in the aquifer characterization work plan submittal.		1) The requested information is provided in the supplied SOPs. 2) The proposed aquifer test will be addressed in a separate work plan and executed by the U.S. Geological Survey.

WSMR response to 1. **NMED NOTICE OF DISAPPROVAL, RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82), WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235, WSMR-07-001, 24 August 2007.** 2. **NMED Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001, 18 March 2008.** 3. **NMED E-Mail Message, Monitoring plan clarifications – STP Ditches, T. Diaz, NMED, to José Gallegos, WSMR, 25 March 2008, and 18 April 2008 telephone conversation, C. Frischkorn/J. Gallegos, further clarifying NMED comments.**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
5		In Table 5-2 (Planned Analytical Program), the Permittee lists the proposed analytical methods for the sample analysis. The methods proposed for analysis of Volatile Organic Compounds (VOCs) and cyanide are not the most current according to Environmental Protection Agency (EPA) methods. The most current are Method 8260C for VOCs and Method 9010C for cyanide. Please refer to http://www.epa.gov/sw-846/new-meth.htm and http://www.epa.gov/fedfac/pdf/mra_hbook_5_05.pdf. The Permittee must revise the Monitoring Plan to propose using these updated analytical methods. This correction must also be included in the aquifer characterization work plan.		We acknowledge the new methods, but recognize that the guidance leaves it to our discretion, we will propose using new methods if readily available, and otherwise, current methods will continue to be used.
6		In Section 5.4 (Aquifer Testing), the Permittee references NMED' Comment 2 of the December 8, 2006 (located in Appendix A). In the response letter, NMED requires the Permittee to provide aquifer testing in multiple wells that include, but are not limited to, wells MPL-02, MPL-17 and SMW-03, In the Monitoring Plan the Permittee states "[t]hese wells are too far to allow measurable drawdown in adjacent wells." The Permittee must propose a well or wells that will allow for a multiple-well constant discharge test(s) in the area near SMW-03. The well or wells proposed for this study, along with a description of the detailed proposed aquifer testing, must be included in the aquifer characterization work plan.		Aquifer Testing details will be addressed in the separately provided Aquifer Characterization Work Plan.
7		In the Comment Response table (located in Appendix A) addressing NMED's Comment Response Letter dated August 7, 2006, and NMED's Notice of Deficiency (NOD), dated December 8, 2006, the Permittee states that a work plan is being prepared and will be submitted to NMED. The Permittee must include all proposed aquifer testing details in the aquifer characterization work plan to be submitted to NMED. Monitoring addressed in the Comment Response tables must be included in the revised Monitoring Plan.		By prior agreement with NMED [fonecon 18 April 2007, Gallegos / Frischkorn and follow-up C. Frischkorn e-mail message, 19 April 2007], the provided Monitoring Plan contained the planned aquifer testing program. However, the revised Monitoring Plan will not address aquifer tests. Aquifer testing details will be addressed in the separate Aquifer Characterization Work Plan.
8		The Permittee failed to provide the details for conducting any aquifer tests at the site. As stated in previous comments, the Permittee must submit an aquifer characterization work plan for NMED's approval that provides the details for conducting aquifer tests at a minimum of four wells, including at least one multiple well constant discharge test.		See responses to Comments 4 and 7.

WSMR response to 1. **NMED NOTICE OF DISAPPROVAL, RCRA MONITORING PLAN, FORMER STP PERCOLATION DITCHES, WSMR-62 (SWMU 82), WHITE SANDS MISSILE RANGE, EPA ID NO. NM2750211235, WSMR-07-001, 24 August 2007.** 2. **NMED Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001, 18 March 2008.** 3. **NMED E-Mail Message, Monitoring plan clarifications – STP Ditches, T. Diaz, NMED, to José Gallegos, WSMR, 25 March 2008, and 18 April 2008 telephone conversation, C. Frischkorn/J. Gallegos, further clarifying NMED comments.**				
Comment Number		**NMED Comments**		**WSMR Response and Discussion**
9		In the Comment Response table (located in Appendix A) addressing NMED's Comment Response Letter, dated August 7, 2006, Comment 7, NMED requires that the Permittee provide reliable information to support current aquifer conditions at the site. In response to NMED's comment, the Permittee states "WSMR believes that, properly interpreted, the available data provide a coherent, plausible, and acceptable description of current and past hydrogeologic conditions. These data provide an adequate basis for interpreting and predicting future conditions." In the past, the Permittee has not provided current aquifer data; therefore, based on proposed investigations and results, the Permittee must therefore re-evaluate the data collected during the upcoming well characterization activities and develop a model of current hydrogeologic conditions. Results from this study must be included in the Closure Plan. (See Comment 1)		WSMR will conduct an additional aquifer test (as described in the separate Aquifer Characterization Work Plan) and will consider this new data with data previously collected (e.g., *Considerations of Aquifer Permeability in the Vicinity of the Former Sewage Treatment Plant (STP) Percolation Ditches*, WTS, May 2006) to describe aquifer conditions.
10		In the Comment Response table addressing NMED's NOD dated December 8, 2006 (Appendix A), the Permittee proposes to submit a Work Plan that describes proposed activities in response to NMED's request, as well as a complete CMS. As stated in Comment 1, the Permittee must submit a Closure Plan to NMED, not a CMS. This issue is being addressed in the WSMR Draft RCRA Permit dated, June 11, 2007.		See response to Comment 1.
NMED Rejection of the Revised RCRA Monitoring Plan, Former STP Percolation Ditches, WSMR-62 (SWMU 82), White Sands Missile Range, EPA ID No. NM2750211235, WSMR-07-001, 18 March 2008.				
1		NMED has determined that the Permittee did not respond to the comments established in the NOD, but instead addressed a former NOD dated August 7, 2006. NMED hereby rejects the Monitoring Plan.		The ambiguity should be cleared up throughout the current version.
NMED E-Mail Message, Monitoring plan clarifications – STP Ditches, T. Diaz, NMED, to José Gallegos, WSMR, 25 March 2008, and 18 April 2008 telephone conversation, C. Frischkorn/J. Gallegos, further clarifying NMED comments.				
1		Discussion specified certain portions of the Monitoring Plan to be removed.		All such material has been removed.
2		Discussion questioned accuracy of citations for cyanide methods in Table 5-2.		Full method citations have been provided. WSMR has verified that appropriate methods are being employed.

APPENDIX B

Standard Operating Procedures

APPENDIX B

White Sands Technical Services, LLC, has a set of Standard Operating Procedures (SOPs) addressing common tasks. For each project, an SOP can be used, *verbatim*, or it can be modified to meet the needs of the specific program. Listed below are the SOPs to be used for execution of this Work Plan. The documents, themselves, are included on the following pages.

SOP 1 Quality Control Program

SOP 1.1 - Chain of Custody

SOP 1.2 - Field Activity Documentation

SOP 2 Sample Handling, Packing, and Shipping

SOP 2.1 - Sample Labeling

SOP 2.2 - Sample Numbering

SOP 2.3 - On-Site Sample Storage

SOP 4 Calibration and Maintenance of Measurement and Test Equipment

SOP 4.1 - Field Instrument

SOP 5 Water Level Measurements in Monitoring Wells

SOP 6 Field Equipment Decontamination

SOP 9.3 Low-Flow Ground Water Sampling

SOP 13 Field Quality Control Sampling

SOP 14 Management of Investigation-Derived Waste

SOP 15 Preparation, Revision, and Approval of Plans and Procedures

SOP 16 Quality Inspection and Inspection Records

FIELD QUALITY PROGRAM

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the Field Quality Program developed to implement the quality requirements applicable to the field activities at the various sites at White Sands Missile Range, New Mexico.

2.0 REFERENCES

None.

3.0 RESPONSIBILITIES

The Project Manager is responsible for the overall implementation of the Work Assignment Orders. He/she should establish and cultivate principles and practices that integrate field quality requirements into the daily work and provide individuals performing the work with proper information, tools, support, and encouragement to properly perform their assigned work. He/she will coordinate the preparation of project specific Quality Control Project Plans (QCPPs) (i.e., Sampling and Analysis Plans, Field Sampling Plans, etc.).

The Project Technical Manager, Technical Coordinator, and Project Chemist are responsible for assisting the Program Manager to assure that the project's goals and objectives are clearly stated and communicated to participating personnel. Each will provide direct oversight and coordination of operations in order to assure that they are suitably controlled, including acting on the behalf of the Program Manager in his/her absence. Each will prepare portions of project specific Quality Control Project Plans appropriate to his/her background and experience.

The Quality Assurance Officer is responsible for preparing the programmatic documents and applicable SOPs that describe the implementation of the requirements of the field work and related QC activities. He/She will assign project specific Quality Assurance Officers as appropriate, and provide oversight and assistance in the implementation of the SOPs.

4.0 DEFINITIONS/MATERIALS

Quality Control Project Plans (QCPPs) (i.e., Sampling and Analysis Plans, Field Sampling Plans, etc.)

5.0 PROCEDURE

The SOPs are designed to implement the quality requirements applicable to the program/project specific activities. The SOPs will be reviewed and approved by responsible management prior to their implementation.

Quality affecting SOPs prepared to perform work assignment orders are prepared and revised by technical personnel under the direction of the Project Environmental Engineer or Project Geologist and are reviewed and approved by the Program Manager, Quality Assurance Officer and as applicable by the Health and Safety Manager.

6.0 REQUIRED FORMS/DOCUMENTATION

None

CHAIN OF CUSTODY

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the method and responsibilities associated with the maintenance and custody of samples that are to be used to provide data that form a basis for making project related decisions. It outlines the general procedures for maintaining and documenting sample chain of custody from the time of sample collection through sample disposition.

2.0 REFERENCES

USEPA, Test Methods for Evaluating Hazardous Waste, (SW-846), current revision.

3.0 RESPONSIBILITIES

The Project Technical Manager or Technical Coordinator is responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Project Chemist is responsible for assuring that the proper chain of custody is initiated at the time the sample(s) are collected and maintained throughout the handling and subsequent transportation of the sample(s) to the designated laboratory. Additionally, the Project Chemist is the project authority for determining the disposition and fate of sample(s) that have identified deficiencies (e.g., missed holding times, elevated temperature at receipt, etc.).

The Quality Assurance Officer is responsible for periodic review of Chain of Custody records generated and other documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader is responsible for properly documenting and maintaining the Chain of Custody from the time of sample collection until the sample is delivered to the laboratory.

Laboratory Personnel are responsible for receipt and entry of samples into the laboratory that have been submitted to the laboratory under a Chain of Custody document. Additionally, samples received will be entered into the laboratory Chain of Custody procedures by properly documenting and maintaining chain of custody from the moment that they take custody of the sample at the laboratory until the sample is disposed of or returned to the client.

4.0 DEFINITIONS/MATERIALS

4.1 Chain of Custody

The Chain of Custody document sometimes called the “cradle to grave” record is the written record that traces the sample possession from the time each sample is collected until its final disposition. Chain of Custody is maintained by compliance with one of the following criteria:

- The sample is in the individual’s physical possession.
- The sample is maintained in the individual’s physical view after being in his/her possession.
- The sample is transferred to a designated secure area restricted to authorized personnel.
- The sample is sealed and maintained under lock and key to prevent tampering, after having been in physical possession.
- The sample is transferred under proper manifesting and documentation from one party to another with documentation being maintained throughout the sampling and analysis period.

4.2 Waybill

A waybill is a document that contains a list of the goods and shipping instructions relative to a shipment.

4.3 Common Carrier

For the purpose of this procedure, the common carrier is any commercial carrier utilized for the transportation of the sample(s) from the field to the laboratory.

5.0 PROCEDURE

5.1 General

The ability to demonstrate that the samples were obtained from the locations stated and that they reached the laboratory without alteration is required to maintain documented chain-of-custody. Evidence of collection, shipment, laboratory receipt, and laboratory custody until disposal must be documented to accomplish this. Documentation will be accomplished through a Chain of Custody Record that lists each sample and the individuals performing the sample collection, shipment, and receipt.

The Chain of Custody document is a preprinted form. The original will accompany the samples to the laboratory and a copy will be retained in the field project file.

5.2 Field Sample Custody

Sampling personnel, upon collection of samples for analysis, will properly complete a Chain of Custody record form. The Chain of Custody document will be the controlling document to assure that sample maintenance and custody are maintained; thereby assuring the sample(s) are representative of the environment from which they were collected. At a minimum, the following information will be recorded on the Chain of Custody document:

- The unique identification number assigned to each sample.
- A brief description of the sampling location and a physical description of the sample type.
- The date and time of the sample collection.
- The general environmental conditions (i.e. temperature, weather) at the time of sample collection.
- Container type (e.g., glass, poly, brass sleeve, etc.).
- Sample volume and number of containers (e.g., 2 x 40 ml, 3 x 1 liter)
- Sample preservation (e.g., HNO_3, H_2SO_4, 4^oC).
- Requested analyses.
- Special instructions to the laboratory including handling requirements, quality assurance / quality control, health and safety, and sample disposition.
- The project name and number.
- The date the analytical report is due.
- The names of all sampling personnel.
- The name and telephone number of the project contact.
- The name and telephone number of the laboratory contact.
- The name of the courier and the waybill number (if applicable).
- A unique document reference number.

5.3 Transferring Chain-of-Custody

The Chain of Custody document will be initiated in the field by the person collecting the sample and signed by each individual who has the samples in their possession. Each time that sample custody is transferred, the former custodian must sign over the Chain of Custody as “Relinquished By,” and the new custodian must sign on to the Chain of Custody as “Received By.” The date, time, and the name of their

FIELD ACTIVITY DOCUMENTATION

1.0 PURPOSE

This purpose of this Standard Operating Procedure (SOP) is to define the minimum requirements for documenting field activities in the field logbooks. Field logbooks provide a detailed daily handwritten record, kept in real time, of field activities performed at an investigation site. Logbooks are permanently bound by glue or thread into a hard cover, and should be waterproof. Field logbooks may be assigned to specific activities, positions, or areas within the site. Field logbook covers must be sequentially numbered and indicate the position, task, activity, or area assigned to the logbook.

2.0 REFERENCES

None.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities and geotechnical measurements are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field-generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) quality issues are identified.

The Sampling Team Leader is responsible for ensuring that field logbooks are completed daily in accordance with this procedure.

The Sampling Team Members are responsible for making timely and complete entries in the field logbook and for reporting daily activities to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer, as appropriate.

4.0 DEFINITIONS/MATERIALS

4.1 Field Logbook

The field logbook is a surveyor's book or record book, bound and ruled/gridded, with sequentially numbered and water proof pages.

4.2 Waterproof black ink pens

Required for entry into field logbook.

5.0 PROCEDURE

5.1 Field Logbook Cover

Label the front cover of the field logbook with the project name and number, subcontractor name, client name, the start date and, when complete, the finish date. The field logbooks must be sequentially numbered.

project or company affiliation must accompany each signature. Shipping by common carrier is addressed separately, elsewhere in this subsection.

Transferring of Chain of Custody from sampling personnel to the analytical laboratory will be performed in accordance with the requirements stated below. If the sampling personnel deliver the samples to the laboratory directly, transfer of Chain of Custody occurs as follows:

- The sample collector delivers the samples to the laboratory and relinquishes the sample directly to a laboratory representative.
- The collector signs the Chain of Custody listing his/her name, affiliation, the date, and time. Any person involved in the collection of the sample may act as the sample custodian.
- The laboratory representative must receive the samples by signing his/her name, affiliation, the date, and time of the Chain of Custody Record. The laboratory representative may decline to take receipt of the samples if the Chain of Custody Record is not properly completed or if the samples are not properly packaged. All designated laboratory personnel may act as the sample custodian.

If the sampling personnel transfer sample(s) to the laboratory utilizing a common carrier, sampling personnel will retain Chain of Custody responsibility and the common carrier is not responsible for maintaining sample custody. The sample collectors are responsible for packaging the samples in a manner that meets the Chain of Custody definition criteria, that is; the samples are sealed to prevent tampering. When transferring samples to the courier for transport, Chain of Custody procedures are maintained as follows:

- The sample collector lists the courier affiliation and waybill number on the Chain of Custody Record.
- The sample collector relinquishes custody by signing his name, affiliation, date, and time. The collector keeps a copy of the relinquished Chain of Custody Record for the project file.
- The relinquished original Chain of Custody Record is sealed in a watertight plastic bag and taped to the inside of the lid of the transport container.
- The transportation container is sealed to prevent tampering and given to the courier for delivery to the laboratory.
- The sample collector obtains a copy of the waybill from the courier for the project file.
- The laboratory representative must receive the samples by signing his/her name, affiliation, the date, and time on the Chain of Custody Record. This copy is maintained with the samples at the laboratory.
- The laboratory representative obtains a copy of the waybill from the courier for the project file.

5.4 Analytical Laboratory Custody

Upon receipt at the analytical laboratory, the field generated Chain of Custody document will be signed, dated, time marked, temperature marked, and laboratory identification will be provided in the appropriate spaces. Laboratory receipt personnel will enter the samples into the laboratory by implementing the sample custody procedures addressed within their approved Program Plan.

After completion of analytical testing, sample remnants not consumed during testing may be kept for six months beyond the completion of analysis, unless otherwise specified by a notation on the Chain of Custody record that samples are to be returned to the project site for disposal. Once this time period has elapsed, the samples will be disposed of and the disposal record number will be recorded on the laboratory record copy of the Chain of Custody Record.

6.0 REQUIRED FORMS/DOCUMENTATION

Chain of Custody Record
Shipping waybill (as applicable)

5.2 Field Logbook

The following steps must be followed when making entries in the field logbook:

1. Enter the day and date; time the task started; weather conditions; and the names, titles, and organizations of personnel performing the task.
2. Record the name, title and organization, time of arrival, and time of departure of all personnel and visitors to the task area.
3. Describe all site activities in specific detail or indicate the forms used to record such information (e.g., soil boring log or well completion log). A partial data list is given below:
   - Monitor wells: complete the Monitor Well Construction Log form.
   - Monitor well development: complete the Well Development Log.
   - Monitor well purging and sampling: complete the Monitor Well Purge and Sample Log form.
   - Surface water and sediment/sludge sampling: complete the Surface Water/Sediment Sampling Log form.
   - Subsurface soil sampling:
   - Soil borings: complete the Soil Boring Log and include borehole size, depth, sample equipment, method, and sample collected. Detailed lithologic data will be recorded on the boring log.
   - Trenches, and test pits: record the excavation dimensions, sampling equipment or method(s), and samples collected. Detailed lithologic data will be recorded on the Test Pit Information Log.
   - Soil gas and geophysical surveys: grid or line dimensions, probe or sensor spacing, depths, survey and recording equipment type and serial or identification number, and location of resulting data (e.g., strip chart, analog data record, computer file, and file name). Sketches are valuable additions to field notes and should be used where possible.
4. Describe in specific detail any field tests that were conducted and instruments used. Reference any forms that were used, other data records, and the procedures followed in conducting the test. If the final results of any field activity are obtained in the field, these data should be annotated in the field logbook.
5. Changes in procedures or sample locations and reasons for change.
6. Describe in specific detail any samples collected and whether splits, duplicates, matrix spikes or blanks were prepared.
7. Upgrades or downgrades of personal protective equipment and the rationale for such action, and health and safety information such as level of personal protective equipment (PPE) used.
8. List the time, equipment type, and the procedure followed for all decontamination actions carried out. Reference the page number(s) in the decontamination log (if any) where detailed information is recorded; if not referenced, detailed information shall appear in the field logbook.
9. List all instrument calibrations, person(s) performing calibration, and the page number of the calibration log that provided specific information on calibration procedures and results when the calibrations occur in the field.
10. Record all photographs by number and includes a description of the subject, the direction the photographer is facing, and the photographer's initials. If the event photographed is the collection of a sample, record the sample ID number.
11. List any equipment failures or breakdowns that occurred, together with a brief description of repairs or replacements.

12. List in specific detail any exceptions or modifications to any applicable SOP's or standards and provide full description of justification for such variances.
13. No pages may be removed from the site or field logbooks for any reason. Blank pages must be marked "page intentionally left blank".
14. Mistakes must be crossed out with a single line, initialed, and dated. Only persons authorized by the Project Technical Manager or Technical Coordinator may make entries in the logbook.
15. The Project Technical Manager, Technical Coordinator, or Sampling Team Leader must sign the field logbook at the bottom of each page.

6.0 REQUIRED FORMS/DOCUMENTATION

None.

SAMPLE HANDLING, PACKING, AND SHIPPING

1.0 PURPOSE

This Standard Operating Procedure (SOP) outlines the methods and responsibilities for field personnel to use in the packaging and shipping of environmental samples for chemical and physical analysis. This SOP only applies to the packaging and shipping of limited quantity, low concentration environmental samples. This procedure does not apply to those samples considered hazardous materials, hazardous waste, mixed waste, radioactive waste, and/or dangerous goods. Those requirements are specified in the Department of Transportation (DOT) 49 CFR 114-327 and the International Air Transport Association (IATA) procedures. The details within this SOP are only applicable to the general requirements for sample packaging and shipping and should only be used as a guide for developing more job-specific work plans.

2.0 REFERENCES

EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER directive 9355.3-01.

Code of Federal Regulations, DOT 49 CFR parts 100 to 177, revised October 1, 1992.

Dangerous Goods Regulations, IATA, January 1, 1994.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Project Chemist is responsible for the development and review of site-specific work plans that address the specific sample handling, packaging, and shipping requirements for the project. Review the project specific documentation forms to ensure they are appropriate for the field activities. The Project Chemist is also responsible for seeing that field personnel receive proper training and maintain quality assurance/quality control (QA/QC). If problems arise, the Project Chemist is responsible for swift implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to requirements, issuing nonconformances, etc.).

The Quality Assurance Officer is responsible for periodic review of documentation generated during sample handling, packaging, and shipping and the periodic review and audit of field personnel as they perform the work.

The Sampling Team Leader(s) is responsible for ensuring that samples are handled, packed and shipped in accordance with this procedure.

4.0 DEFINITIONS/MATERIALS

4.1 Environmental Sample

A limited quantity, low concentration sample that does not require DOT or IATA hazardous waste labeling as a hazardous waste or material.

4.2 Hazardous Waste Sample

Medium or high concentration sample requiring either DOT or IATA labeling as a hazardous waste or material.

4.3 Hazardous Waste

Any substance listed in 40 CFR Subpart D (260.30 et seq.) or otherwise characterized as ignitable, corrosive, reactive, or toxic as specified in Subpart C (261.20 et seq.) and that would be subject to manifest and packaging requirements specified in 40 CFR 262. Hazardous waste is defined and regulated by the U.S. Environmental Protection Agency (USEPA).

4.4 Hazardous Material

A substance or material in a quantity or form that may pose an unreasonable risk to health, safety, and/or property when transported in commerce and as specifically defined and regulated by DOT (49 CFR 173.2 and 172.101) and IATA (Section 4.2).

4.5 Sample

Physical evidence collected from a facility or the environment that is representative of conditions at the point and time at which the sample is collected.

5.0 PROCEDURE

5.1 Sample Handling

Inspect the sampling containers (as applicable, generally obtained from the analytical laboratory prior to the sampling event) to ensure that they are appropriate for the samples being collected, correctly preserved, and undamaged.

When collecting or handling a sample, always use approved/site specific personal protective equipment (e.g., gloves, etc.) not only to prevent cross-contamination from sample to sample but also as a health and safety requirement.

5.2 Field Packaging

1. Collect the samples in accordance with the site-specific work plans and applicable SOPs.
2. As soon as possible after sample collection, tightly seal the container, and place a piece of custody tape over or around the cap. The custody tape should be placed over the cap so that any attempt to remove the cap will cause the tape to be broken. Do not place custody tape over a volatile organic analysis (VOA) vial septum.
3. Place each container in a separate, appropriately sized, airtight, seam-sealing polyethylene bag (e.g., ZiplocTM or equivalent). Seal the bag, removing any excess air.
4. Place the bagged container inside an insulating shipping container, “cooler”. This cooler should have frozen blue ice or airtight, seam-sealing polyethylene bags of ice inside to assure samples remain cool, 4°C ± 2°C, during transit from field to the packaging location.
5. Because blue ice does not maintain 4°C standard required for sample shipping, it should only be used while in the field collecting samples.
6. Maintain the samples under chain of custody in accordance with the site-specific work plans and appropriate SOPs.

5.3 Sample Packaging

1. Inspect the integrity of the shipping container. The container is generally a "cooler" constructed of heavy plastic or metal with appropriate insulating properties so that variation in temperature during shipping is minimized. Also make sure that the drain plug has been sealed with nylon reinforced strapping tape or mailing tape.
2. Place two or four inches of absorbent packaging material (e.g., Styrofoam bubbles, Vermiculite™ etc.) in the bottom of the shipping container.
3. Carefully check the chain of custody record against the collected sample labels and containers to ensure that the sample numbers, sample description, date and time of collection, container type and volume, preservative, and the required analytical methods are correct and in agreement.
4. Place the samples in the shipping container, allowing sufficient room between the samples to place ice and/or packing material.
5. Double bag and seal crushed or cubed ice in heavy-duty polyethylene bags (Ziplock™ or equivalent). Place these bags of ice on top of and between samples. Blue ice should not be used for sample shipping; it does not maintain the 4°C temperature necessary for regulatory compliance. Include a VOA vial of tap water clearly labeled "temperature blank" so that the laboratory can verify the temperature of the samples upon receipt. The remaining space will be filled with packing material.
6. All samples requiring temperature preservation stated at 4°C will be acceptable "as is" within the range of 4°C ± 2°C. The laboratory should record the temperature of receipt upon the chain of custody report. For all samples received at less than 2°C (note not frozen), or at greater than 6°C, the sample(s) and temperature (in 1°C increments) will be identified on the chain of custody and the Project Chemist notified in order to provide a determination and written authorization to proceed to analysis.

5.4 Sample Shipping

1. The laboratory will be contacted prior to sample shipments. Delivery on weekends and holidays will be confirmed in advance, and prior to shipment.
2. The person in charge of sample custody will note the time, date, and sign over relinquishment of custody on the Chain of Custody. When a common carrier is to be used for sample shipment, also record the air/waybill number (tracking number) and the name of the carrier on the Chain of Custody record.
3. Place the original copy of the Chain of Custody record and a copy of the task specific analyte list in a sealed, clear plastic envelop or bag and tape the envelope to the inside lid of the shipping container. Retain a copy of the Chain of Custody record and shipping waybill (as applicable) for tracking purposes.
4. Using nylon reinforced strapping tape or mailing tap, seal the shipping container. Place custody tape over opposite ends of the lid. Apply a label stating the name and address of the shipper and the receiving laboratory on the outside of the cooler.
5. If QA split samples are shipped the Project Chemist or Project Manager shall notify the QA Laboratory in advance of sample shipment (for large numbers of samples, greater than 20).

   NOTE: The courier or carrier is not responsible for sample custody and is not required to sign the Chain of Custody record. Contact the appropriate laboratory personnel to advise them of the sample shipment.
6. Review the Chain of Custody and sample collection forms for completeness and turn them over to site or project management.

6.0 REQUIRED FORMS/DOCUMENTATION

Chain of Custody Record

Shipping Waybill (as applicable)

Task Specific Analyte List (as applicable)

SAMPLE LABELING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for sample labeling. Sample labeling is required to identify, track and trace samples from the time of collection until the time of disposal. Additional specific procedures and requirements will be provided in the project work plans.

2.0 REFERENCES

EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER directive 9355.3-01.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection and labeling activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this sample labeling SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to sample labeling requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to sampling and sample labeling activities are responsible for completing their tasks to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager or Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Sample Label

Sample labels include all forms of sample identification (labels and tags) that are physically attached to samples collected and provide, at a minimum, the information required by this SOP and related project work plans.

5.0 PROCEDURE

This section contains the procedures involved with sample labeling. Sample labeling is required to identify, track and trace samples from the time of collection until the time of disposal. The details within this SOP should be used in conjunction with the project work plans and other related SOPs. The project work plans will commonly provide the following information:

- Sample collection objectives.
- Number, types and locations of samples to be collected.
- Any additional sample labeling requirements or procedures beyond those covered in this or related SOPs, as applicable.

5.1 Sample Labeling

Document all the information necessary on the sample label and ensure that the label is physically attached to each respective sample. Each sample label must contain at a minimum the following information:

- Project name
- Project number
- Date and Time of collection
- Sample location
- Sample identification number
- Collector's name
- Preservative used (if any)

Additional information may also be required per the project work plans and must accordingly be included on all sample labels. Indelible ink should be used in filling out all sample labels. Ensure that each sample collected has a sample label.

Ensure that the information documented on the sample label corresponds with the information documented on the Field Logbook and Chain of Custody Record.

6.0 REQUIRED FORMS

Sample Labels

Chain of Custody Record

SAMPLE NUMBERING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for sample numbering. Sample numbering is required to identify, track and trace samples from the time of collection until the time of disposal. Additional specific procedures and requirements will be provided in the project work plans and/or related SOPs.

2.0 REFERENCES

EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection and numbering activities are conducted in accordance with this SOP and any other appropriate procedures. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this sample numbering SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to sample numbering requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to sampling and sample-numbering activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager or Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Area

An area is a common name given to a subdivision of White Sands Missile Range (WSMR).

4.2 Composite Sample

A composite sample is one that was obtained by thoroughly mixing two or more distinct samples until the individual ones were no longer distinguishable.

4.3 Sample Number

A sample number is a unique alphanumeric identification (ID) assigned to all samples of air, soil, water and waste collected as part of any given project. It is also known as the sample ID.

4.4 Site Code

A Site Code is a unique identifier given to a specific solid waste management unit (SWMU), area of concern (AOC), or locality where an investigation is being conducted. It is generally a small area defined by the boundaries of contamination or investigation.

5.0 PROCEDURE

5.1 Introduction

The following is a site-specific sample identification system that will ensure the uniform documentation of soil borings, soil and sediment samples, monitoring wells, groundwater samples and surface water samples.

A unique identification number (ID) will be assigned to each sample. This ID is called the sample number. It references information pertaining to a particular sample including the location of the site, the type of sample, sample location number and other information contained in the suffix, such as the date, sample interval. The sample identification number is recorded on the sample container label, in the field logbook, and on the chain of custody form.

5.2 Location

Each sample collected will be designated with a prefix which identifies the site where it was taken using two identifiers. These identifiers include the area and site code. Both are a four character alphanumeric code.

An index of these identifiers is maintained in the Environmental Data Management System (EDMS), which is an online database located in WTS's Intranet. The following is an example of the identifiers for a particular site:

> The systemic diesel spill site is located at the High Energy Laser System Test Facility (HELSTF). HELSTF is identified as an area and has been given the abbreviation "HLSF". The systemic diesel spill also known as solid waste management unit (SWMU 154) is identified specifically with a site code of "0154". Therefore every sample at the HELSTF systemic diesel spill site will be identified with the prefix "HLSF-0154".

When a particular site or area is not identified in the EDMS, the Task Coordinator should contact the database administrator for directions on adding it to the online database. If the sample is being collected to determine site-wide background concentrations in a large area, the site code "BKGD" should be used.

5.3 Location Number

Each sample will be identified by a unique three digit number. The first digit is a marker to identify and improve the electronic data management of replicate and other QA/QC samples and analytical results (see Section 4.4.10). The last two digits are used to indicate different sample locations of identical sample types. An example would be that most sites have multiple monitoring wells which are numbered 01, 02, 03 etc.

5.4 Types of Samples

There are many types of samples that may be taken. The most common ones are listed in the following sections. Directions are provided for identifying them in a meaningful and consistent manner.

5.4.1 Surface Soil and Sediment Sample Identification

The sample ID for surface soil, sediment and wash sediment samples contains the area identifier, site code, and location number along with the abbreviation "SD" for sediment.

The surface soil and sediment samples are identified as follows:

ABCD-####-SD-$$$

Where:

- ABCD = Area Identifier
- #### = Site Code
- SD = Surface soil or sediment
- $$$ = Location number

5.4.2 Composite Samples

The sample ID for composite samples contains the area identifier, site code, and location number along with the abbreviation “CS” for composite.

The composite samples are identified as follows:

ABCD-####-CS-$$$

Where:

- ABCD = Area Identifier
- ## = Site Code
- CS = Composite sample
- $$$ = Location number

5.4.3 Subsurface Soil Samples

The sample ID for subsurface soil samples contains the area identifier, site code, location number, and depth interval, along with the abbreviation “SB” for soil boring.

The subsurface soil samples are identified as follows:

ABCD-####-SB-$$$-(yy.y-zz.z)

Where:

- ABCD = Area Identifier
- #### = Site Code
- SB = Soil boring
- $$$ = Location number
- (yy.y-zz.z) = Depth interval where soil sample was taken in feet

5.4.4 Surface Water Samples

The sample ID for surface water samples contains the area identifier, site code, and location number, along with the abbreviation “SW” for surface water.

The surface water samples are identified as follows:

ABCD-####-SW-$$$

Where:

- ABCD = Area Identifier
- #### = Site Code
- SW = Surface water
- $$$ = Location number
- Groundwater Samples

The sample ID for groundwater samples contains the area identifier, site code, location number (monitoring well number), and date, along with the site specific well abbreviation. Many different well abbreviations have been previously used to identify wells at a particular site. Examples include MW, B, DRW, HCF, HMW, SRW, TTF, etc. Up to four alphanumeric characters may be used to uniquely identify the wells. The existing abbreviations already in use at a given site should generally continue to be used for consistency when possible. If an existing well abbreviation exceeds four characters it must be truncated with a note in the log book indicating the new well name. In addition, inform the EDMS database administrator of the change so that it can be noted in the database. Do not confuse the well abbreviation with the well number. The specific number for the well must go after the abbreviation as designated below with $$$.

The groundwater samples are identified as follows:

ABCD-##-WXYZ-$$$-MMYY

Where:

- ABCD = Area Identifier
- ## = Site Code
- WXYZ = Monitoring well abbreviation
- $$$ = Monitoring well number
- MMYY = Sample date indicated by the month and year by four numbers.

5.4.5 Rinsate Blank Samples

The sample ID for rinsate blank water samples contains the area identifier, site code, rinsate blank number, and date, along with the abbreviation “RB” for rinsate blank.

The subsurface soil samples are identified as follows:

ABCD-####-RB-$$$-MMYY

Where:

- ABCD = Area Identifier
- #### = Site Code
- RB = Rinsate blank
- $$$ = Rinsate blank sample number
- MMYY = Sample date indicated by the month and year by four numbers.

5.4.6 Waste Samples

The sample ID for waste samples contains the area identifier, site code, sample number and date, along with the waste type abbreviation.

Investigation Derived Waste such as purge water, soil cuttings, personal protective equipment and decontamination water will be identified with the following alphanumeric abbreviation containing no more than four digits:

Purge Water	–	PW
Soil Cuttings	–	SC
Personal Protective Equipment	–	PPE
Decontamination Water	–	DCON

Generic solid and liquid waste will be designated as follows:

Solid	–	SL
Liquid	–	LQ

The waste samples are identified as follows:

ABCD-####-XXXX-$$$-MMYY

Where:

- ABCD = Area Identifier
- #### = Site Code
- XXXX = Waste type
- $$$ = sample number
- MMYY = Sample date indicated by the month and year by four numbers.

5.4.7 Trip Blank Samples

The sample ID for trip blank samples contains the area identifier, site code, year and chain of custody number, along with the abbreviation "TB" for trip blank. The chain of custody number is a sequential three digit number which starts at 001 each calendar year.

The trip blank samples are identified as follows:

ABCD-####-TB-YY-&&&

Where:

- ABCD = Area Identifier
- #### = Site Code
- TB = Trip blank
- YY = Calendar Year designated by a two digit number
- &&& = Chain of custody number

5.4.8 Replicate Samples

As previously noted, there is an "extra" digit or marker in the sample ID format. It is placed in the location number to provide a more discreet identifier of QA related samples.

For normal (non-QA related) samples the digit remains a zero. For replicate or other QA/QC-related samples co-located with the first sample, the first replicate will have this place filled with a "1", the second replicate or QA/QC sample will have this place filled with a "2", etc. For example, a duplicate sample might be collected on January 7, 2003 from DRW01 at the HELSTF systemic diesel spill site.

The identical groundwater samples would be identified as follows:

The original sample ID would be: HLSF-0154-DRW-001-0103

The duplicate sample ID would be: HLSF-0154-DRW-101-0103

5.4.9 Matrix Spike Samples

Matrix spike and matrix spike duplicate samples are provided as a courtesy to the laboratory for complying with data quality objectives. The abbreviation "-MS/MSD" is added at the end of any sample ID used for this purpose.

6.0 REQUIRED FORMS

Field Log Book

Chain of Custody Record

ON-SITE SAMPLE STORAGE

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for on-site sample storage. On-site sample storage may be required for samples collected during a given project. Additional on-site sample storage procedures and requirements will be provided in the project work plans and/or related SOPs.

2.0 REFERENCES

EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER directive 9355.3-01.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all on-site sample storage activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to sample numbering requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to sample storage activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager or Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Field Sample

A sample that has been collected at a project site, during the execution phase of the project, and for the purposes of the project, as defined in the project work plans.

4.2 On-site

For purposes of this SOP, “on-site” is defined as any area within the project site.

4.3 On-site sample storage

For purposes of this SOP, “on-site sample storage” applies to samples stored within the project site for a temporary period of time. Typically, samples may be stored on-site if they are in transit between the project site and a designated laboratory.

5.0 PROCEDURE

This section contains the requirements pertaining to on-site sample storage. Proper storage is essential to maintain in the quality and integrity of samples collected during a field project.

The details within this SOP should be used in conjunction with project specific work plans. At a minimum, the project work plans will provide the following information:

- Sample collection objectives.
- Number, types and locations of samples to be collected.
- Any additional sample numbering requirements or procedures beyond those covered in this SOP, as necessary.

5.1 On-Site Sample Storage

Samples of all types of media may require being stored on-site. The manner in which these samples are stored will be appropriate for individual samples and each sample type.

Samples collected for chemical analysis are typically required to be stored at approximately 4° Centigrade (°C). Therefore, such samples should either be preserved in a "cooler" using water ice, or a "Sample-Only" refrigerator until received by the assigned laboratory. Blue ice is not recommended for on-site sample storage as is does not maintain the 4°C temperature necessary for regulatory compliance. If a refrigerator is used to store samples at the project site, this refrigerator will be dedicated for the sole use of samples and will be located in an area that is access controlled; no food, drinks, or other personal items will be allowed in this refrigerator.

Samples that do not require refrigeration (e.g., air samples and samples for geotechnical or radionuclide analysis) should be stored on-site in a designated, marked area which is access controlled.

Samples that are stored on-site must be stored in appropriate containers per the project-specific work plans and be maintained under custody per SOP No. 1.1.

Samples that are stored on-site must not be stored in a manner in which they may threaten the integrity of other samples in the holding location.

All samples that are stored on-site must be labeled per SOP No. 2.1, numbered per SOP 2.2, and appropriately handled per SOP 2.0.

The Sampling Team Leader or other designee is responsible for maintaining a master sample log listing sample numbers and a brief description of samples collected. The master log should be reviewed on a daily basis for samples that are under storage on site. The samples should then be appropriately shipped, following procedures per SOP No. 2.1, to ensure that holding time is not missed.

6.0 REQUIRED FORMS

Chain of Custody Record

Master Sampling Log

SURFACE AND SHALLOW SUBSURFACE SOIL SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of surface (0 to 6-inch depth below ground surface (bgs)) and shallow subsurface (6-inch to 6-feet in depth bgs) soil samples for physical and chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all surface and shallow subsurface soil samples. Additional specific procedures and requirements will be provided in the project work plans.

2.0 REFERENCES

EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures and/or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to sample numbering requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to surface and shallow subsurface soils sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures and/or related SOPs. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer as appropriate.

4.0 DEFINITIONS/MATERIALS

4.1 Surface Soil Sample

Soil collected form the surface to a depth of no more than 6 inches bgs.

4.2 Shallow Subsurface Soil Sample

Soil collected from a depth of 6 inches to 6 feet bgs.

4.3 Subsurface Soil Sample

Soil collected at any depth interval greater than 6 inches.

4.4 Disturbed Soil Sample

Soil sample whose in situ physical structure and fabric has been disturbed as the direct result of sample collection.

4.5 Undisturbed Soil Sample.

Soil sample whose in situ physical structure and fabric has not been disturbed as the result of sample collection.

4.6 Grab Samples

Representative disturbed soil sample that is collected by using such devices as a shovel, stainless steel spoon, etc.

5.0 PROCEDURE

This section contains both the responsibilities and procedures involved with surface and shallow subsurface soil sampling. Proper surface and shallow soil sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives.
- Locations and depths of soil samples to be collected.
- Number and volumes of samples to be collected.
- Types of analyses to be conducted for the samples.
- Specific quality control (QC) procedures and sampling required.

Any additional surface or shallow subsurface soil sampling requirements or procedures beyond those covered in this SOP, as necessary.

At a minimum, the procedures outlined below for surface and shallow subsurface soil sampling will be followed unless otherwise directed within project specific work plans or SOPs.

5.1 Surface Soil Sampling Equipment

A number of devices are available for the collection of surface soil samples. These include, but are not limited to, core samplers, hand augers, spoons, scoops, trowels and, shovels. These devices are constructed of a number of materials including, but not limited to, stainless steel, brass, glass and, Teflon. The sampling and analytical requirements, as well as site characteristics, must be taken into account when determining the proper surface soil sampling equipment to use.

At present, the method commonly used for the collection of surface samples and shallow subsurface samples, both disturbed and undisturbed, is with a core sampler. The core sampler is usually a hollow, stainless steel cylinder, tapered at the leading end. A sample sleeve (brass, stainless steel, lexan, etc.) is inserted into the trailing end. The trailing end is then connected to a piston-type drive hammer. The core is driven into the soil by a hammer so that a relatively undisturbed sample is collected in the sleeve. The sample is then handled and shipped in the sample sleeve.

When a core sample is not feasible or planned, such devices as a stainless steel shovel, hand auger, trowel and, spoon, can be used to collect a sample. The soil is transferred from the collection device into decontaminated sample containers (commonly glass jars). The project work plans will specify the type of sampling equipment containers to be used; the sample to be used will be specified in the project work plans.

5.2 Surface Soil Sample Collection

Prior to sampling and between sampling locations, decontaminate the sample equipment according to WTS-SOP 6.0 and procedures outlined in the project work plans.

1. Ensure that all surface and shallow subsurface soil sampling locations have been appropriately cleared of all underground utilities and buried objects per the project work plans. Review all forms and diagrams documenting the location of the cleared sampling locations, as well as that of any underground utilities or lines, or other buried objects.
2. As required, calibrate any health and safety monitoring equipment according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s), as specified in the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.
3. Don appropriate personal protection equipment as specified in the project work plans.
4. Using equipment that will not be used for sample collection, clear the area to be sampled of surface debris and vegetation.
5. If using the coring device, place the sleeve into the device and drive the assembly into the soil using the drive hammer. Drive the device into the soil until the trailing end of the sleeve is at the soil surface.
6. Retrieve the device; check to see that soil recovery is adequate in the sample sleeve. If there is sufficient recovery, mark or note the leading end of the sample sleeve.
7. If using a different sample collection device (other than the coring device), use the other device to scoop or collect soil and directly transfer the soil into the sample container (e.g., glass jar, brass sample sleeve, etc.). Fill the sample container such that little to no headspace exists.
8. If using sample sleeves, place Teflon squares over each end of the sleeve and seal each end with plastic end caps. With a permanent marker, write a "T" for top on the trailing end and a "B" for bottom on the leading end.
9. Appropriately label and number the sample containers per WTS-SOP 2.1 and 2.2, respectively, and the project work plans. The label will be filled out with waterproof ink and will contain, at a minimum, the following information:
   - Project number
   - Sample number
   - Sample location
   - Sample depth
   - Sample type
   - Date and time of collection
   - Parameters for analysis
   - Sampler's initials.
10. Document the sampling event on the Field Logbook or an equivalent form as specified in the project work plans. Note any pertinent field observations, conditions or problems on the Field Logbook. Any encountered problems or unusual conditions should also be immediately brought to the attention of the field geologist.
11. Appropriately preserve, handle, package, and ship the samples per WTS-SOP No. 2.0 and the project work plans. The samples shall also be maintained under custody per WTS-SOP No. 1.1.
12. Fill and abandon the sample hole as required by the project work plans.

5.3 Subsurface Soil Sample Collection

The common method to collect shallow subsurface soil samples is to use a hand auger to bore to the desired sampling depth and then retrieve the sample with a core sampler. The hand auger might also be used to recover the sample for direct transfer into glass jars. The exact methodology to be used will be specified in the project work plans.

For subsurface soil samples of less than 18 inches in depth, successive drives of the core sampler may potentially be used to recover shallow subsurface soil samples. In all methods cited above, borehole stability should be maintained to prevent the recovery of slough in the samples. If sloughing cannot be controlled, than another sampling methodology may have to be considered.

As with surface soil samples, shallow subsurface soil sampling follows the same sample collection procedures specified in Section 5.2.1 through 5.2.13.

6.0 REQUIRED FORMS

Chain of Custody

Master Sampling Log

Field Log Books

SUBSURFACE SOIL SAMPLING WHILE DRILLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for subsurface soil sampling while drilling. Proper collection procedures are necessary to assure the quality and integrity of all subsurface soil samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary.

2.0 REFERENCES

American Society for Testing Materials (ASTM), 1989, Standard Method for Penetration Test and Split-Barrel Sampling of Soils, Method D-1586-84, Philadelphia. PA.

American Society for Testing Materials (ASTM), 1986, Standard Practice for Thin-Walled Tube Sampling of Soils, Method D-1587-83, Philadelphia. PA, pp. 304-307.

American Society for Testing Materials (ASTM), 1986, Standard Practice for Ring-Lined Barrel Sampling of Soils, Method D-3550-84, Philadelphia. PA, pp. 560-563.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures and/or other SOPs as applicable. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to sample numbering requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to subsurface soils sampling activities during drilling is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures and/or other SOPs as applicable. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer as appropriate.

4.0 DEFINITIONS/MATERIALS

4.1 Borehole

Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil samples, and/or installing a monitor well.

4.2 Split-Spoon Sampler

A steel tube, split in half lengthwise, with the halves held together by threaded collars at either end of the tube. This device can be driven into resistant (semiconsolidated) materials using a drive weight or drilling jars mounted in the drilling rig. A standard split-spoon sampler (used for performing standard penetration tests) is 2 inches in outside diameter and 1 ⅜ inches in inside diameter. This standard spoon typically is available in two common lengths, providing either 20-inch or 26-inch internal longitudinal clearance for obtaining 18-inch or 24-inch long samples, respectively. Six-inch long sleeves (tubes) of brass, stainless steel, or plastic are commonly placed inside the sampler to collect and retain soil samples. A five-foot long split-spoon sampler is also available. A California modified split-spoon sampler is also commonly used. The design is similar to the standard split-spoon except the outside diameter is 2 ½ inches and the inside diameter is 2 inches.

4.3 Shelby Tube Sampler

A thin-walled metal tube used to recover relatively undisturbed samples. These tubes are available in various sizes, ranging from 2 to 5 inches in outside diameter and 18 to 54 inches in length. A stationary piston device is included in the sampler to reduce sampling disturbance and increase sample recovery.

5.0 PROCEDURE

This section contains both the responsibilities and procedures involved with subsurface soil sampling while drilling. Proper subsurface soil sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives.
- Locations of soil boreholes and target horizons or depths of soil samples to be collected.
- Number and volumes of samples to be collected.
- Types of chemical analyses to be conducted for the samples.
- Specific quality control (QC) procedures and sampling required.
- Any additional subsurface soil boring sampling requirements or procedures beyond those covered in this SOP, as necessary.

There are many different methods that may be used for subsurface soil sample collection during drilling. This SOP focuses on the two most common methods of soil sample collection: split-spoon sampling and Shelby tube sampling. At a minimum, the procedure outlined below for these two subsurface soil-sampling methods will be followed unless specifically noted within project specific work plans. If other subsurface soil sampling methods are deemed necessary to meet project objectives, the procedures for these methods will be updated in this SOP or included in the project work plans.

5.1 General Sampling Considerations

The two subsurface soil sampling methods covered in this SOP, split-spoon and Shelby tube, are commonly used in conjunction with hollow stem auger, air rotary, and dual tube percussion drilling methods. Split-spoon or Shelby tube sampling may be conducted when drilling with mud rotary methods. However, when using this drilling method, the samples are not generally useful for chemical analyses. This is because the samples may become invaded or chemically altered when they are tripped through the drilling mud during sample retrieval. In addition, loose unconsolidated soils may also literally wash out of the samplers when they are tripped through the mud column.

The procedures described in the SOP must be used in conjunction with the SOP proscribed for the specific drilling method used at the site. These also include, but are not limited to, site clearance, site preparation, and health and safety requirements. Consequently, the SOP for the specific drilling method to be used at the site, the project work plans, and this SOP must be reviewed together in their entirety before the initiation of drilling and sampling.

5.2 Split-Spoon Sampling

Split-spoon samples for chemical analysis will be obtained in brass, plastic, or stainless steel sleeves. The types, dimensions and number of sleeves to be used, along with the length and type of sampler will be stated in the project work plans. The split-spoon sampler, lined with the brass, plastic, or stainless steel sleeves, is connected to the drill rod string or a wireline sampling string. The procedure for collecting samples from the split-spoon sampler will be outlined in the project work plans.

- ✓ Calibrate all field analytical and health and safety monitoring equipment according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s) as specified by the project-specific work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

- ✓ Wear the appropriate personal protection equipment as specified in the project work plans and the applicable drilling method SOP. Personnel protection will typically include a hard hat, safety glasses, gloves, steel-toed boots, hearing protection, and coveralls.
- ✓ Between each sampling location and prior to each sampling run, decontaminate the sampler, sleeves, and other sampling equipment as described in WTS-SOP No. 6.0.
- ✓ Advance the borehole to the desired depth or target horizon where the sampling run is to begin. During drilling, monitor vapors in the breathing zone according to the project work plans, and drilling method SOP.
- ✓ Insert the sleeves into the split-spoon sampler, connect the halves, and screw together the rear threaded collar and front drive shoe. Attach the split-spoon sampler to the bottom end of the drill rod string or wireline sampling string. Set up and attach the specified weight, if used.
- ✓ Drive the sampler into the soil at the bottom of the borehole. Record the type of sampler assembly and hammer weight on the Visual Classification of Soils form and/or other appropriate form(s), as specified in the project work plans. To minimize off gassing of the volatiles, the sampler should not be driven until the sampling team is ready to process the sample.
- ✓ When conducting penetration testing, observe and record on the Visual Classification of Soils form the number of hammer blows as described in WTS-SOP No. 10.0.
- ✓ Pull the drill rod or wireline sampling string up from the bottom of the borehole and remove the sampler.
- ✓ Remove the drive shoe and rear collar from the sampler and open the split barrel.
- ✓ Remove the sleeves one at a time, starting with the sleeve adjoining the drive shoe. Observe and record the amount of sample recovery on the Visual Classification of Soils form per WTS-SOP No. 10.0. Any observed field problems associated with the sampling attempt (e.g., refusal) or lack of recovery should be noted on the Visual Classification of Soils form within a clean area on a stand or table between samples.
- ✓ Select sleeve(s) to be submitted for laboratory analysis. Sample sleeve selection should be based on four factors: judgment that the sample represents relatively undisturbed intact material, not slough; proximity to the drive shoe; minimal exposure to air; lithology; and obvious evidence of contamination. The project work plans will specify the sample sleeve to be submitted for specific analyses and confirm the selection criteria.
- ✓ Place Teflon film over each end of sleeves to be submitted for chemical analysis and seal each end with plastic end caps. Place custody tape over each end cap so that any attempt to remove the cap will break the tape.
- ✓ Appropriately label and number each sleeve to be submitted for analysis per WTS-SOP No. 2.1 and 2.2, respectively. The label will be filled out using waterproof ink and will contain, at a minimum, the follow information:
  - Project number
  - Boring number
  - Sample number
  - Bottom depth of sleeve
  - Date and time of sample collection
  - Parameters for analysis
  - Sampler's initials.
- ✓ Document the sampling event on the Field Logbook or an equivalent form as specified in the project work plans. At a minimum, this log will contain:
  - Project name and number
  - Date and time of the sampling event
  - Drilling and sampling methods
  - Sample number

- Sample location
- Boring number
- Sample depth
- Sample description
- Weather conditions
- Unusual events
- Signature or initials of the sampler.

✓ Appropriately preserve, package, handle, and ship the sample in accordance with the procedures outlined in WTS-SOP No. 2.0 and the project work plans. The samples shall also be maintained under custody per WTS-SOP No 1.1. Samples stored on-site will be subject to the provisions of WTS-SOP No. 2.3.

✓ One of the sample sleeves shall be utilized for lithologic logging per WTS-SOP No. 10.0. This sleeve may not then be retained for chemical analysis, as soil must be removed from the sleeve to effectively describe the soils/lithology and compile the lithologic log.

✓ When VOCs or petroleum hydrocarbons are of concern, remove the soil from one of the remaining sleeves and place in a glass mason jar (fill to one half volume of jar) and seal for organic vapor screening using either Teflon tape or aluminum foil. Place the jar in a warm water bath or in the sunlight (warm) for at least five minutes, shake vigorously for one minute, then using an organic vapor probe (e.g., portable photoionization detector, flame ionization detector, or other appropriate instrument), pierce the lid seal with the probe and monitor the soil for organic vapors. Record the reading on the Visual Classification of Soils form, the Field Logbook, and any other form(s) specified in the project work plans.

✓ Repeat this sampling procedure at the intervals specified in the project work plans until the bottom of the borehole is reached and/or last sample is collected.

5.3 Thin Walled or Shelby Tube Sampling

A thin-walled tube or Shelby tube sampler may be used to collect relatively undisturbed soil samples. The procedure for collecting soil samples using a Shelby tube sampler should be outlined in the project work plans. The standard procedure is described below.

✓ Calibrate all field analytical and health and safety monitoring equipment as discussed in Section 5.2.1.

✓ Wear the appropriate personal protective equipment as described in Section 5.2.2.

✓ Between each sampling location and prior to each sampling run, decontaminate the sampler and other sampling equipment as described in WTS-SOP No. 6.0.

✓ Advance the borehole to the desired depth or target horizon where the sampling run is to begin. While drilling, monitor the breathing zone according to the project work plans and applicable drilling method SOP.

✓ Connect the sampling tube to the drill rod string and advance the tube to the bottom of the boring. The tube is then pushed about 2 to 2.5 feet into the soil with a continuous, rapid motion without impact or twisting.

✓ Pull the drill rod strip up from the bottom of the borehole and remove the sampling tube from the string. Observe and record the amount of sample recovery and any associated problems as discussed in Section 5.2.11.

✓ Place Teflon film over each end of the tube if it is to be submitted for chemical analysis and seal the ends with plastic end caps. Place custody tape over each end cap so that any attempt to remove the cap will break the tape. With a waterproof marker, write a “T” for top on the trailing end and a “B” for bottom on the leading end of the tube.

- ✓ Appropriately label and number the tube as described in Section 5.2.14.
- ✓ Document the sampling event on the Field Logbook as discussed in Section 5.2.15.
- ✓ Appropriately preserve, package, handle, and ship the sample in accordance with the procedures outlined in WTS-SOP No. 2.0 and the project work plans. The samples shall also be maintained under custody per WTS-SOP No. 1.1. Samples stored on-site will be subject to the provisions of WTS-SOP 2.3.
- ✓ Repeat this sampling procedure at the intervals specified in the project work plans until the bottom of the borehole is reached and/or last sample is collected.

6.0 REQUIRED FORMS

Visual Classification of Soils Form

Chain of Custody

Master Sampling Log

Field Log Books

COMPOSITE SAMPLE PREPARATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the requirements for compositing techniques. Composite samples, regardless of the media, consist of two or more subsamples taken from a specific media and site at different depth intervals. The subsamples are collected and mixed. A single average sample is taken from the mixture.

The composite sampling will be used at sites where hand augered borings are to be performed. Composite samples are useful in estimating the overall contamination properties of a specific site. They are less expensive than non-composite samples because one sample for analysis represents many subsample locations. Composite samples do not provide detailed information of contamination variability as a function of the location.

2.0 REFERENCES

None.

3.0 DEFINITIONS/MATERIALS

The equipment required to obtain a composite sample is identical to that for primary media sampling.

4.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all composite sample collection activities are conducted in accordance with this SOP and any other appropriate procedures and/or other SOPs as applicable. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for ensuring that this procedure is correctly implemented and that the quantity and quality of composite samples meet the requirements of the project Sample and Analysis Plan.

The Sampling Team Leader(s) assigned to composite soil sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures and/or other SOPs as applicable. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer as appropriate.

5.0 PROCEDURE

5.1 Preparation

Site preparation for the purpose of composite sampling is not different from that required for any of the media/waste sampling activities.

5.2 Surface Soil Compositing

The following steps must be followed when compositing surface soil samples in the field:

1. Determine where composite sample(s) will be obtained as indicated in the site-specific sampling plan.
2. Volatile organic compound (VOC) and, in some cases, semivolatile organic compound (SVOC) samples of solids (e.g., soils, sludge) must be collected and contained immediately as stand-alone samples and, therefore, <u>cannot</u> be composited.

3. Collect a minimum of three equal-volume samples from the specific sample location. The volume of each sample must be at least the amount required for a single sample.
4. Place the samples on an appropriate mixing tray. Thoroughly homogenize the pooled samples using the appropriate equipment.
5. Transfer subsamples of the composite sample into the appropriate sample containers. Seal, decontaminate, and label sample containers. Use the same care in handling these samples as that used for other samples from the site.
6. Document activities in field log book(s) as appropriate. Documentation should consist of detailed notes of locations and methods used to collect individual samples included in each composite sample.
7. Decontaminate sampling equipment between sample events.

5.3 Subsurface Soil Compositing

Compositing of subsurface soils refers to a single borehole in which several consecutively sampled depths are combined for a single sample. This is done to allow sufficient sample volume for the required analysis.

The following steps must be followed when compositing subsurface soil samples:

1. Determine where composite sample(s) will be obtained as indicated in the site-specific sampling plan.
2. Obtain samples by the methods:
3. For split-spoon or Shelby tube cores from a specified depth or range of depths:
   - Extract or extrude the sample from the split-spoon or Shelby tube onto an appropriate mixing tray, peel sample, and discard ends.
   - Continue with the four-quarters mixing method.
   - Document activities.
   - Decontaminate sampling equipment.
4. For hand auger samples:
   - The sample is acquired directly from the withdrawn auger.
   - Extract or extrude the sample from the bucket to an appropriate mixing tray.
   - Continue with the four-quarters mixing method.
   - Document activities.
   - Decontaminate sampling equipment.

5.4 Surface Water Compositing in the Field

The following steps must be followed when compositing surface water samples:

1. Determine where composite sample(s) will be obtained as detailed in the site-specific sampling plan.
2. VOC and, in some cases, SVOC samples must be collected and contained immediately as stand-alone samples and, therefore, <u>cannot</u> be composited.
3. Collect a minimum of three equal volume samples from the specified sample locations. The volume of each sample must be at least the amount required for a single sample.
4. Place the samples in the appropriate mixing container. Thoroughly homogenize the pooled samples using the appropriate equipment.
5. Transfer aliquots of the composited sample into the appropriate sample containers. Seal, wipe clean, and label sample container. Handle with the same care as that used for other samples from the site.

6. Document activities in field log book(s) as appropriate. Documentation should consist of detailed notes of locations and methods used to collect individual samples included in each composite sample.
7. Decontaminate sampling equipment between sampling events.

5.5 Collection of Replicate Samples

The following steps must be followed when compositing ground water samples:

1. Determine the well that a composite sample(s) will be obtained as detailed in the site-specific sampling plan.
2. VOC and, in some cases, SVOC samples must be collected and contained immediately as stand-alone samples and, therefore, cannot be composited.
3. Collect a minimum of three equal volume samples from the specified sample locations. The volume of each sample must be at least the amount required for a single sample.
4. Place the samples in the appropriate mixing container. Thoroughly homogenize the pooled samples using the appropriate equipment.
5. Transfer aliquots of the composited sample into the appropriate sample containers. Seal, wipe clean, and label sample container. Handle with the same care as that used for other samples from the site.
6. Document activities in field log book(s) as appropriate. Documentation should consist of detailed notes of locations and methods used to collect individual samples included in each composite sample.
7. Decontaminate sampling equipment between sampling events.

6.0 REQUIRED FORMS / DOCUMENTATION

Filed Log Books

Master Sampling Log

Chain of Custody

DUPLICATE AND SPLIT SAMPLE PREPARATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the requirements for the collection and preparation of duplicate, split, and/or co-located samples.

Duplicate, split, and co-located samples are typically obtained for either of two purposes: (1) as a means of quality control (QC) from the point of sample collection through all analytical processes (if the initial and duplicate samples are not within specification, the reasons for the discrepancy must be found and corrected, if possible), or (2) for later laboratory analyses, if needed. For WTS projects, co-located or duplicate samples will be collected to provide information on the variability of the contaminants in the field.

Duplicate or co-located samples are samples collected from a location as close to the primary sample location as possible. They are collected to provide a means of assessing the reliability of field sampling methods and analytic data resulting from field samples.

Split samples are normally obtained for the express purpose of submitting identical samples to different laboratories for comparative analytical results. Duplicate, split, and co-located samples may be collected as composite or grab samples from most media or waste types.

The same equipment and techniques will be required when obtaining duplicate and/or split samples as for primary samples. Briefly, the sampling requirements are: (1) grab samples will be collected for surface soil, surface water, ground water, sediment, and sludge, destined for volatile organic compound (VOC) analysis, and, (2) composite or grab sampling techniques can be used for non-VOCs and for subsurface soils.

Comparative analyses between laboratories can also be obtained for semivolatile organic compounds and/or metals. Duplicate samples can also be obtained for VOC and non-VOC contaminated media by careful grab samples. For most duplicate, split, or co-locate sampling for non-VOC parameters, in all media, compositing is recommended.

2.0 REFERENCES

None.

3.0 DEFINITIONS/MATERIALS

The equipment necessary to obtain a duplicate, split, and/or co-located sample is identical to that for primary media sampling.

4.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all duplicate, split, and co-located sample collection activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for ensuring that this procedure is correctly implemented and that the quantity and quality of duplicate and split samples meet the requirements of the project Quality Assurance Project Plan.

The Sampling Team Leader(s) assigned to duplicate, split, or co-located sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager, Technical Coordinator, or Quality Assurance Officer as appropriate.

5.0 PROCEDURE

5.1 Duplicate or Co-located Samples

The following steps must be followed when collecting duplicate or co-located samples:

1. Determine the frequency of obtaining duplicate samples as specified in the site-specific sampling plan.
2. Proceed with site sampling to the point that a duplicate or co-located sample is required.
3. The duplicate or co-located sample is a sample taken at the same time, as close as possible, and under the exact conditions as those required for the primary sample. Note: any sample or portion of a sample that is to be analyzed for VOCs shall be collected and contained immediately. Do not stir, mix, or agitate samples for VOC analysis before containment.
4. Follow the specific media-sampling plan. The preparation and disposition of the duplicates will be the same as those for the primary samples.
5. Obtain VOC samples first (without mixing or compositing), then proceed to Step 6. Samples for VOCs must be collected and contained immediately. Agitation by mixing, stirring, or shaking will cause vaporization of the volatile fraction to a significant degree. Resample if agitation has occurred. Mix all non-VOC duplicate samples or when taking duplicates of surface water or ground water samples. Mixing may be accomplished by pouring a portion of the sample directly from the sampling device into the original container, and then pouring an equal portion into the duplicate container, alternating between the two until the sample containers are full.
6. Place the sample(s) in the appropriate sample container. Duplicate and co-located samples will be labeled or tagged according to their intended use as detailed in the site-specific sampling plan. If the sampling plan duplicates are to be held for possible later analyses, they may be labeled as “sample XXX duplicate”, where the number “XXX” refers to the primary sample. If the duplicates are intended for QC measures, they may be given discrete sample numbers. Duplicate and co-located samples must be properly identified in the field logbook.
7. Seal, pack, and transport duplicate and co-located samples in the same manner as that used for other samples from the sampling site.
8. Decontaminate all equipment. Place all disposable liquids and solids in the appropriate receptacles.
9. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.
10. Document activities.

5.2 Split Samples for Surface Soils, Sediments, and Sludges

The following steps must be followed when collecting split samples of surface soils, sediments, and sludges:

1. Determine the number and frequency of required sample splits as specified in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media sampling procedure.

   <u>NOTE</u>: Split samples for VOCs are not recommended. Adequate cross-laboratory checks can be obtained by splits of non-VOC samples. If QA is required for VOC samples, obtain duplicates as outlined in Section 5.1 of the SOP. All split samples for VOC analysis for the above media are grab samples taken as specified in Step (3), Section 5.1 of this SOP.

4. For non-VOC grab samples, obtain a sufficient volume to fill all required sample containers, including those required for splits.
5. Composite these samples.
6. Split the composite sample equally and place the required volumes into the sample containers.
7. Seal and decontaminate the outside surfaces of the containers.
8. Label split samples as specified in the site-sampling plan. Record all pertinent information in the field logbook.
9. Split samples will have a separate chain of custody record.
10. Split samples will be sealed, packed, and transported in an identical manner as that specified for other samples from the site. The difference may be their destination (different laboratories) and the extent of analytical work. The site-specific sampling plan specifies the disposition of split samples.
11. Decontaminate all equipment according. Place all disposables in the appropriate receptacles.
12. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.
13. Document activities.

5.3 Split, Duplicate, or Co-located Volatile Organic Compound Sampling of Subsurface Soils with Split-Spoons or Shelby Tubes

The following steps must be followed when sampling subsurface soils with split-spoons or Shelby tubes:

1. Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media-sampling plan.

   NOTE: Most split-spoon sampling in the field is accomplished with 2-inch outside diameter (OD) split-spoons. When split, duplicate, or co-located samples are required, a 2-inch OD split-spoon will usually not collect sufficient sample volume if a number of analytes are to be sampled. In such situations, it is advisable to follow the American Society for Testing Materials (ASTM) D-1584 modified method of split-spoon sampling and a 3-inch OD split-spoon. If blow counts are not required for engineering purposes, and the site soils permit, attempts may be made to drive the 3-inch split-spoon by the 140-lb. weight. This deviation will ensure collection of enough sample volume.
4. Upon retrieval of the split-spoon, the sample should be peeled and the ends discarded. Divide the sample into four sections (A, B, C, and D). Sample A should be immediately containerized and becomes the original sample for VOC analysis. Sample B is also immediately containerized and becomes the duplicate sample for VOC analyses. Section C and D can be composited for all other non-VOC analyses.
5. Decontaminate the outside of the sample container after sealing.
6. Label split samples as specified in the site-specific sampling plan. Record all pertinent information in the field logbook.
7. Split samples will have a separate chain of custody record.
8. Split samples will be sealed, packed, and transported in an identical manner as other samples from the site. The difference may be their destination (different laboratories) and the extent of analytical work. The site-specific sampling plan specifies the disposition of split samples.

9. Decontaminate all equipment. Place all disposables in the appropriate receptacles.
10. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.
11. Document activities.

5.4 Split, Duplicate, or Co-located Non-Volatile Organic Compounds Sampling of Subsurface Soils with Split-Spoon or Shelby Tubs

The following steps must be followed when sampling subsurface soils with split-spoon or Shelby tubes:

1. Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media-sampling plan.
4. Peel the sample and composite the sample.

   NOTE: Most split-spoon sampling in the field is accomplished with 2-inch outside diameter (OD) split-spoons. When split, duplicate, or co-located samples are required, a 2-inch OD split-spoon will usually not collect sufficient sample volume if a number of analytes are to be sampled. In such situations, it is advisable to follow the American Society for Testing Materials (ASTM) D-1584 modified method of split-spoon sampling and to use a 3-inch OD split-spoon. If blow counts are not required for engineering purposes, and the site soils permit, attempts may be made to drive the 3-inch split-spoon by the 140-lb. weight. This deviation will ensure collection of enough sample volume.
5. Seal sample containers and wipe outside surfaces.
6. Label split samples as specified in the site-specific sampling plan. Record all pertinent information in the field logbook.
7. Split samples will have a separate chain of custody record.
8. Split samples will be sealed, packed, and transported in an identical manner as other samples from the site. The difference may be their destination (different laboratories) and the extent of analytical work. The site-specific sampling plan specifies the disposition of split samples.
9. Decontaminate all equipment. Place all disposables in the appropriate receptacles.
10. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.
11. Document activities.

5.5 Split Samples for Surface Water and Ground Water

The following steps must be followed when collecting split samples for surface water and ground water:

1. Determine the number and frequency of required sample splits as stated in the site-specific sampling plan.
2. Proceed with site sampling to the point of obtaining split sample(s).
3. Follow the specific media-sampling plan.
4. Split samples for VOCs are not recommended. Adequate cross-laboratory checks can be obtained by splits of non-VOC samples. If QA is required for VOC samples, obtain duplicates as outlined in Section 5.1 of this SOP. All split samples for VOC analysis for the above media are grab samples taken as specified in Step (3), Section 5.1 of this SOP.

5. For non-VOC grab samples, obtain a sufficient volume to fill all required sample containers, including those required for splits.
6. Obtain VOC samples first (without mixing or compositing). Samples for VOCs must be collected and contained immediately. Agitation by mixing, stirring, or shaking will cause vaporization of the volatile fraction to a significant degree. Resample if agitation has occurred. Mix all non-VOC duplicate samples or when taking duplicates of surface water of ground water samples. Pouring a portion of the sample directly from the sampling device into the original container, and then pouring an equal portion into the duplicate container, alternating between the two until the sample containers are full will accomplish mixing.
7. Split the composited sample by placing the required volumes in the sample containers, including those for split samples.
8. Seal sample containers and wipe outside surfaces.
9. Label split samples as specified in the site-specific sampling plan. Record all pertinent information in the field logbook.
10. Split samples will have a separate chain of custody record.
11. Split samples will be sealed, packed, and transported in an identical manner as other samples from the site. The difference may be their destination (different laboratories) and the extent of analytical work. The site-specific sampling plan specifies the disposition of split samples.
12. Decontaminate all equipment. Place all disposables in the appropriate receptacles.
13. Remove personal protective clothing and equipment and place in the designated receptacles. Field sampling personnel must be contamination-free before leaving the sampling site.
14. Document activities.

6.0 REQUIRED FORMS/DOCUMENTATION

Chain of Custody Record

CALIBRATION AND MAINTENANCE OF MEASURING AND TEST EQUIPMENT

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the methods and responsibilities associated with the calibration, control, and maintenance of measuring and test equipment (M&TE). It applies to all tools, gauges, instruments, and other test equipment where the manufacturer requires or recommends equipment accuracy to be checked periodically. In the case of commercial devices such as rulers, tape measures, and levels, calibration controls will not be required.

2.0 REFERENCES

None

3.0 RESPONSIBILITIES

The Quality Assurance Officer or his/her designee is responsible for monitoring the effective implementation of this SOP and/or the M&TE manufacturer's recommendations.

The Project Technical Manager, Technical Coordinator, and Sampling Team Leader(s) are responsible for the selection of M&TE to be used in the field activity and to assure it is of the proper type, range, accuracy and tolerance required to meet project objectives. Additionally, they are responsible for storage and protection of M&TE.

The field personnel performing tests are responsible for assuring that all M&TE is properly calibrated prior to and during use, and for documenting the calibration or deficiencies of equipment.

4.0 DEFINITIONS

4.1 M&TE

Measuring and test equipment used to obtain data during the performance of tests or inspections.

4.2 Calibration

The comparison of a measurement standard or instrument of a known accuracy with another standard or instrument to detect, correlate, report, or eliminate by adjustment, any variation in the accuracy of the items being compared within allowable deviations.

4.3 Reference Standard

An item of known and verifiable value that is used to check or establish the basis for tests or inspections.

5.0 PROCEDURE

5.1 Equipment Identification and Control

M&TE that requires calibration will be uniquely identified by the manufacturer's serial number, or other suitable assigned number. If this should prove to be impractical, an identification label will be affixed using materials and methods that provide a clear and legible identification and do not detrimentally affect the function or service life of the M&TE. This identification will be replaced as needed to provide clear identification of the M&TE.

All M&TE and reference standards shall be stored between uses in a manner that will minimize damage or deterioration.

5.2 Calibration

Written and approved procedures will be used for calibration of M&TE. Calibration procedures that have been previously established and approved by the M&TE manufacturer or a nationally recognized authority (i.e., ASTM, EPA) will be used when available. If no preexisting procedure is available, procedures will be developed by qualified personnel familiar with the M&TE and approved by the Project Technical Manager and the Quality Assurance Officer. Development of procedures will take into consideration the intended use and objective of the resulting data, equipment characteristics, required accuracy and precision of data, location of examination, effects of climate or any other parameter that would adversely influence the calibration. The procedures will include, as applicable:

- Name/type of equipment to be calibrated
- Reference standards to be used
- Calibration method and sequential actions
- Acceptance criteria
- Frequency of calibrations/checks
- Data recording form/format
- Data processing methodology
- Any special instructions
- Operator training and qualification requirements.

Field M&TE will be calibrated prior to use. Calibrations of M&TE will be performed by trained and qualified personnel, approved external agencies or by the equipment manufacturer. The following types of calibrations and checks will be performed by qualified personnel:

- Periodic calibrations - are performed at prescribed intervals established for the M&TE to assure that the equipment is operating within its designed range and accuracy. These are usually performed by outside agencies or the M&TE manufacturer. A calibration certificate will be provided documenting the operational and functional acceptance of the M&TE.
- Specific calibrations - are performed for specific measurements or tests and vary from instrument to instrument and from procedure to procedure. Specific calibrations are performed prior to start of each work shift.

5.3 Calibration Frequency

M&TE will be calibrated at prescribed intervals and before each specific use. The frequency of periodic calibrations will be based on manufacturer's recommendations, national standards of practice, equipment type and characteristics, and past experience.

A scheduled calibration of M&TE does not relieve the user of the responsibility for selecting the appropriate and properly functioning equipment. In the event that the calibration has expired, the M&TE will be removed from service and tagged as “out-of-service” in order to prevent inadvertent use until it has been appropriately recalibrated.

5.4 Reference Standards and Equipment

Calibration reference standards and equipment will have known relationships to the National Institute of Standards and Technology (NIST) or other nationally recognized standards. If a national standard does not exist, the basis for calibration will be fully documented by the Project Technical Manager and approved by the Quality Assurance Officer.

Physical and chemical standards will have certifications traceable to NIST, EPA or other recognized agencies. Standards that are repackaged or split will also have traceable lot or batch numbers transferred onto the new container.

It is the responsibility of the user to select, verify and use the correct standard in accordance with an approved procedure or established practice.

5.5 Calibration Failure

Each individual user of M&TE is responsible for checking the calibration status of equipment to be used and confirming the acceptable calibration status prior to use. Equipment for which the periodic calibration period has expired, equipment that fails calibration, or equipment that becomes inoperable during use will be removed from service and tagged as out-of-service.

Out-of-service M&TE will be segregated from operational M&TE when practical. The specific reason for removal from service and the date of removal will also be stated on the out-of-service tag. The M&TE will then be repaired and/or recalibrated by the appropriate vendor or manufacturer as deemed necessary by the Project Technical Manager. M&TE that cannot be repaired will be replaced, as necessary, to provide support to the project. Any M&TE consistently found to be out-of-calibration would be replaced.

The Project Technical Manager and the Quality Assurance Officer will evaluate results of activities performed using equipment that has failed recalibration. If the activity results are adversely affected, the results of the evaluation will be documented as a nonconformance.

5.6 Calibration Documentation

Specific calibration records will be prepared and documented for each calibrated M&TE used. Periodic calibration certificates will be maintained and available for review at the field office. Calibration data will be recorded on the Field Logbook or other suitable form. The Project Technical Manager will be responsible for reviewing the calibration data for appropriateness, accuracy, readability, and completeness.

Calibration records will include, as applicable, the following information:

- Equipment identification number
- Calibration procedure used
- Date/time of calibration
- Time of calibration checks (if required)
- Identification of reference standard(s) used
- Applicable responses or readings of calibration
- Name of individual performing calibration
- Item(s) that are being tested or inspected.

5.7 Preventive Maintenance

Preventive maintenance of M&TE will be performed in accordance with the manufacturers' recommendations to maintain proper M&TE performance, minimize equipment failure and to increase measurement reliability.

6.0 REQUIRED FORMS/DOCUMENTATION

None

FIELD INSTRUMENT

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to define field requirements for quality assurance/quality control (QA/QC), for equipment and instrument calibration, inspection, and maintenance. Instruments and equipment used to gather, generate, or measure environmental data must be calibrated to ensure that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Equipment, instruments, tools, gauges, and other items requiring preventive maintenance must be serviced according to the manufacturer's specifications. Raw data from the field measurements and sample collection activities must be recorded in the appropriate logbook or field form, and standard reporting units must be used for comparability and consistency.

2.0 REFERENCES

EPA, September 1987, EPA Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer has the responsibility for periodic review of procedures and documentation associated with the calibration of field instrumentation. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformance's and requesting corrective actions.

The Health and Safety Officer is responsible for ensuring that calibration is completed daily in accordance with this procedure, that equipment and instrument inspection and maintenance is conducted, that measurements are taken to the specified accuracy. The Health and Safety Officer is also responsible for validation of field data by:

Conducting routine checks during the processing of data (e.g. errors in identification codes);
Checking the consistency with parallel data sets obtained presumably from the same population (e.g., from the same portion of the aquifer or volume of soil).

The Sampling Team Leader(s) is responsible for calibrating, inspecting, and maintaining instruments, and for taking measurements to the specified precision.

4.0 DEFINITIONS/MATERIALS

4.1 Instruments (to be calibrated, and manufacturer's operating manual)

- pH Meter
- Conductivity meter
- Turbidity meter
- Photoionization detector
- Thermometer
- Water level measurement device

- Magnetometer
- Gas chromatographer, equipped with FID and PID (for soil sampling)

Other:

- Maintenance schedule.
- Field logbook.
- Indelible black ink pens.

5.0 PROCEDURE

5.1 Equipment and Instrument Calibration

The frequency of calibration for field instruments will be performed at the intervals specified by the manufacturer or more frequently as conditions dictate, but daily as a minimum. Field instruments will include a pH meter, thermometer, conductivity meter, organic vapor photoionization detector (PID), magnetometer, and a radioactivity meter. Calibration will be documented on the Field Logbook and will be conducted per WTS-SOP No. 4.0 unless otherwise noted..

The manufacturer's guide will be followed when calibrating the pH meter, thermometer, conductivity meter, organic vapor photoionization detector (PID), magnetometer, and radioactivity meter

To ensure comparability between sample data of similar samples and sample conditions, standard solutions and material traceable to the National Institute of Standards and Technology or EPA-published standards/protocols will be used to calibrate the field instruments.

5.2 Equipment and Instrument Inspection and Maintenance

5.2.1 Equipment and Instrument Inspection

Equipment to be used during field sampling will be examined to ensure that it is in proper operating condition. This includes checking the manufacturer's operating manual and the instructions for each instrument to ensure that all maintenance requirements are being observed. Field notes for previous sampling trips will be reviewed so that the notations on any prior equipment problem are not overlooked and all necessary repairs to equipment have been carried out.

5.2.2 Equipment and Instrument Maintenance

Equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be serviced in accordance with the manufacturer's recommendations.

Manufacturer's procedures identify the schedule for servicing critical items in order to minimize the downtime of the measurement system. It will be the responsibility of the operator to adhere to the maintenance schedule and to arrange prompt service as required. Service to the equipment, instruments, tools, gauges, etc. will be performed by qualified personnel. In the absence of any manufacturer's recommended maintenance criteria, the operator based upon experience and previous use of the equipment, will develop a maintenance procedure.

5.3 Field Measurement Precision

For the pH meter and the conductivity meter, precision will be tested by multiple readings in the medium of concern. Consecutive readings should agree within ±0.1 standard unit's pH and ±0.01 ohms/cm conductivity. The thermometer will be visually inspected prior to each use. The photoionization detector probe will be exposed to a volatile organic compound source prior to field use in order to determine if the instrument is working. Water level indicator readings will be precise within ±0.01 feet for duplicate measurements.

The following standard reporting units will be used during all phases of the project:

- Water levels measured in wells will be reported to the nearest 0.01-foot.
- Soil sampling depths will be reported to the nearest 0.1-foot.
- Soil gas results will be reported to two significant figures.

6.0 REQUIRED FORMS/DOCUMENTATIONS

Field Logbook

WATER LEVEL MEASUREMENTS IN MONITORING WELLS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for personnel to use in determining the depth to water in monitoring wells.

2.0 REFERENCES

EPA, 1986, RCRA Groundwater Monitoring Technical Enforcement Guidance Document, OSWER-9950.1, U.S. Government Printing Office, Washington, D.C.

EPA, 1991, Environmental Compliance Branch, Standard Operating Procedures and Quality Assurance Manual, Region IV, Environmental Services Division, Athens, Georgia, U.S. Government Printing Office, Washington, D.C.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for the periodic review of documentation generated as a result of this SOP and the periodic review and audit of field personnel as they perform the work. If problems arise, the Quality Assurance Officer is also responsible for verifying implementation of corrective action(s) (i.e., retraining personnel, additional review of work plans and SOPs, variances to requirements, and issuing nonconformances) and assuring through monitoring the continued implementation of stated corrective actions.

The Sampling Team Leader(s) is responsible for ensuring that monitoring well water level measurements are properly collected and documented.

4.0 DEFINITIONS/MATERIALS

A number of devices are available for the determination of water level measurements in monitoring wells. Those most commonly used and covered in this SOP includes steel tapes, electric sounders, and petroleum product probes. The equipment must be capable of recording a measurement to the accuracy required by the project plans.

5.0 PROCEDURE

Water level measurements are commonly taken in each monitoring well immediately prior to, during, and following well development, and both before and after well purging and sampling. Water level measurements may also be taken where no development or purging is being conducted, strictly to monitor or generate water table or piezometric surfaces. When such measurements are made to monitor water table or piezometric surfaces, water levels in all wells at a given site should be measured within a 24-hour maximum period whenever possible. When measuring wells for water for water table or potentiometric surface analysis, and if the contaminant history is known for each of the wells, it is advisable to monitor water levels beginning with the least contaminated wells first and progressing to the most contaminated wells last.

5.1 Equipment Selection

Project data quality objectives and site characteristics must be taken into account when determining the water level measurement equipment to use. The total number of wells to be measured, weather, tidal influences, pumping, and construction can all affect water level measurements. The project-specific work plans will identify the specific equipment to be used.

5.2 Determining Water Level Measurements in Monitoring Wells

The standard procedure for determining depth to water is described below.

1. Calibrate all measuring devices according to the manufacturer's specifications. Measuring tapes should be checked a minimum of every six months against a surveyor's tape to determine if shrinking or stretching has occurred.
2. Prior to taking a water level measurement at each well, decontaminate the measuring device according to the procedures outlined in WTS-SOP 6.0. During decontamination, all measuring tapes should be inspected for kinks, cracks, or tears and, if present, repaired or replaced with undamaged equipment.
3. Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any damage or problems with the well head should be noted on the Field Logbook and the site superintendent notified for repair or replacement of the equipment.
4. Uncap the well and monitor the air space immediately above the open casing per the project-specific health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Field Logbook. Lower the electric sounder or equivalent (product probe or steel tape) into the well until the water surface is encountered. If air is observed to be entering or flowing out of the casing, the sounder should not be placed inside the well until the air flow stops and pressure equalizes.
5. Measure the distance from the water surface to the permanent reference point. For aboveground “stickup” completions, the reference point is usually a groove cut into the north side of the casing. If no permanent reference point is available for an aboveground completion, measure from another permanently fixed structure or from ground level. The point of measurement should then be noted on the Field Logbook. For flush mount completions, such as street boxes, the water level measurement should be referenced to a steel rate placed across the rim of the street box and over the casing. Any aboveground completions without permanent reference points or marks should be brought to the attention of the appropriate supervisory personnel per the project-specific work plans.
6. Collect measurements until two consecutive measurements are identical or within the specified tolerance of the project-specific work plan (usually 0.01 ft). Record all appropriate information on the Field Logbook. At a minimum, the following information must be recorded:
   - project name and number;
   - unique well identification number;
   - date and time of measurement collection;
   - depth to water to the specified tolerance;
   - weather conditions; and
   - any problems encountered.
7. If product or other nonaqueous liquid is encountered, follow the procedures outlined in WTS-SOP 5.1.
8. Cap and relock the well.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

NONAQUEOUS PHASE LIQUID MEASUREMENTS IN MONITORING WELLS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for field personnel to use in determining the thickness of nonaqueous phase liquid in monitoring wells. The details within this SOP should also be used in conjunction with project work plans and/or related SOPs.

2.0 REFERENCES

EPA, 1986, RCRA Groundwater Monitoring Technical Enforcement Guidance Document, OSWER-9950.1, U.S. Government Printing Office, Washington, D.C.

EPA, 1991, Environmental Compliance Branch, Standard Operating Procedures and Quality Assurance Manual, Region IV, Environmental Services Division, Athens, Georgia, U.S. Government Printing Office, Washington, D.C.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all nonaqueous phase liquid in monitoring wells is properly measured and documented in accordance with this SOP and other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for the periodic review of documentation associated with this SOP and the periodic review and audit of field personnel as they perform the work. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformance and requests for corrective action.

The Sampling Team Leader(s) is responsible for the proper measurement and documentation of the nonaqueous phase liquid measurement in monitoring wells.

4.0 DEFINITIONS/MATERIALS

4.1 Product

For the purposes of this procedure, product refers to liquid that is petroleum based (e.g., gasoline, diesel, or petroleum byproducts) or chlorinated hydrocarbon based (e.g., trichloroethene, tetrachloroethene, etc.).

Two types of equipment used to measure nonaqueous phase liquids (NAPLs) in monitoring wells: product probes and clear bailers. The type of equipment used will be determined on a project specific basis and identified in the Field Sampling Plan.

5.0 PROCEDURE

5.1 Equipment Selection

This procedure addresses the operation of two types of equipment used to measure nonaqueous phase liquids (NAPLs) in monitoring wells: product probes and clear bailers. Clear bailers include both single- and double-check valve bailers. Single check valve bailers can only be used for measuring light nonaqueous phase liquids (LNAPLs) or floating products. Double check valve bailers can be used for measuring both LNAPLs and dense nonaqueous phase liquids (DNAPLs) or sinking product. The equipment must be capable of recording a measurement to an accuracy of 0.01 foot.

Several problems can arise in measuring product thickness with either product probes or clear bailers. Product probes can malfunction, particularly when measuring degraded or weathered product that sticks to the probe sensors. When the thickness of the product layer in a well is greater than the length of the bailer, the product layer cannot be accurately measured with the bailer. Consequently, it is recommended that both methods be used (one to check the other) to measure product thicknesses in wells. The project work plans will identify the specific equipment to be used.

5.2 Product Probe Procedure

The product probe, sometimes called an immiscible layer probe, is a device that can detect the presence of both LNAPLs and DNAPLs (both “floating” and “sinking” layers) in water wells. The device detects the difference in conductivity or specific gravity between the aqueous and nonaqueous phases in the well. The device is generally a probe connected to a measuring tape with a reel. The device contains a receiver with an audio and/or visual signal that indicates when phase changes occur. The standard procedure for using a petroleum product probe is described below.

Check the accuracy of the measuring tape of the petroleum product probe according to the manufacturer's specifications. Measuring tapes should be checked at least every six months against a surveyor's tape to determine if shrinking or stretching has occurred.

1. Prior to taking a measurement and between wells, decontaminate the probe and tape measure according to the procedures outlined in WTS-SOP 6.0. It is extremely important to conduct thorough decontamination to prevent cross-contamination between wells. During decontamination, all measuring tapes should be inspected for kinks, cracks, or tears and, if present, repaired or replaced with undamaged equipment.
2. Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any damage or problems with the well head should be noted on the Field Activity Daily Log and notify the site superintendent per the project work plans.
3. Uncap the well and monitor the air space immediately above the open casing per the Project Health and Safety Plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Field Logbook. If air is observed to be flowing into or out of the casing, the probe should not be placed inside the well until the airflow stops and pressure equalizes. Lower the probe into the well until the liquid surface is encountered. Continue lowering the probe, recording the depths at which any audio or visual changes in the device indicate a phase change. When measuring for DNAPL, continue lowering the probe to the bottom of the well. When measuring for LNAPL, there is no need to lower the probe further once the product/water interface is encountered and measured.
4. While lowering the probe, measure the distances to the encountered phase/phases from the permanent reference point. For aboveground “stick-up” completions, the reference point is usually a groove cut into the north side of the casing. If no permanent reference point is available for an aboveground completion, measure from another permanently fixed structure or from ground level. The point of measurement should then be noted on the Field Logbook and the appropriate form on which the water level is recorded.
5. For flush mount completions, such as street boxes, the water level measurement should be referenced to a steel rule placed across the rim of the street box and over the casing. Any aboveground completions without permanent reference points or marks should be brought to the attention of the site supervisor per the project work plans.
6. Collect measurements until two consecutive measurements are identical or within tolerances specified in the project work plans. Record all appropriate information on the field Logbook. At a minimum, the following information must be recorded:
   - project name and number;
   - well identification number;
   - date and time of measurement collection;

- depth to water to the specified tolerance;
- depth to and description of any nonaqueous phase liquid encountered;
- weather conditions; and
- comments, including any problems encountered.

7. Cap and relock the well.

5.3 Bailer Procedure

1. A single check-valve bailer is a cylindrical tube, open at the top and containing a floating ball at the bottom. Lowering the bailer into liquid allows the bottom ball to float allowing floating product or water to enter the bailer. The design of this type of bailer only allows collection of a floating product (LNAPL) sample.
2. A double check-valve bailer is an enclosed cylindrical tube containing a floating ball at both the top and the bottom. Lowering the bailer into liquid causes both balls to float allowing water or product to enter the cylinder. Raising the bailer through the water causes both balls to settle, effectively trapping a discrete section of the water so that it can be brought to the surface. Since the double check-valve bailer is capable of collecting a discrete sample at any depth within the well, it can be used on both “floating” and “sinking” nonaqueous liquids.
3. The bailers must be constructed of clear material so that any product can be visibly measured. Some are also available with graduated markings on the side to allow easier measurement. Bailers are commonly used with a thin nylon line or “chord” made of similar material. Some are supplied with a connectable measuring tape. The standard procedure for using bailers to measure nonaqueous phase liquids in monitoring wells is described below.
4. Check the accuracy of the measuring tape to be used with the bailer according to the manufacturer’s specifications. Measuring tapes should be checked a minimum of every six months against a surveyor's tape to determine if shrinking or stretching has occurred.
5. Prior to taking a measurement and between wells, decontaminate the bailer and tape measure according to the procedures outlined in WTS-SOP 6.0, Sampling Equipment and Well Material Decontamination. If a bailer line is used, it is advised to slip, cut, and dispose of any. That runs inside a previous well and then decontaminate the remaining line. Bailers used for product sampling should never be used for purging or collecting water samples.
6. If product probe measurements are to be used in conjunction with a bailer, the probe measurements should first be made, recorded, and noted by field personnel taking the measurements.
7. If bailer measurements are to be taken before or without product probe measurements, visually inspect and document wellhead conditions per Section 5.2.4 above. Uncap the well and monitor and observe the well head per Section 5.2.5 above.
8. Lower the bailer into the well until the liquid surface is encountered. Use the measuring tape if available to determine the depth to which the bailer should be lowered to recover either the LNAPL or DNAPL product.
9. If using bailer chord and attempting to recover DNAPL (“sticking”) product, a double check-valve bailer may simply be run to the bottom of the well. If attempting to recover LNAPL (“floating”) product using bailer chord, it is advisable to first note the depths to product and water made with the product probe and mark the depths on the bailer chord with a rubber band or twine. The bailer (either single or double check-valve) should then be lowered such that the bailer retrieves product layer, thereby retrieving only water.
10. If no product probe measurements are available, the person attempting to retrieve the bailer product sample will then have to “feel” for first contact with the liquid while the bailer is descending inside the well. Once the contact is felt, the bailer descent should be halted. The bailer should then be slowly lowered no more than ¾ of its total length to avoid overtopping. Retrieve the bailer and visually inspect for product. Measure the amount of product contained in the bailer with the measuring tape.

Note any appropriate conditions observed in the bailer such as:

- Color and clarity of the product
- Length of product column in bailer compared to overall length of bailer
- Evidence of any problems with the bailer valves
- Evidence of overtopping or complete run through the product column.

11. Record all appropriate information on the Field Logbook. At a minimum, the following information must be recorded:

    - project name and number;
    - well identification number;
    - date and time of measurement collection;
    - depth to water if available to the appropriate tolerance specified in the project work plans;
    - measurement and description of any nonaqueous phase liquid encountered;
    - any observations made in 5.2.5 above; and
    - comments, including any problems encountered.

12. Cap and relock the well.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

FIELD EQUIPMENT DECONTAMINATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures required for decontamination of field equipment. Decontamination of field equipment is necessary to ensure the quality of samples by preventing cross-contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants off site.

2.0 REFERENCES

EPA, September 1987, EPA Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Project Chemist is responsible for ensuring that field personnel are trained in the use of this procedure and that decontamination is conducted in accordance with this procedure.

The Quality Assurance Officer has the responsibility for periodic review of procedures and documentation associated with the decontamination of drilling and heavy equipment. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformances and requesting corrective actions. Additionally, he/she will perform the three phases of inspections and continuous monitoring of the decontamination activities.

The Sampling Team Leader(s) is responsible for verifying that this procedure is correctly implemented. The Sampling Team Leader may also be required to collect and document rinsate samples to provide quantitative verification that these procedures have been correctly implemented. This SOP and the project work plans should be reviewed before implementing decontamination procedures at the project field area.

4.0 DEFINITIONS/MATERIALS

4.1 Deionized Analyte-Free Water

Ion-free, analyte-free water produced on site or purchased from a supplier with a deionization chamber equipped with a carbon filter.

4.2 Potable Water

Treated municipal water.

4.3 Laboratory Grade Detergent

A standard brand of laboratory-grade detergent, such as “Liquinox.”

4.4 Methanol

Laboratory-grade methanol alcohol, CAS #67-56-1

4.5 Hexane

Laboratory-grade hexane, CAS #110-54-3

4.6 HPLC Water

High purity laboratory-grade water.

4.7 Non-sampling Equipment

Non-sampling equipment includes:

- Field logbook.
- Drilling rigs, backhoes, augers, drill pipe, bits, casing, and screen.
- High-pressure pump soap dispenser or steam-spray unit.
- 2- to 5-gal manual-pump sprayer (pump sprayer material must be compatible with the solution used).
- Stiff-bristle brushes.
- Gloves, goggles, boots, and other protective clothing as specified in the site-specific health and safety plan.

4.8 Small Equipment

Small equipment includes:

- Split spoons, bailers, bowls, and filtration equipment
- 5-gal plastic buckets
- Laboratory-grade detergent (phosphate free)
- Stiff-bristle brushes
- Nalgene or Teflon, sprayers or wash bottles or 2- to 5-gal manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting
- Disposable wipes or rags
- Potable water
- Appropriate decontamination solutions
- Gloves, goggles, and other protective clothing as specified in the site-specific health and safety plan

4.9 Pumps and Pump Assemblies

The required pumps and pump assemblies include:

- Three or more empty 30-40 gallon containers
- Plastic sheeting
- 5-gal (or larger) containers of potable water and other required decontamination solutions
- Disposable wipes or rags
- Gloves, goggles, and other protective clothing as specified in the site-specific health and safety plan.

5.0 PROCEDURES

This section contains responsibilities, requirements, and procedures for sampling equipment and well material decontamination. The decontamination is required in order to maintain proper quality and integrity of collected samples.

The details within this SOP should be used in conjunction with the project work plans. The project work plans will provide the following information:

- Types of equipment requiring decontamination under this SOP;
- Specific materials to be used for the decontamination; and
- Additional decontamination requirements and procedures beyond those covered in this SOP, as necessary.

All field personnel associated with decontamination of sampling equipment or well materials must read both this SOP and the project work plans prior to implementation of related decontamination activities. Information and requirements for the decontamination of any and all drilling and heavy equipment is provided in MSOP No. 6.1.

5.1 Decontamination Facility

If possible, sampling equipment decontamination will take place in an area designed exclusively for decontamination. This area will ideally be located within the contamination reduction zone on the project site. Well materials may be decontaminated at the facility set up for decontamination of drilling and heavy equipment (see MSOP No. 6.1).

Each decontamination facility will be constructed so that the equipment, as well as all wastes generated during decontamination (e.g.: soil, rinsate, liquid spray, debris, etc.), is fully contained. In addition, chemical products used in the decontamination process must be properly containerized and labeled.

5.2 Decontamination of Non-dedicated Sampling Equipment

Each piece of reusable, small or non-dedicated sampling equipment will be decontaminated before mobilization to each site and before each sampling event. The standard procedure will be performed as described below.

1. All personnel involved with the task must wear suitable personal protective equipment to reduce personal exposure (specified by the project work plans).

2. Heavily caked soil and/or other material will be scraped or brushed from equipment. The scrapings will be placed into an appropriate container for disposal. Steam cleaning of equipment may be required to remove material from samplers.

3. Equipment that will not be damaged by water should be placed into a wash tub containing a laboratory-grade detergent solution and scrubbed with a brush or clean cloth. Rinsing will then be conducted with fresh, potable water, followed by deionized water.

4. Methanol, hexane, and HPLC water rinses may then follow for some sampler components when specified by the project work plans.

5. Any equipment that may be damaged by submersion into water will be wiped clean using a sponge and detergent solution. Wiping the equipment with deionized water will follow cleaning.

6. Air-dry the rinsed equipment. Soil organic vapor sampling equipment should be flushed dry with bottled air of known quality and/or as per the project work plans.

7. Place decontaminated equipment on clean plastic sheeting to prevent contact with contaminated soil. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

8. Decontamination activities shall be documented on the Field Logbook.

5.3 Decontamination of Dedicated Sampling Equipment

Dedicated sampling equipment, such as submersible pumps, will be decontaminated prior to installation inside monitoring wells. At a minimum, the procedure outlined below must be performed. If factory-cleaned, hermetically sealed materials are used, no decontamination will be necessary provided that laboratory certification of decontamination is submitted with the equipment.

1. All personnel involved in the task will wear suitable personal protective equipment in accordance with the project work plans.

2. Foot vale and pumping lines will be washed with a laboratory-grade detergent solution.

3. The equipment will then be rinsed twice with tap water, followed by a rinse with deionized water.

4. Air dry.

5. Place decontaminated equipment on clean plastic sheeting to prevent contact with contaminated soil. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

6. Decontamination activities will be documented on the Field Logbook.

5.4 Decontamination of Well Materials

Well materials including well casing, well screens, centralizers, and end caps will be decontaminated prior to use in constructing monitoring wells. (If factory-cleaned, hermetically sealed materials are used, no decontamination will be necessary provided that laboratory decontamination certification is submitted with the equipment.) The standard procedure outlined below must be performed when decontaminating well materials.

1. All personnel involved in the task will wear appropriate personal protective equipment in accordance with the project work plans.

2. Materials will be thoroughly sprayed and washed with water using a high-pressure steam cleaner.

3. Air dry.

4. Decontaminated materials will be placed on clean metal racks or clean plastic sheeting. If equipment is not used immediately, cover or wrap the equipment in clean plastic sheeting to minimize airborne contamination.

5. Decontamination activities will be documented on the Facility Logbook.

5.5 Pump Decontamination

The following steps must be followed when decontaminating pumps:

1. Set up decontamination area and separate clean storage area using plastic sheeting to cover the ground, tables, and other porous surfaces. Set up three 30-40 gallon containers in a triangle. The two containers at the base of the triangle will be used to contain dilute (non-foaming) soapy

water and potable water. The drum at the apex will receive wastewater. Place 5-gal cans of potable water adjacent to the water container on the same side as the potable water container.

2. Pump should be set up in the same configuration as for sampling. Submerge pump intake (or pump if submersible) and all downhole wetted parts (tubing, piping, foot valve) in soapy water of the first container. Place the discharge outlet in the waste container above the level of wastewater.

3. Pump soapy water through the pump assembly until it discharges to the waste container.

4. Move pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.

5. Decontaminate the discharge outlet by hand following the steps outlined in Section 5.2. Part 2 of this SOP.

6. Remove the decontaminated pump assembly to the clean area and allow to air dry. Intake and outlet orifices should be covered with aluminum foil to prevent the entry of airborne contaminants and particles.

7. Record the equipment type and identification, and the date, time, and method of decontamination in the appropriate logbook.

5.6 Waste Disposal

The following steps must be followed when disposing of wastes:

1. All wash water and rinse water that have come in contact with contaminated equipment are to be handled, packaged, labeled, marked, stored, and disposed of as investigation-derived waste unless other arrangements are approved in advance. Waste disposal will be in accordance with the project-specific Investigation-Derived Waste Management Plan.

2. Small quantities of decontamination solutions may be allowed to evaporate to dryness.

3. If large quantities of used decontamination solutions are generated, segregate each type of waste in separate containers. This may permit the disposal of wash water and rinse water in a sanitary sewage treatment plant rather than as a hazardous waste.

4. Unless required, plastic sheeting and disposable protective clothing may be treated as a solid non-hazardous waste.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

DRILLING, DEVELOPMENT, AND HEAVY EQUIPMENT DECONTAMINATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for use by field personnel in the decontamination of drilling, development, and heavy equipment. The details within this SOP are applicable as general requirements for drilling and heavy equipment decontamination, and should also be used in conjunction with project work plans and/or related SOPs.

2.0 REFERENCES

EPA, September 1987, EPA Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidelines for Conducting Remedial Investigation and Feasibility Studies under CERCLA, Interim Final OSWER Directive 9355.3-01.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator have the responsibility for ensuring that the decontamination of drilling and heavy equipment is properly performed through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer has the responsibility for periodic review of procedures and documentation associated with the decontamination of drilling and heavy equipment. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformances and requesting corrective actions. Additionally, he/she will perform the three phases of inspections and continuous monitoring of the decontamination activities.

The Sampling Team Leader(s) assigned to drilling, development, trenching, or construction activities are responsible for ensuring that subcontractors or equipment operators properly decontaminate the drilling, development, and heavy equipment associated with those tasks. The project staff is also responsible for documenting the decontamination activities on the Field Logbook.

This SOP and the project work plans should be reviewed before implementing decontamination procedures at the project field area.

4.0 DEFINITIONS/MATERIALS

4.1 Laboratory Grade Detergent

A standard brand of laboratory-grade detergent, such as “Liquinox”.

4.2 Potable Water

Water dispensed from a municipal water system.

5.0 PROCEDURE

5.1 General

This section provides requirements for the set up of a decontamination facility for drilling, development, and heavy equipment and the decontamination procedures to be followed. The project work plans will provide specific information regarding:

- Types of equipment requiring decontamination under this SOP;
- Location of the decontamination station;
- Types and/or specifications on materials to be used in the fabrication of the decontamination station; and
- Types of materials and additional details on the procedures to be used in the decontamination process.

All field personnel associated with either the fabrication of the decontamination station or the decontamination of drilling or heavy equipment must read both this SOP and the project work plans prior to implementation of related decontamination activities. Information and requirements for the decontamination of any and all equipment used specifically for sampling is presented in WTS-SOP 6.0.

5.2 Decontamination Facility

A decontamination station will be set up in an area exclusively for decontamination of drilling, well development, and/or heavy equipment. The location of the decontamination station will be specified in the project work plans. All decontamination of drilling, development, and heavy equipment will be conducted within the station.

At a minimum, the station will be constructed such that all rinsates, liquid spray, soil, debris, and other decontamination wastes are fully contained and may be collected for appropriate waste management and disposal. The station may be as simple as a bermed, impermeable polyethylene sheeting, of sufficient thickness, with an impermeable sump for collecting rinse water. More sophisticated designs involving self-contained metal decontamination pads in combination with bermed polyethylene sheeting may also be used, depending on project-specific requirements. These requirements along with specific equipment and construction specifications for the decontamination station will be provided in the project work plans.

5.3 Decontamination of Downhole Equipment

All downhole drilling and development equipment (including but not limited to drill pipe, drive casing, drill rods, bits, tools, bailers, etc.) will be thoroughly decontaminated before mobilization onto each site and between borings or wells at each site or as required in the project work plans. The standard procedure will be performed as described below. Decontamination will be performed in accordance with this SOP and the project work plans.

1. All personnel involved with the task must wear appropriate personal protective equipment to limit personal exposure (as specified in the project work plans).
2. Equipment caked with drill cuttings, soil, or other material will initially be scraped or brushed. The scrapings will be containerized and appropriately disposed.
3. Equipment will then be sprayed with potable water using a hot water, high-pressure washer.
4. Washed equipment will then be rinsed with potable water.
5. Decontaminated downhole equipment (such as drill pipe, drive casing, bits, tools, bailers, etc.) will be placed on clean plastic sheeting to prevent contact with contaminated soil and allowed to air dry. If equipment is not used immediately, it will be covered or wrapped in plastic sheeting to minimize airborne contamination.
6. Decontamination activities will be documented by the Sampling Team Leader, lead geologist, or lead engineer on the Field Logbook.

5.4 Decontamination of Heavy Equipment

Heavy equipment (e.g., drill rigs, development rigs, backhoes, and other earthmoving equipment) will be decontaminated between drilling sites or inside the contaminant reduction area prior to entering and leaving an exclusion zone. Decontamination will be performed in accordance with the project work plans.

The standard procedure will be performed as described below.

1. All personnel involved in the task will wear appropriate personal protective equipment in order to limit personal exposure (as specified in the project work plans).
2. Equipment caked with drill cuttings, soil, or other material will be initially scraped or brushed. The scrapings will be containerized and appropriately disposed.
3. Equipment will then be sprayed with potable water using a hot water, high-pressure washer.
4. Clean equipment will then be rinsed with potable water.
5. During the decontamination effort, fluid systems should be inspected for any leaks or problems that might potentially result in an inadvertent release at the site, thereby contributing to the volume of waste or contamination. Any identified problems should be immediately repaired and documented on the Facility Activity Daily Log. Decontamination should then be completed before moving the equipment onto the site or exclusion zone.
6. The Sampling Team Leader, lead geologist, or lead engineer will document decontamination activities on the Field Logbook.
7. Between boreholes at the same site, the back-end of the drilling rigs will be washed with potable water until surfaces are visibly free of soil buildup.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook.

SURFACE AND SUBSURFACE GEOPHYSICS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for acquiring surface geophysical data. This includes the direct use of surface geophysical equipment by subcontractors conducting surface geophysical surveys. Additional specific surface geophysical procedures and requirements will be provided in the project work plans and/or related SOPs.

Surface geophysical surveys image into the subsurface using measuring equipment that is placed or located upon or above the ground surface. Common applications of surface geophysics for environmental projects include utility clearance, buried waste delineation, plume delineation, and geologic or hydrologic characterization. The most common surface geophysical techniques used for environmental applications and therefore, covered in this SOP; include electrical resistivity, seismic refraction, electromagnetics (EM), ground penetrating radar (GPR), metal detectors, and magnetometry.

2.0 REFERENCES

Manufacturer's instructions for the specific instrument utilized shall be consulted for proper operation and preventive maintenance requirements.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all surface geophysical activities are conducted and documented in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retaining personnel, additional review of work plans and SOPs, variances to surface geophysics requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to surface geophysical activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Electromagnetic Induction (EM or EMI)

A method of sending electromagnetic waves into the ground and measuring the responding secondary electromagnetic wave. The secondary wave is generated in the proportion to the conductivity of the earth or objects therein. EM may be used to reveal utility lines, buried waste dumps, former excavations, and in some specific cases, changes in groundwater conductivity.

4.2 Ground Penetrating Radar

A method utilizing radar waves generated and propagated into the ground surface. The reflected (backscattered) waves are received back as data. GPR is typically used to reveal buried manmade objects, such as tanks, pipes, drums, etc. It may also at times be used to delineate backfilled excavations and waste cells.

4.3 Magnetic Survey

The process of accurately measuring the earth's magnetic field (on the order of 10/50,000 of the total field). The survey reveals magnetic anomalies that may result from buried metal objects or rock-type differences.

4.4 Metal Detector

An EM tool with a specialized sensor to detect metallic objects.

4.5 Resistivity Survey

A geophysical method of determining the resistivity of the earth's layers. The survey is conducted by inducing electrical currents of into the subsurface and measuring electrical potential differences at points of secondary electrical fields generated in the earth in response to the input of electrical current. Resistivity surveys are typically used to provide information on subsurface lithologies and, in certain instances, plume distributions.

4.6 Seismic Methods

Seismic surveys are conducted by inducing seismic (acoustic) waves into the around and recording the arrival times at varying distances of the refracted waves. They are typically used to reveal buried geologic structures and contacts between rock units.

4.7 Materials

Any of listed surface geophysical instruments or data collection devices – EM, GPR, magnetometer, earth resistivity, seismic.

- Field logbook
- Indelible black ink pens and markers
- Survey measurement documentation forms or data sheets
- Personal protective equipment and gear
- Appropriate surveying equipment for obtaining field measurements as specified in site-specific sampling plans
- Survey stakes

5.0 PROCEDURE

This section contains responsibilities, requirements and procedures for conducting surface geophysical surveys. Selection and design of the geophysical surveys to be used on a site must be based upon several factors. These include but are not limited to the following:

- Specific objectives or anticipated use of the survey (e.g., surface clearance, buried object identification, waste cell delineation, etc.)
- Known or expected site-specific conditions
- Targeted parameters and overall surface areas to be evaluated
- Potential site-induced effects that may limit specific survey methods
- Applicability of specific survey methods in meeting above objectives given the site-induced effects.

Consequently these factors must be considered and the tests designed well before generation of the project work plans and implementation in the field. The project work plans will specify all necessary details to complete the geophysical surveys at a particular site. Surface geophysical survey information and specifications to be included in the project work plans will include at a minimum the following:

- Objectives of the surveys
- Type(s) of surveys to be conducted
- Equipment to be used
- Lay-outs of survey grids at each site or location, including sample point spacing
- Type, duration and frequency of measurements to be made
- Additional procedures or requirements beyond those covered in this SOP

Subcontracted geophysical surveys will also be directed by specifications defined in Statements of Work for sub-contractor services, as well as the project work plans.

5.1 General Requirements

The following requirements apply to all surface geophysical surveys and should be performed as required by the project work plans and the conditions present at each survey site.

1. Inspect all equipment and supplies to ensure that they are in proper working order, using the equipment manuals provided by the equipment manufacturer.
2. Assure that annual calibration/service by the manufacturer has been conducted as recommended by the manufacturer. Calibration/service records should be maintained in the office where the instrument is stored between investigations. A copy of the calibration records should be kept with the equipment at all times. More frequent calibration/services may be necessary if field measurements indicate possible instrument malfunction.
3. Prior to mobilization to the site, conduct appropriate decontamination as and if required by the project work plans.
4. Perform field calibration checks where required by instrument manufacturer or the project work plans. Perform calibration (accuracy and reproducibility) checks in the field by reoccupying base stations at periodic time intervals. Perform the calibration checks in accordance with manufacturer's specifications or the project work plans.
5. The calibration checks should be entered on a Field Logbook. At a minimum, this document should contain the following information:
   - Make and model number of the geophysical instrument.
   - Serial number of the instrument.
   - The date and time of calibration or instrument check.
   - All calibration or instrument-check measurements.
   - The name and signature of the person conducting the calibration or instrument check
6. Establish grid and stake locations or set up traverses for locations of sampling stations.
7. Make sure all survey and sampling locations are properly staked and the location ID is readily visible on the location stake.
8. Include a diagram of the measurement locations with the data records on a daily basis. The diagram should include grid alignment, station numbering (if used), and base station location(s).
9. At the termination of each survey ensure that all equipment is accounted for, and decontaminated as required by project work plans.
10. Any unusual conditions or problems encountered during the survey must be recorded on the Field Logbook and brought to the attention of the Site Superintendent.
11. When the activity is completed, or at the end of the day, return the instrument(s) to a secure area. Equipment requiring electrical charging should be placed on charge.

It is recommended that Surface geophysical survey data be stored on diskette for retrieval and management. The following information should be included for each stored data field:

- Site Location
- Location ID (or station)
- Date
- Time

Base station values and calibration measurements do not necessarily need to be recorded on the diskette. However, they must accompany the diskette record in paper copy.

5.2 Surface Geophysical Surveying

5.3 Electrical Resistivity

The electrical resistivity method uses an instrument to measure the apparent electrical resistivity of the subsurface. This includes the underlying soil, rock, and groundwater. An electrical current is introduced into the ground through surface electrodes. The resulting potential field (voltage) is measured at the surface between a second pair of electrodes. The procedure below requires the following below in addition to the general requirements listed in Section 4.2.

1. Set up and operate the geophysical electrical resistivity instrument according to manufacturers operating instructions.
2. Record the readings and other pertinent information on the appropriate forms per the project work plans.
3. Calculate apparent resistivities and review plots in the field as a means of quality control. Sounding curves should be relatively smooth. Abrupt changes commonly occur in sounding and profiling data. Near-surface inhomogeneities, electrode contact problems, or changes in hydrogeology may cause unwanted noise. Any changes or noise should be identified. Corrective actions may be taken and the survey re-run if significant improvement to the survey may be attained.
4. Any identified noise problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.4 Seismic Refraction

Seismic refraction techniques use instruments to determine the travel time or velocity of seismic waves within layers and interpret the thickness and depth of geologic units and other subsurface features. Other potential applications include the location of the water table and definition of burial pits and trenches. The procedure requires the following elements below in addition to the general requirements listed in Section 4.2.

1. Verify that factory maintenance and calibration has been conducted as recommended by the equipment manufacturer. Manufacturer maintenance should include the electronic calibration of the seismograph timing circuits.
2. Check the seismic signal and noise conditions on the instrument display to verify the proper functioning of the source geophones and trigger cables.
3. If possible, obtain or install boring logs before the survey in order to detect hidden layers or velocity inversions.
4. Set up and operate the geophysical seismic refraction instrument according to operating instructions supplied by the manufacturer.
5. Record the readings and other pertinent information on the appropriate forms.

6. Where possible collect seismic data where known geologic information is available to establish background responses. This information is useful for evaluating complex site conditions.
7. Make a hard copy of the data if the data output is on paper records.
8. In cases where paper records are not produced, plot arrival time picks made from the electronic display on a time/distance graph in the field. Problems with improper picks are often discovered through an early inspection of these plots.
9. Review all output and records of the survey, identifying any potential problems requiring corrective actions.
10. Implement corrections and re-run the survey as appropriate and if significant improvement to the survey may be attained.
11. Any identified problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.5 Electromagnetics

The EM survey detects lateral and vertical variations of electrical conductivity in the subsurface environment. EM is used for the assessment of hydrogeologic conditions, and identification and mapping of contaminant plumes, trench boundaries, buried conductive wastes, steel drums, and metallic utility lines. The procedure requires the following elements in addition to the general requirements listed in Section 4.2.

1. Establish a local standard site in the field. This will provide a reference base station to check the instrument's performance and allow correlation between instruments.
2. Check the signal and noise conditions on the instrument display to verify proper functioning and assure the correct setting of the instrument.
3. Before conducting the survey, select a temporary site on location for daily base station measurements and calibration checks. Calibration checks should be made twice daily, before and after conducting daily survey operations. Readings will repeat within approximately 10 percent.

NOTE: Do not make calibration checks in the presence of sources of cultural interference like power lines or buried utilities. Make them on a relatively flat surface outside of topographic lows and away from areas that may include subsurface waste materials.

4. Operate the EM instrument according to operating instructions supplied by the manufacturer.
5. Record instrument sensitivity settings, readings and all other pertinent information on the appropriate forms.
6. When using an automatic recording device, enter the readings from the first and last stations of each traverse. Compare these data to data from the automatic recorder at the end of each day. Recorded data and field-transcribed data must agree to within ±5 percent to meet acceptability requirements.
7. The field operating party should check instrument stability when there is local or distant thunderstorm activity. Electromagnetic radiation from thunderstorms can generate noise in the EM system. Operations may have to be postponed during thunderstorms.
8. Review all output and records of the survey, identifying any potential problems requiring corrective actions.
9. Implement corrections and re-run the survey as appropriate and if significant improvement to the survey may be attained.
10. Any identified problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.6 Ground Penetrating Radar

GPR uses high frequency radio waves to acquire subsurface information. The method produces a continuous cross-sectional image or profile of shallow subsurface conditions. The procedure below requires the following elements in addition to the general requirements listed in Section 4.2. Calibration and calibration checks of the radar system require the process described below:

1. Accurately determine the total time window (range) set by the operator.
2. Determine or estimate the electromagnetic velocity (or travel time) of the local soil/rock condition.
3. Calibrate the time window picked for the survey by using a signal calibrator in the field. This device is used to produce a series of time marks on the graphic display measured in nanoseconds. These pulses are counted to determine the total time of the radar unit. A calibration curve can be designed for each radar system.
4. If possible, use known trenches, buried pipes, and road culverts to provide a radar target of known depth. The depth of a known target, a radar record taken over the known target, and a time scale provided by the signal calibrator will provide a basic calibration record. From these data, a velocity can be accurately determined at the given target location from the following equation:

   $$V = 2d/t$$

   The average dielectric constant of the soil is then calculated using

   $$Er = c\ 2\ /v\ 2 = 1/v$$

   Where:

   v_1 = Average electromagnetic wave velocity, feet/nanosecond
   t = Two-way travel time, nanoseconds
   d = Distance of antenna to the buried object, feet
   Er = Average relative dielectric constant of the soil (unitless)
   c = Velocity of light in air equal to 1 foot/nanosecond
   v_2 = Average electromagnetic wave velocity of the soil, feet/nanosecond

   Note: The above assumes a soil with a relative magnetic permeability of 1 (unitless). If significant changes in soil type or moisture content occur with depth, velocity will not be the same throughout the vertical radar profile. Therefore, the vertical radar depth scale will be nonlinear.

   This approach will provide calibration at a specific site; however, this assumes that conditions in other areas are the same as the calibration area. Calibration should be repeated at each new site.
5. Repeat a short GPR traverse twice daily over a known feature before and after conducting daily operations to insure those changing soil conditions, rather than the electronics causes readings.
6. Conduct the GPR traverse at the sites or locations specified in the project work plans.
7. Record calibration, instrument settings, measurements and all other pertinent information on the appropriate forms.
8. Print out and review all hardcopies and records of the survey, identifying any potential problems requiring corrective actions.
9. Implement corrections and re-run the survey as appropriate and if significant improvement to the survey may be attained.
10. Any identified problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.7 Metal Detection

Metal detectors are electromagnetic devices designed to locate metallic objects buried near the surface. In hazardous waste site investigations, metal detectors are invaluable for detecting utility lines, survey markers, steel drums buried at shallow depths, and delineating areas that may potentially include metallic waste materials.

Metal detectors respond to nearby metallic objects in a relative way. For instance, closer or large metallic objects create a greater output level than more distant or smaller ones. An experienced operator can usually make a reasonably accurate estimate of target size and depth. Metal detection survey requirements at a minimum include:

1. Set up and operate the metal detector according to operating instructions supplied by the manufacturer.
2. Record the readings and all other pertinent information on the appropriate forms as outlined in the project work plans.
3. Review all data and records of the survey, identifying any potential problems requiring corrective actions.
4. Implement corrections and re-run the survey as appropriate and if significant improvement to the survey may be attained.
5. Any identified problems, corrective actions taken, and re-runs should be noted in the Field Logbook.

5.8 Magnetometer

Magnetometer surveys are used to locate metallic objects buried near the surface such as well casings, utility lines, steel drums, and tanks. They may also be used to delineate trenches and landfills. Ferrous metal objects carried by the operator will have a detrimental effect on the accuracy of the magnetometer data. Therefore, the survey team should not wear metal items like rings, watches, belt buckles, coins, and steel-toed boots.

Total field and vertical field measurements may be corrected for the diurnal variation of the earth's magnetic field by employing a reference base station magnetometer. Changes in the earth's field are removed by adding or subtracting variations of fixed base station readings from the moving survey data. Gradiometers do not require the use of a base station because they inherently eliminate time variation in the data. Requirements are as follows:

1. Conduct a swing sensor test with the proton precision magnetometer before initiating operations at a site and at least once more during the day.
2. Four readings with the sensor oriented 90° to the other readings should be taken with the operator moving with the sensor. Variations greater than one gamma should not be observed.
3. Correct any directional bias by washing the sensor with ordinary soap and water and maintaining an adequate distance between the sensors and battery pack.
4. Obtain a daily background reading in the immediate vicinity of the site to be surveyed. This reading should be outside the influence of all possible sources of cultural magnetic fields (e.g., power lines or pipelines). This daily background reading should repeat to within reasonable diurnal variations in the earth's magnetic field.
5. Take base station readings to remove the effects of the diurnal variation of the earth's magnetic field from the data.
6. Periods of rapid variation may be documented at a permanent base station, set up at the site, where continuous readings are automatically recorded approximately every 10 to 15 minutes. Alternatively, a base station(s) may be reoccupied during the survey at intervals of 45 to 60 minutes.

7. Collect survey data and record on the appropriate form per the project work plans.
8. Take readings within 10 seconds of each other.
9. Site locations influenced by cultural magnetic fields should be recorded in the logbook.
10. Take three to four sequential readings and record time when recording data manually. In the absence of magnetic storms, the readings should compare within several tenths of a gamma. Repeatability during magnetic storms may degrade to one gamma or more.
11. The use of automatic recording magnetometers requires recording the magnetometer readings for the first and last station of each traverse in a logbook.
12. Compare the data recorded in the logbook with data from the automatic recording device. Data recorded in the logbook should be within one gamma of the values derived from the recording device.
13. During cold weather, maintain the battery pack for a fluxgate magnetometer at a relatively warm temperature. This is most easily accomplished by surveying with the battery pack beneath the operator's coat or jacket.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

MONITORING WELL INSTALLATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) provides procedures and requirements for the installation of monitoring wells using rotary, dual-tube percussion, or hollow-stem auger drilling techniques. Monitoring wells are installed to provide access to groundwater for collecting samples, as well as for obtaining water level and other data. Because monitoring wells are used to collect samples, it is important that construction materials not interfere with sample quality either by contributing contaminants or by sorbing contaminants already present. Further, construction materials must be compatible with (i.e., not degraded by) contaminants present in soils or groundwater.

Monitoring wells are potential contaminant migration routes between aquifers or from the surface to the subsurface. Construction procedures and standards must ensure that neither passive nor active introduction of contaminants can occur. Properly installed hydraulic seals and locking well covers reduce the potential for cross-contamination of monitoring wells. The details within this SOP should be used in conjunction with specific project work plans and/or related SOPs.

2.0 REFERENCES

U.S. Environmental Protection Agency (EPA), Manual of Water Well Construction Practices, U.S. Environmental Protection Agency, Office of Water Supply, U.S. Government Printing Office, Washington D.C.

U.S. Environmental Protection Agency (EPA), 1986, Resource Conservation and Recovery Act (RCRA) Ground Monitoring Technical Enforcement Guidance Document, OSWER-9950.1, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, U.S. Government Printing Office, Washington D.C.

U.S. Environmental Protection Agency (EPA), 1987, A Compendium of Superfund Field Operations Methods, EPA-500/P-87/001, U.S. Government Printing Office, Washington D.C.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all monitoring well installation activities are conducted and documented in accordance with this and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by quality assurance/quality control (QA/QC) monitoring activities.

The Quality Assurance Officer is responsible for periodic review of well installation activities to assure implementation of this SOP. The Quality Assurance Officer is also responsible for the review and approval of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to monitoring well installation requirements, issuing nonconformances, etc.) identified during the performance of these activities.

The Sampling Team Leader(s) assigned to monitoring well installation activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Manager or Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Cuttings

Pieces of soil, sediment, or rock cut by a bit in the process of drilling borings.

4.2 Borehole

Any hole drilled into the subsurface for the purpose of identifying lithology, collecting soil samples, and/or installing groundwater wells.

4.3 Grout

For the purposes of this SOP, the term “grout” consists of a neat cement grout generally containing three to five percent bentonite powder to water by weight. The grout is emplaced as a slurry, and once properly set and cured, is capable of restricting movement of water.

4.4 Hollow-Stem Auger Drilling

A drilling method using augers with open centers. The augers are advanced with a screwing or rotating motion into the ground. Cuttings are brought to the surface by the rotating action of the augers, thereby clearing the borehole.

4.5 Air Rotary Casing Hammer Drilling

A drilling method using a non-rotating drive casing that is advanced simultaneously with a slightly smaller diameter rotary bit attached to a string of drill pipe. The drive casing is a heavy-walled, threaded pipe that allows for pass-through of the rotary drill bit inside the center of the casing. Air is forced down through the center drill pipe to the bit, and then upward through the space between the drive casing and the drill pipe. The upward return stream removes cuttings from the bottom of the borehole.

4.6 Mud Rotary Drilling

For the purposes of this monitoring well installation SOP, the term "mud rotary drilling" refers to direct circulation (as opposed to reverse circulation) mud rotary drilling. Mud rotary drilling uses a rotating drill bit that is attached to the lower end of a string of drill pipe. Drilling mud is pumped down through the inside of the drill pipe and out through the bit. The mud then flows upward in the annular space between the borehole and the drill pipe, carrying the cuttings in suspension to the surface.

4.7 Dual-tube Percussion Drilling

A drilling method using non-rotating drive casing with a bit on the bottom of the casing string. A smaller diameter tube or drill pipe is positioned inside the drive casing. The drive casing is advanced by the use of a percussion hammer, thereby causing the bit to cut or break up the sediment or soil at the bottom of the boring. Air is forced down the annular space between the drive casing and inner drill pipe and cuttings are forced up the center of the inner drill pipe.

4.8 Monitoring Well

A well that provides for the collection of representative groundwater samples, the detection and collection of representative light and dense nonaqueous phase organic liquids, and the measurement of fluid levels.

4.9 Annular Space

The space between:

- Concentric drill pipes;
- An inner drill pipe and outer drive casing;
- Drill pipe or drive casing and the borehole wall; or
- Well screen or casing and the borehole wall.

4.10 Filter Pack

Granular filter material (sand, gravel, etc.) placed in the annular space between the well screen and the borehole to increase the effective diameter of the well and prevent fine-grained material from entering the well.

4.11 Well Screen

A perforated, wire wound, continuous wrap or slotted casing segment used in a well to maximize the entry of water from the producing zone and to minimize the entrance of sand.

4.12 Tremie

A tubular device or pipe used to place grout, bentonite, or filter pack in the annular space.

5.0 PROCEDURES

5.1 Well Installation Procedures

This section contains the procedures for monitoring well installation activities. The procedures described herein are applicable as requirements for monitoring well installations using mud rotary, air rotary, air rotary casing hammer, dual tube percussion, or hollow-stem auger drilling techniques. Site-specific factors need to be considered in the selection of well construction and completion materials, specification of well designs, and choosing well drilling methods. These factors will be incorporated in project planning activities and the compilation of specific project work plans. The project work plans will contain the following information related to monitoring well installation:

- Objectives of the monitoring well
- Specific location of the well to be installed
- Zone or depth well is to be installed
- Drilling method(s) to be used
- Well construction materials to be used
- Specification of well design(s) including Well Construction Diagrams.
- Additional procedures or requirements beyond this SOP.

1. Before mobilization of a rig to the well site, ensure that the monitoring well location has been appropriately cleared of all underground utilities, buried objects, and that drill permits have been issued per the project work plans.
2. Review all forms and diagrams documenting the location of the cleared monitoring well site and the location of any identified underground utility lines or other buried objects.
3. Decontaminate all downhole equipment and well construction materials before monitoring well installation, as described in WTS-SOP 6.0.
4. Decontaminate the drilling rig and all drilling equipment before monitoring well installation per WTS-SOP 6.1.
5. Clear the work site of all brush and minor obstructions and then mobilize the rig to the monitoring well location.
6. The rig geologist or engineer should then review with the driller the proposed well design and details of the well installation including any anticipated potential drilling or completion problems.
7. Calibrate health and safety monitoring equipment according to the instrument manufacturer's specifications.
8. Document the calibration results on the appropriate form(s). Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

9. Workers will be provided with, and don, the appropriate personal protective equipment as specified by the project work plans. Typically, the minimum personal protection will include a hard hat, safety glasses, gloves, steel-toed boots, hearing protection, and coveralls.
10. Commence drilling and advance the borehole while conducting health and safety monitoring according to the project work plans.
11. Perform readings as often as necessary to ensure the safety of workers.
12. Record all measurements on the Field Logbook.
13. Record all other pertinent information (date, site, well or boring number, and location) on the Field Logbook. Also note and record observed field conditions, any unusual circumstances, and weather conditions.
14. Drilling of the borehole should be conducted in conformance with applicable SOPs, as appropriate.
15. During drilling, collect representative cutting and soil samples as required by the project work plans.
16. Compile a boring or lithologic log from the cuttings and samples per WTS-SOP 10.0.
17. At total depth, remove soil cuttings through circulation or rapidly spinning the augers prior to constructing the well.
18. Review logs and notes with the driller for any zones or depths exhibiting drilling problems that may affect the well installation.
19. Condition the hole or take other actions mutually agreed upon by the rig geologist (or engineer), lead technical personnel, and the driller to ensure or aid in the well development.
20. Remove the drill pipe and bit if using rotary techniques, or remove the center bit boring if using the hollow-stem auger technique. The well construction materials will then be installed inside the open borehole or through the center of the drive casing or augers.
21. Measure the total depth of the completed boring using a weighted sounding line. The borehole depth is checked to assure that formation material has not heaved to fill the borehole. If heaving has taken place, options for cleaning, re-drilling, or installation in the open section of the boring should be discussed with lead technical personnel.
22. In the event that the hole was over-drilled, grout, bentonite pellets, or bentonite chips (as specified in the project work plans) may be added to the bottom of the boring to raise the bottom of the hole to the desired depth. The grout should be pumped through a tremie pipe and fill from the bottom of the boring upward. During grouting, the tremie pipe should be submerged below the top of the grout column in the borehole to prevent free-fall and bridging. If bentonite is used, it should be added gradually to prevent bridging. Grout or bentonite addition will stop when its level has reached approximately one foot below the desired base of the well string (casing, screen, end plug or sump, etc.). The bentonite plug will be hydrated for at least one hour before installation of a filter pack.
23. Calculate volumes of filter pack, bentonite pellets/slurry, and grout required, based on borehole and well casing dimensions. If required by the project work plans, determine the filter pack and well screen slot size for the monitoring well.
24. Place a layer of filter pack (one to two feet, unless otherwise specified in the project-specific work plans) at the bottom of the borehole. The filter pack will be installed through the center of the drive casing/augers. Filter pack will be added slowly while withdrawing the drive casing/augers.
25. Inspect the casing, screen, and any other well construction materials prior to installation to assure that no damage has occurred during shipment and decontamination activities.
26. Connect and carefully lower the well string through the open borehole, drive casing, or inside of the augers until the well string is at the desired depth. The well string should be suspended by the installation rig and should not rest on the bottom of the boring. In the event the well string was dropped, lowered abruptly, or for any other reason suspected of being damaged during placement,

the string should be removed from the boring and inspected. In certain instances, the well string may rise after being placed in the borehole due to heaving sands. If this occurs, the driller must not place any drilling equipment (drill pipe, hammers, etc.) to prevent the casing from rising. The rig geologist or engineer shall note the amount of rise and then shall consult the lead technical personnel for an appropriate course of action.

27. Record the following information on the As-Built Well Completion Form and/or other appropriate forms per the project work plans:
    - Length of well screen
    - Total depth of well boring
    - Depth from ground surface to top of grout or bentonite plug in bottom of borehole (if present)
    - Depth to base of well string
    - Depth to top and bottom of well screen.

28. When using the mud rotary drilling technique, tremie the filter pack into the annular space around the screen. Clean, potable water may be used to assist with the filter pack tremie operation. For all other drilling techniques, the filter pack may be allowed to free-fall or be tremied per the project work plans. If using drive casing or augers, the drive casing or augers should be pulled slowly during filter pack installation in increments no greater than five feet.

29. Filter pack settlement should be monitored by initially measuring the sand level (before beginning to withdraw the drive casing/augers). In addition, depth soundings using a weighted tape shall be taken repeatedly to continually monitor the level of the sand. The top of the well casing shall also be monitored to detect any movement due to settlement or from drive casing/auger removal. If the top of the well casing moves upwards at any time during the well installation process, the driller should not be allowed to set drilling equipment (downhole hammers, drill pipe, etc.) on the top of the casing to prevent further movement.

30. Filter pack should be added until its height is approximately two feet above the top of the screen (unless otherwise specified in the project work plans), and verification of its placement (by sounding) should be conducted. The filter pack should then be gently surged using a surge block or swab in order to settle the pack material and reduce the possibility of bridging.

31. The height of the filter pack will then be re-sounded and additional filter pack placed as necessary. Once the placement of the filter pack is completed, the depth to the top of the pack is measured and recorded on the As-Built Well Completion Form or other appropriate forms per the project work plans.

32. A three-foot thick (unless otherwise specified in the project work plans) bentonite seal is then installed on top of the filter pack. If pellets or chips are used, they should be added gradually to avoid bridging. Repeated depth soundings will be taken using a weighted tape to ascertain the top of the bentonite seal. The seal should be allowed to hydrate for at least one hour before proceeding with the grouting operation.

33. After hydration of the bentonite seal, grout is then pumped through a tremie pipe and filled from the top of the bentonite seal upward. The bottom of the tremie pipe should be maintained below the top of the grout to prevent free fall and bridging. When using drive casing or hollow-stem auger techniques, the drive casing/augers should be raised in incremental intervals, keeping the bottom of the drive casing/augers below the top of the grout. Grouting will cease when the grout level has risen to within approximately one to two feet of the ground surface, depending on the surface completion type (flush mount versus aboveground). Grout levels should be monitored to assure that grout taken into the formation is replaced by additional grout. If settling of the grout occurs, additional topping off of the grout may be necessary.

34. For aboveground completions, the protective steel casing will be centered on the well casing and inserted into the grouted annulus. Prior to installation, a 2-inch deep temporary spacer shall be placed between the PVC well cap and the bottom of the protective casing cover to keep the protective casing from settling onto the well cap.

35. After the protective casing has set, a drainage hole may be drilled into the protective casing if required by the project work plans. The drainage hole is positioned approximately two inches above ground surface. The protective casing will be painted with a rust-preventive colored paint.

36. The well head will be labeled to identify, at a minimum, the well number.

37. A minimum of 24 hours after grouting should elapse before installation of the concrete pad and steel guard posts for aboveground completions, or street boxes or vaults for flush mount completions.

    - For aboveground completions, a concrete pad, usually 3-foot by 3-foot by 4-inch thick, is constructed at ground surface around the protective steel casing. The concrete is sloped away from the protective casing to promote surface drainage from the well.

    - For aboveground completions, where traffic conditions warrant extra protection, three steel bucking posts will be embedded to a depth approximately 1.5 feet below the top of the concrete pad. The posts will be installed in concrete filled postholes spaced equally around the well at a distance of approximately 1.5 feet from the protective steel casing. Where removal of bucking posts is required for well access, mounting sleeves should be imbedded into the concrete.

    - For flush mount (or subgrade) completions, a street box or vault is set and cemented in position. The top of the street box or vault will be raised slightly above grade and the cement sloped to grade to promote surface drainage away from the well.

    - Following well completion and demobilization of the rig, the well site should be cleared of all debris and trash and restored to a neat and clean appearance per the project work plans. All investigation-derived waste generated at the well site should be appropriately contained and managed per the project work plans.

6.0 REQUIRED FORMS/DOCUMENTATION

Well Construction Diagram

Field Logbook

Lithologic/Soil Boring Log

As-Built Well Completion Form

MONITORING WELL DEVELOPMENT

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for specifying, assessing and documenting the well development process. Additional specific well development procedures and requirements will be provided in the project work plans and/or related SOPs. Monitoring wells are developed to remove skin (i.e., near-well-bore formation damage), well drilling fluids, sediments, and to settle and remove fines from the filter pack. Wells should not be developed for 48 hours after completion when a cement bentonite grout is used to seal the annular space, or after 7 calendar days beyond internal mortar collar placement.

2.0 REFERENCES

U.S. Environmental Protection Agency (EPA), August 1988, *Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA,* Interim Final OSWER Directive 9355.3-01.

U.S. Environmental Protection Agency (EPA), 1987, *A Compendium of Superfund Field Operations Methods,* EPA-540/P-87/001a, U.S. Government Printing Office, Washington D.C.

ASTM, 1988, *Standards Technology Training Program - Groundwater and Vadose Zone Monitoring*, Nielsen, et al.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that monitoring wells are properly developed and that the development process is properly documented. This will be accomplished by staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with well development. If deviations from project requirements occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformances and requests for corrective action.

The Sampling Team Leader(s) is responsible for conducting monitoring well development and documentation in accordance with the specifications outlined in this SOP and by the project work plans.

4.0 DEFINITIONS/MATERIALS

4.1 Well Development

The act of removing fine grained sediment and drilling fluids from the sand pack and formation in the immediate vicinity of the well, thus increasing the porosity and permeability of the materials surrounding the intake portion of the well.

4.2 Eductor Pipe

The pipe used to transport well discharge water to the surface.

4.3 Materials

- Submersible pump or bailer.
- Power source (e.g., generator), if required.
- Electronic water level indicator and/or oil/water interface probe.
- Temperature, conductivity, pH, and turbidity meters.
- Personal protective equipment as specified in the project health and safety plan.

- Organic vapor meter (MicroTip, OVM, HNU, etc.).
- Teflon-coated stainless steel cable or acceptable material.
- Well development logs.

5.0 PROCEDURE

5.1 General

The most common methods used to develop monitoring wells consist of surging and bailing, surging and pumping, or combinations of all these.

The project work plans will identify the specific well development procedure to be followed. The standard procedure for field personnel to use in assessing and documenting well development is described below and is intended only for development methods listed above.

5.2 Well Development

Decontaminate the rig and development equipment in accordance with WTS-SOPs 6.0 and 6.1, respectively.

Calibrate all field analytical test equipment (pH, temperature, conductivity, and turbidity) according to the instrument manufacturer's specifications and WTS-SOP No. 4.0. Specific test equipment to be used should be identified in the project-specific work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service, tagged with an out of calibration label, and segregated (when possible) from the calibrated equipment area. An exception to the daily calibration requirements will be made in the case of the water level meters. The tape of these instruments will be checked prior to the beginning of the project and each succeeding six months using a steel surveyor's tape.

Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Any observed problems with the well head should be noted in the Field Activity Daily Log and reported to the Sampling Team Leader(s). Unlock the well and obtain a depth to water level measurement according to the procedures outlined in WTS-SOP No. 5.0. Calculate the volume of water in the well (cased well volume) as follows:

$$\pi \times (d/2)^2 \times (h_1 - h_2) \times 7.48 = \text{cased well volume (in gallons)}$$

Where

d = inside diameter of well casing (in feet)
h_1 = depth of well from top of casing (in feet)
h_2 = depth to water from top of casing (in feet)

The depth to the bottom of the well should be sounded and then compared to the completion form or diagram for the well. If sand or sediment is present inside the well, it should first be removed by bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Instead report the conditions to the Site Superintendent and obtain approval to continue or cease well development activities.

Begin development by first gently surging followed by bailing or pumping. This is then continued with alternate surging and bailing or pumping. At no time should the surge block be forced down the well if excessive resistance is encountered. During development, the bailer should not be allowed to free-fall or descend rapidly such that it becomes lodged in the casing or damages the end cap or sediment trap at the bottom of the well.

While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the Well Development Record.

While developing, calculate the rate at which water is being removed from the well. Record the volume on the Well Development Record.

While developing, water is also periodically collected directly from the eductor pipe or bailer discharge and readings taken of the indicator parameters: pH, specific conductance, and temperature. Development is considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans) and a minimum of three well volumes of water have been removed. In certain instances, for slow recharging wells, the parameters may not stabilize. In this case, well development is considered complete upon removal of the minimum of three well volumes. In some cases, the project work plans may also specify a maximum turbidity requirement for completion of development.

Obtain a water level and turbidity measurement at the completion of development.

Complete documentation of the well development event on the Well Development Record form. At a minimum this record must contain:

- Project name and number
- Well identification number
- Well depth, casing size, and completion date
- Method of development
- Volume of water removed
- Water levels (including the time of measurement)
- Physical description of the water (e.g., discoloration, turbidity, odor, etc.) and solids removed from the well
- Test equipment readings for pH, conductivity, temperature and turbidity (including the time of collection)
- Signature of the well development observer.

Collect and appropriately transport and dispose of water removed from the well in accordance with criteria listed in the project-specific work plans and regulatory requirements.

Allow the well to recover for at least 24 hours prior to sampling.

6.0 REQUIRED FORMS/DOCUMENTATION

Well Development Record Form

GROUND WATER SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of ground water samples for chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all ground water samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary and/or related SOPs. Work plans may range in complexity and formality from fully published, reviewed, and approved plans (typically provided for single events) down to WAO responses with notes (typically provided for routine, ongoing monitoring programs).

2.0 REFERENCES

EPA, September 1987, *Compendium of Superfund Field Operations Methods*, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, *EPA Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA*, Interim Final OSWER Directive 9355.3-01.

ASTM, 1988, *Standards Technology Training Program - Groundwater and Vadose Zone Monitoring*, Nielsen, et al.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QC/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to ground water sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from procedures to the Project Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Bladder Pump

A bladder pump is an enclosed cylindrical tube containing a flexible membrane bladder. Well water enters the bladder through a one-way check-valve at the bottom. Gas is forced into the annular space (positive displacement) surrounding the bladder through a gas supply line. The gas displaces the well water through a one-way check-value at the top. The water is brought to the surface through a water discharge line. Compressors or cylinders provide gas (air or nitrogen).

4.2 Peristaltic Pump

A peristaltic pump is a self-priming, low volume pump consisting of a rotor and a ball bearing roller. The rotor squeezes tubing placed around the rotor as they revolve. The squeezing produces a wavelike contractual movement that causes water to be drawn through the tubing. The peristaltic pump is limited to sampling at depths of less than 25 feet.

4.3 Electric Submersible Pump

An electric submersible pump is an enclosed cylindrical tube containing a motor with rotary attachments. Well water enters the cylinder through a one-way check valve. Electrical power to the motor causes rotors or impellers to turn and displace the groundwater.

4.4 Bailer

A bailer is an enclosed cylindrical tube containing a floating ball check-valve at the bottom. Lowering the bailer into water causes the ball to float allowing water to enter the cylinder. Raising the bailer through the water causes the ball to settle, creating a seal to trap the water so that it can be brought to the surface.

4.5 Dedicated Ground Water Monitoring Equipment

Dedicated ground water monitoring equipment is used to purge and sample only one well. The equipment is installed and remains in the well for the duration of the monitoring program. Dedicated equipment does not need to be decontaminated between sampling events.

4.6 Materials:

- Clean rope or wire line of sufficient length for conditions.
- Appropriate sample containers with labels and preservatives, as required.
- Hard plastic or steel cooler with cold packs (or ice) for samples.
- Temperature, pH, conductivity, and turbidity meters.
- Equipment calibration standards.
- Electronic water level indicator.
- Organic vapor meters.
- Plastic sheeting, if needed.
- 55-gallon drums for purge water.
- Decontamination supplies, as required.
- Personal protective clothing and equipment, if required by the project health and safety plan.
- Field logbook and monitoring well purge and sample forms

5.0 PROCEDURE

This section contains the procedures involved with groundwater sampling. Proper ground water sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives
- Locations of ground water samples to be collected
- Numbers and volumes of samples to be collected
- Types of chemical analyses to be conducted for the samples
- Specific quality control (QC) procedures and sampling required
- Any additional groundwater sampling requirements or procedures beyond those covered in this SOP, as necessary.

At a minimum, the procedures outlined in this SOP for ground water sampling will be followed.

5.1 Ground Water Sampling Requirements – Equipment Selection and Sampling Considerations

Purging and sampling equipment is constructed from a variety of materials. The most inert material (e.g., Teflon, stainless steel), with respect to known or anticipated contaminants in the well(s), should be used whenever possible. The project work plans will describe the type of equipment to be used.

If non-dedicated sampling is to be used and the contaminant histories of the wells are known, it is advisable to establish a sampling order starting with the least contaminated well and progressing to the most contaminated last.

5.2 Ground Water Purging and Sampling

Pre-sample purging and sampling should be conducted in accordance with the project work plans. The standard procedure for purging and sampling will be conducted as described below.

1. Inspect the equipment to ensure that it is in good working order.

2. Calibrate all field analytical test equipment (e.g., pH, temperature, and conductivity) according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

   NOTE: An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.

3. If non-dedicated equipment is being used, decontaminate according to WTS-SOP No. 6.0. During decontamination, the equipment should again be inspected for damage and, if present, repaired or replaced with undamaged equipment.

4. Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Damage or other conditions that may affect the integrity of the well will be recorded on the Field Activity Daily Log and brought to the attention of the Sampling Team Leader.

5. Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted on the Sampling Information Form.

6. Obtain a depth to water level measurement according to the procedures outlined in WTS-SOP 5.0. Calculate the volume of water in the well (cased well volume) as follows:

   $$\pi \times (d/2)^2 \times (h_1 - _ h_2) \times 7.48 = \text{cased well volume (in gallons)}$$

   Where

   d = inside diameter of well casing (in feet)
   h_1 = depth of well from top of casing (in feet)
   h_2 = depth to water from top of casing (in feet)

   Record static water level measurement and calculations on the Field Logbook.

5.3 Purging with various devices

If using non-dedicated equipment, lower the pump and associated tubing and/or lines into the well.

For a bladder pump, attach the compressor or cylinder to the controller and the controller to the gas supply line, making sure that the compressor is downwind of the monitoring well. Attach the sampling tube to the discharge supply line. Adjust the pressure/discharge cycle on the controller.

For a peristaltic pump, conduct equipment decontamination as described in Section 5.2.3. However, the old Tygon™ tubing should not be decontaminated. New tubing should be used for each well. Connect new Tygon™ tubing to the rotor head of the pump motor and tighten until snug. Run a short section of the tubing from the discharge side of the pump head to a collection vessel. Insert the free end of the influent tubing into the well and lower it to the middle of the well screen.

For an electric submersible pump, place the generator downwind of the well. Start the generator and then plug the pump into the generator.

For a bailer, Secure the bailer to a five foot length of Teflon™ coated stainless bailer wire with a bowline knot or clip. Attach the bailer wire to bailing line or chain. Begin purging by slowly lowering the bailer into the groundwater. Allow the floating ball valve to seat, and slowly retrieve the bailer. Repeat this procedure to purge the well. During purging, the descent of the bailer should be controlled to prevent free fall inside the well. In the event the bailer encounters an obstruction inside the well, no attempts may be made to push the bailer beyond the obstruction. If the bailer becomes lodged in the well, the line should not be pulled with such force that it would part from the bailer. Such conditions should also be noted in the Field Logbook and brought to the immediate attention of the field geologist or engineer.

Begin purging. Collect, transport, and dispose of purge water in accordance with the criteria specified by the project work plans.

Physical parameters (pH, specific conductance, and temperature) of the purge water will be measured when purging begins and then periodically throughout the purging procedure. These measurements will be recorded on Sampling Information Form. Purging is considered complete when a minimum of three casing volumes have been removed and pH, specific conductivity, and temperature measurements have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans). Standard tolerances for successive readings are as follows:

- pH within 0.1 standard unit;
- Specific conductance within 10%;
- Temperature within 0.5^{o} C; and
- No trends among the successive readings.

If stability is not reached within the removal of three well volumes then purging is continued until a maximum of five cased well volumes have been removed. If stability is not reached within removal of five well volumes, the Sampling Team Leader will, at their discretion, elect to collect the sample or discontinue the effort.

For slowly recharging wells (i.e., wells that are purged to dryness at the lowest practicable purge rate), the well will be purged to dryness, allowed to recover, and sampled without further purging. Allow the well to recover to at least 80 percent of the initial cased well volume prior to sampling.

Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.

5.4 Sampling with various devices

For a bladder pump, turn on the pump and adjust the pressure/discharge cycle on the pump controller so that the water will flow smoothly and without agitation into the sample containers.

For a peristaltic pump, turn on and adjust the rotor speed of the pump so that the water will flow smoothly and without agitation into the sample bottles.
For an electric submersible pump, turn on and adjust the flow rate of the pump by using the check-valve on the discharge line so that the water will flow smoothly and without agitation into the sample bottles.

For a bailer, lower the sample collection bailer and submerge into the water column as above. Retrieve the bailer and insert a bottom-emptying device into the bailer so that the water will flow smoothly and without agitation into the sample bottles.

Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle. Samples collected for metals and general water chemistry analysis should be filled to the base of the bottleneck.

The samples should be collected in the order of volatility, collecting the most volatile samples first, followed by the least volatile samples. The volatile samples should be collected during one full discharge cycle. Do not partially fill a volatile sample during one cycle and complete the filling during the next cycle. VOC samples should not be collected with a peristaltic pump.

Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans. The standard filter size is 0.45 microns.

Cap the bottle and attach custody tape across the cap so that any attempt to remove the sample or open the sample bottle will be evident. Fill out and attach the sample label to the bottle per WTS-SOP No. 2.1. The sample will be assigned a sample number per WTS-SOP No. 2.2.

Document the sampling event on the Field Logbook.

As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziplock™ or equivalent). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.

Handle and ship the sample according to the procedures outlined in WTS-SOP No. 2.1, following appropriate custody procedures described in WTS-SOP No. 1.1. Samples stored temporarily on site will be maintained per WTS-SOP No. 2.3.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

CONE PENETRATION TESTING (CPT) AND HYDROPUNCH® GROUND WATER SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for conducting cone penetration testing (CPT), soil sampling using a CPT rig, and Hydropunch® groundwater sampling. The details within this SOP should also be used in conjunction with project work plans and/or related SOPs.

2.0 REFERENCES

ASTM, 1988, Standard Method for Deep, Quasi-Static, Cone and Friction-Cone Penetration Tests of Soil, Designation: D 3441-86, Volume 4.08 Soil and Rock, Building Stones: Geotextiles, pp.409-414.

Manchon, B., 1992, Introduction to Cone Penetrometer Testing and Groundwater Samplers, Sixth National Outdoor Action Conference on Aquifer Restoration, Groundwater Monitoring and Geophysical Methods, May 1992.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are representative is responsible for ensuring that all CPT, soil sampling, and Hydropunch® activities are conducted and documented in accordance with this and any other appropriate procedures or related SOPs. This will be accomplished by staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field activities and documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, generation of variances to CPT and sampling requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) and sampling personnel assigned to CPT, soil sampling, and Hydropunch® activities are responsible for completing their tasks according to this and other appropriate procedures. All staff members are responsible for reporting deviations from the procedure to the Project Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Cone

The cone-shaped point of the penetrometer tip, upon which the end-bearing resistance develops.

4.2 Cone penetrometer

An instrument in the form of a cylindrical rod with a conical point, designed for penetrating soil and soft rock and for measuring the end-bearing component of penetration resistance.

4.3 Cone resistance or end-bearing resistance

The resistance to penetration developed by the cone, equal to the vertical force applied to the cone divided by its horizontally projected area.

4.4 Hydropunch®

A device used to collect groundwater samples using CPT or drill rig technology. Various forms of the Hydropunch® exist; they vary in the method used for sample collection. Hydropunch® I uses the body of the hydropunch to collect and retrieve the sample. Hydropunch® II allows for the collection of water samples using a bailer lowered within the CPT rods or drill stem.

4.5 Sounding

The entire series of penetration tests performed at one location.

4.6 Friction Ratio

The ratio of friction resistance to cone resistance, expressed in percent.

4.7 Friction Resistance

The resistance to penetration developed by the friction sleeve, equal to the vertical force applied to the sleeve divided by its surface area. This resistance consists of the sum of friction and adhesion.

4.8 Differential Pore Pressure Ratio

A calculated parameter equal to the excess pore pressure measured behind the tip divided by the sum of the tip resistance (corrected for pore pressure effects and the total overburden stress). Used in combination with the end-bearing resistance to infer lithology.

4.9 Pore Pressure

Water pressure in the formation.

4.10 Push Rods

The thick-walled tubes, or other suitable rods, used for advancing the penetrometer tip or Hydropunch® to the required test depth.

5.0 PROCEDURE

Depending on the sampling activities to be performed, CPT/Hydropunch® testing may require multiple runs to complete the desired tests. The first run is generally conducted to generate stratigraphic or hydrogeologic information. The stratigraphic or hydrogeologic data is then evaluated to determine optimum depth intervals to obtain soil and ground water samples that will be collected in subsequent runs.

An experienced contractor under the contract of the prime contractor or their subcontractors will perform CPT soundings, and soil and groundwater sampling. All CPT, soil sampling, and Hydropunch® techniques covered in this SOP will be performed in accordance with the project work plans. The project work plans will identify the following:

- Testing and sampling objectives
- Locations and depths of CPT and sampling points
- Numbers and volumes of soil or groundwater samples to be collected
- Types of chemical analyses to be conducted for the samples
- Specific quality control (QC) procedures and sampling required
- Specific procedures to be performed in addition to those covered in this SOP.

At a minimum, the procedures outlined below for CPT, soil sampling, and Hydropunch® groundwater sampling will be followed.

5.1 Preparation Procedures

Prior to commencement of CPT activities ensure that all CPT, soil sampling, and Hydropunch® locations have been appropriately cleared of all underground utilities and buried objects per the project work plans. Review all forms and diagrams documenting the location of the cleared sampling and CPT locations, as well as that of any underground utility lines or other buried objects.

Perform a specific calibration of air monitoring equipment required for air space monitoring according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s), as specified in the project work plans. Instruments that can not be calibrated according to the manufacturer's specifications will be removed from service and tagged.

Don the appropriate personal protection equipment specified in the project-specific work plans.

5.2 Cone Penetration Testing

In general, the CPT is the first run to be conducted. The CPT rig is normally truck-mounted and contains a hydraulic push system (20 ton is typical). The depth of investigation will typically be less than 100 feet below ground surface (bgs). Lighter weight rigs can be utilized for shallow surveys up to approximately 15 feet bgs.

Some CPT rigs are equipped with an automatic decontamination system featuring an enclosed chamber that may be mounted beneath the CPT rig (project-specific decontamination requirements are specified in the project work plans). This chamber contains scrubbers and spray nozzles for pressure washing of the CPT probe as it is retrieved from the ground. In this type of system, all activities are conducted within the enclosed CPT rig.

The standard procedure for conducting stratigraphic and hydrogeologic investigations is described below.

1. Obtain specifications on the type and dimensions of the probes and equipment, along with the results of current shop calibrations from the CPT subcontractor.
2. With the CPT subcontractor, inspect all equipment to ensure that it is in proper working order.
3. Examine data from adjacent soil borings, if available. Initial correlation of the CPT data with site lithologies will be accomplished by comparison with existing boring logs, geophysical logs, and CPT logs.
4. Before moving onto the site, decontaminate the outside of the rig per WTS-SOP No. 6.1 and the project work plans. For those rigs that do not have an automatic decontamination system, the CPT probe and rods should also be decontaminated per WTS-SOP No. 6.1.
5. Calibrate the CPT cones at zero load reading in air and water, shielding the cone from direct sunlight before commencement of testing at each location.
6. Commence the test and advance the CPT probe into the subsurface at a consistent, controlled rate of 0.03 to 0.07 feet per second (1 to 2 centimeter per second), unless conditions prevent that rate.
7. Record real-time field plots consisting of depth, cone tip resistance, sleeve friction resistance, and friction ratio. Pore pressure and differential pore pressure ratio may be included in some cases.
8. Pore pressure dissipation tests may be conducted to determine relative flow rates at specific depths. The CPT probe is held stationary at a given depth and data are recorded for a set time interval. The time interval is dependent on the lithology of the zone being tested.
9. Once the CPT is pushed to the maximum desired depth, data collection is terminated. The CPT is retracted from the hole and the tip and rods are wiped down during extraction.

10. Upon completion of a test, calibrate the piezocone again to zero load reading and compare this to the initial reading.
11. Abandon the hole in accordance with the project work plans.
12. The rig geologist or engineer will record all pertinent information observed during the investigations. Information will be recorded on the Field Logbook. Any and all problems or unusual conditions encountered should also be noted on the above forms and brought to the attention of the site superintendent.

5.3 Soil Samples

If required, soil sampling will follow the CPT analysis run. Soil sampling locations will be placed updip relative to the location of the previous CPT testing run. The standard procedure is described below.

1. Assemble and check the necessary sampling equipment before soil sampling. Decontaminate all downhole sampling equipment before sampling, as described in WTS-SOP 6.0. The rig should also be decontaminated per WTS-SOP No. 6.1.

2. Deploy and advance the soil sampling probes with the CPT rods to collect soil samples at the sample intervals specified in the project work plans. The sample intervals may be identified from the adjacent CPT data and any other subsurface data available. The sampling device contains removable liners that fit inside the drive tip mechanism.

3. Retrieve the sampler and remove the liners containing the soil. Cover the ends of each liner to be submitted for chemical analysis with Teflon™ film and then cap with plastic end caps.

4. Each liner to be submitted for analysis will be appropriately labeled. The label will be filled out using waterproof ink and will contain, at a minimum, the following information:

   - Project number
   - Sample point (or boring) number
   - Bottom depth of liner
   - Date and time of sample collection
   - Parameters for analysis
   - Sampler's initials.

5. As soon as possible after sample collection, place the sample in an appropriately sized, airtight, seam-sealing polyethylene bag (e.g., Ziploc ™ or equivalent). Seal the bag, removing any excess air, and tape the bag with custody tape so that any attempt to remove the sample will cause the tape to be broken.

6. Document the sampling event on the Field Logbook.

7. Handle the sample according to the procedures outlined in WTS-SOP No. 2.1. For samples submitted to a laboratory for analysis, a task-specific Analyte List and Chain-of-Custody Record shall be completed and maintained per WTS-SOP No. 1.1 and the project work plans.

8. Abandon the hole following the procedure outlined in the project work plans.

5.4 Hydropunch® Ground Water Samples

The Hydropunch® sample locations, if conducted in conjunction with CPT data collection, will be located a few feet in the estimated up gradient direction from the previous CPT location. Hydropunch® sampling will be conducted in accordance with the project work plans. The standard procedure for Hydropunch® sampling is described below.

Decontaminate the Hydropunch® probe and push/drive rods in accordance with WTS-SOP No. 6.0. If the Hydropunch® model is being used with a small diameter bailer, the bailer and associated equipment must also be decontaminated in accordance with WTS-SOP No. 6.0.

Advance the probe to the target depth, which will commonly be a permeable layer as defined from the adjacent CPT or other stratigraphic information. Depth control is maintained by counting the number of whole and partial push or drive rods used. The Hydropunch® is measured at the tip of the tool and zeroed at the ground surface.

To obtain a ground water sample, retract the outer jacket of the Hydropunch® probe to allow ground water inflow into the sample chamber. An optional technique, used to determine when the sample chamber is full as follows:

1. Place a surgical glove over the end of the push rod before the outer jacket of the sampler is retracted.
2. As water enters the sample chamber and displaces air, the glove will inflate.
3. Once the glove stops inflating, water has ceased flowing into the chamber and the sample may be retrieved.
4. The length of time required for the sample chamber to fill is a function of the relative permeability of the formation and the presence or absence of materials that may clog the filter screen, thereby inhibiting the flow of water.
5. Retract the probe from the hole, disconnect the push rods from the Hydropunch®, and remove the upper valve. Replace the upper valve with a Teflon ™ stopcock valve and a disposable tube (Hydropunch® I). Turn the sampler upside down, open the cock valve and decant the sample into the sample container.
6. If using the Hydropunch® II model with a small diameter bailer, the water sample is retrieved by lowering the bailer through the inside of the push rod into the sample chamber. The water recovered in the bailer is then decanted directly into the appropriate sample containers.
7. If collecting samples for analysis of volatile organic compounds (VOCs) first completely fill the VOC sample vials. Each filled, capped vial will be inverted to ensure no air bubbles are present. If an air bubble is present, the vial will be opened and refilled with an additional sample. The vial will be immediately capped and checked again for bubbles. If air bubbles are still present, the VOC sample vial will be discarded and a new vial used. The VOC sample vial filling procedure is then repeated until no air bubbles are present.
8. If other sample analyses are required, fill the other sample containers after the VOC sample vials are filled. Samples collected for metals and general minerals analysis will be filled to the base of the bottleneck. Care will be taken not to aerate the sample during transfer from the bailer to the sample bottles and not to overfill bottles containing preservatives. All samples shall be appropriately preserved per the project work plans.
9. Each sample container to be submitted for analysis will be appropriately labeled. The label will be filled out using waterproof ink and will contain, at a minimum, the following information:
   - date and time sample was collected
   - sample location
   - the initials of the individual conducting the sampling
   - any additional required information.
10. Document the sampling event on the Field Logbook.
11. Place the labeled vials in seam-sealing plastic bags (i.e., Ziplock or equivalent). Seal the bag, removing any excess air, and tape the bag with custody tape so that removal of the sample will cause the tape to be broken.

12. Conduct a visual inspection of the turbidity of samples and record on the Field Logbook to provide a qualitative record of results.
13. Handle the samples according to procedures outlined in WTS-SOP No. 2.1. For samples submitted to a laboratory for analysis, a task-specific Analyte List and Chain-of-Custody Record shall be completed and maintained per WTS-SOP No. 1.1 and the project work plans.
14. After samples are collected, water levels may be measured. For water level measurements using the Hydropunch®, allow enough time for ground water to fill the sample chamber and the push rods. After static water level conditions are achieved, an electric tape is lowered through the push rods and the water level is measured. Document results on the appropriate form, as specified by the project-specific work plans.
15. Abandon the hole following the procedure outlined in the project work plans.

5.5 Reporting

The CPT contractor should provide a field survey report of the test data before demobilizing from each location. The CPT contractor should record on the survey report the operator's name, date of the survey, and the CPT location number. The report should include the following:

- descriptions of the various probes and equipment, and the results of calibrations performed;
- profiles of cone tip resistance, sleeve friction resistance, friction ratio, inclination, pore pressures, and differential pore pressure ratio versus depth; and
- a list of the derived geotechnical parameters related to the subsurface conditions, including soil types, standard penetration test blow counts, relative density, and shear strengths.

The report should then be reviewed, approved, and signed by the Project Geologist as identified in the project work plans.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

Task-Specific Analyte List

Chain-of-Custody Record

SURFACE WATER SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of surface water samples for chemical analysis. Proper collection procedures are necessary to assure the quality and integrity of all surface water samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary and/or related SOPs.

2.0 REFERENCES

EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, Interim Final OSWER Directive 9355.3-01.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QC/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to surface water sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from procedures to the Project Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

Materials:

- Appropriate sample containers with labels and preservatives, as required.
- Hard plastic or steel cooler with cold packs (or ice) for samples.
- Temperature, pH, conductivity, and turbidity meters.
- Equipment calibration standards.
- Organic vapor meters.
- Plastic sheeting, if needed.
- Decontamination supplies, as required.
- Personal protective clothing and equipment, if required by the project health and safety plan.
- Field logbook and sample forms

5.0 PROCEDURE

This section contains the procedures involved with surface water sampling. Proper sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives
- Locations of samples to be collected
- Numbers and volumes of samples to be collected
- Types of chemical analyses to be conducted for the samples
- Specific quality control (QC) procedures and sampling required
- Any additional sampling requirements or procedures beyond those covered in this SOP, as necessary.

At a minimum, the procedures outlined in this SOP for surface water sampling will be followed.

5.1 Surface Water Sampling Requirements

5.1.1 Equipment Selection and Sampling Considerations

Sampling equipment is constructed from a variety of materials. The most inert material (e.g., Teflon, stainless steel), with respect to known or anticipated contaminants, should be used whenever possible. The project work plans will describe the type of equipment to be used.

If non-dedicated sampling is to be used and the contaminant histories of the sites are known, it is advisable to establish a sampling order starting with the least contaminated site and progressing to the most contaminated last.

5.1.2 Sampling with a Bailer or Dipper

Sampling should be conducted in accordance with the project work plans. The standard procedure for sampling using a bailer or dipper will be conducted as described below.

5.1.3 Inspect the equipment to ensure that it is in good working order.

1. Calibrate all field analytical test equipment (e.g., pH, temperature, and conductivity) according to the instrument manufacturer's specifications. Calibration results will be recorded on the appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

2. If non-dedicated equipment is being used, decontaminate according to WTS-SOP No. 6.0. During decontamination, the equipment should again be inspected for damage and, if damage is present, the equipment should be repaired or replaced with undamaged equipment.

3. Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.

4. Using the bailer or dipper, collect water directly from the surface water body being monitored. Care should be taken to avoid disturbing the sample surroundings, e.g., stirring up sediment form the bottom of a stream or pond.

5. Collect the sample directly into the provided sample bottle (container), minimizing aeration of the sample. Completely fill the bottle. Samples collected for metals and general water chemistry analysis should be filled to the base of the bottle neck.

6. The samples should be collected in the order of volatility, collecting the most volatile samples first, followed by the least volatile samples.

7. Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans.

8. Cap the bottle and attach custody tape across the cap so that any attempt to remove the sample or open the sample bottle will be evident. Fill out and attach the sample label to the bottle per WTS-SOP No. 2.1. The sample will be assigned a sample number per WTS-SOP No. 2.2.

5.1.4 Document the sampling event on the Field Logbook.

As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziplock™ or equivalent). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.

Handle and ship the sample according to the procedures outlined in WTS-SOP No. 2.1, following appropriate custody procedures described in WTS-SOP No. 1.1. Samples stored temporarily on site will be maintained per WTS-SOP No. 2.3.

5.1.5 Sampling with a Peristaltic Pump

Sampling will be conducted per the project work plans. The standard procedure for surface water sampling using a peristaltic pump will be conducted as described below.

1. Inspect the equipment to ensure that it is in good working order.
2. Conduct all field analytical test equipment (pH, temperature, and conductivity) calibration as discussed in Section 5.1.2.2.
3. Conduct equipment decontamination as described in Section 5.1.2.3. However, the old Tygon™ tubing should not be decontaminated. New tubing should be used for each site.
4. Connect new Tygon™ tubing to the rotor head of the pump motor and tighten until snug.
5. Run a short section of the tubing from the discharge side of the pump head to a collection vessel.
6. Insert the free end of the influent tubing into the surface water site and lower it to the middle of the water column.
7. Inspect the sampling bottles to be used per Section 5.1.2.12.
8. Turn on and adjust the rotor speed of the pump so that the water will flow smoothly and without agitation into the sample bottles.
9. Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle; however, samples collected for metals and general water chemistry analyses should be filled to the base of the bottle neck.
10. The samples should be collected in the order of volatility as described in Section 5.1.2.15. VOC samples should not be collected with a Peristaltic Pump.
11. Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans.
12. Appropriately cap, label, and number the samples as discussed in Section 5.1.2.17.
13. Document the sampling event on the Field Logbook.
14. Appropriately seal, store, handle, and ship the samples per Sections 5.1.2.19 and 5.1.2.20.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

LOW-FLOW GROUND WATER SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for use by field personnel in the collection and documentation of ground water samples for chemical analysis using low flow procedures. Proper collection procedures are necessary to assure the quality and integrity of all ground water samples. Additional specific procedures and requirements will be provided in the project work plans, as necessary and/or related SOPs. Work plans may range in complexity and formality from fully published, reviewed, and approved plans (typically provided for single events) down to WAO responses with notes (typically provided for routine, ongoing monitoring programs).

2.0 REFERENCES

EPA, September 1987, *Compendium of Superfund Field Operations Methods,* EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, *EPA Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA,* Interim Final OSWER Directive 9355.3-01.

ASTM, 1988, *Standards Technology Training Program – Ground Water and Vadose Zone Monitoring,* Nielsen, et al.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QC/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to ground water sampling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from procedures to the Project Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Bladder Pump

A bladder pump is an enclosed cylindrical tube containing a flexible membrane bladder. Well water enters the bladder through a one-way check-valve at the bottom. Gas is forced into the annular space (positive displacement) surrounding the bladder through a gas supply line. The gas displaces the well water through a one-way check-value at the top. The water is brought to the surface through a water discharge line. Compressors or cylinders provide gas (air or nitrogen).

4.2 Electric Submersible Pump

An electric submersible pump is an enclosed cylindrical tube containing a motor with rotary attachments. Well water enters the cylinder through a one-way check valve. Electrical power to the motor causes rotors or impellers to turn and displace the ground water.

4.3 Dedicated Ground Water Monitoring Equipment

Dedicated ground water monitoring equipment is used to purge and sample only one well. The equipment is installed and remains in the well for the duration of the monitoring program. Dedicated equipment does not need to be decontaminated between sampling events.

4.4 Materials:

- Clean rope or wire line of sufficient length for conditions.
- Appropriate sample containers with labels and preservatives, as required.
- Hard plastic or steel cooler with cold packs (or ice) for samples.
- Temperature, pH, conductivity, and turbidity meters.
- Equipment calibration standards.
- Electronic water level indicator.
- Organic vapor meters.
- Plastic sheeting, if needed.
- 55-gallon drums for purge water.
- Decontamination supplies, as required.
- Personal protective clothing and equipment, if required by the project health and safety plan.
- Field Log Book.

5.0 PROCEDURE

This section contains the procedures involved with low flow ground water sampling. Proper ground water sampling procedures are necessary to insure the quality and integrity of the samples. The details within this SOP should be used in conjunction with project work plans. The project work plans will generally provide the following information:

- Sample collection objectives
- Locations of ground water samples to be collected
- Numbers and volumes of samples to be collected
- Types of chemical analyses to be conducted for the samples
- Specific quality control (QC) procedures and sampling required
- Any additional ground water sampling requirements or procedures beyond those covered in this SOP, as necessary.

At a minimum, the procedures outlined in this SOP for low flow ground water sampling will be followed.

5.1 Ground Water Sampling Requirements – Equipment Selection and Sampling Considerations

Purging and sampling equipment is constructed from a variety of materials. The most inert material (e.g., Teflon, stainless steel), with respect to known or anticipated contaminants in the well(s), should be used whenever possible. The project work plans will describe the type of equipment to be used.

If non-dedicated sampling is to be used and the contaminant histories of the wells are known, it is advisable to establish a sampling order starting with the least contaminated well and progressing to the most contaminated last.

5.2 Ground Water Purging and Sampling

Pre-sample purging and sampling should be conducted in accordance with the project work plans. The standard procedure for purging and sampling will be conducted as described below.

1. Inspect the equipment to ensure that it is in good working order.

2. Calibrate all field analytical test equipment (e.g., pH, temperature, and conductivity) according to the instrument manufacturer's specifications. Calibration results will be recorded in the Field Log Book and any appropriate form(s) as specified by the project work plans. Instruments that cannot be calibrated according to the manufacturer's specifications will be removed from service and tagged.

   NOTE: An exception to the daily calibration requirements will be made in the case of the water level meters. These instruments will be calibrated at the beginning of the project and then every six months using a steel surveyors tape.

3. If non-dedicated equipment is being used, decontaminate according to WTS SOP No. 6.0. During decontamination, the equipment should again be inspected for damage and, if present, repaired or replaced with undamaged equipment.

4. Visually inspect the well to ensure that it is undamaged, properly labeled and secured. Damage or other conditions that may affect the integrity of the well will be recorded in the Field Log Book and brought to the attention of the Sampling Team Leader.

5. Uncap the well and monitor the air space immediately above the open casing per the health and safety plan. Observe if any air is flowing into or out of the casing. In the event such conditions are observed, they should be noted in the Field Log Book.

6. Obtain a depth to water level measurement according to the procedures outlined in WTS SOP 5.0. Record static water level measurement in the Field Log Book.

5.3 Purging with various devices

If using non-dedicated equipment, lower the pump and associated tubing and/or lines into the well. For a bladder pump, attach the compressor or cylinder to the controller and the controller to the gas supply line, making sure that the compressor is downwind of and located 20ft away from the monitoring well. Attach the sampling tube to the discharge supply line. Adjust the pressure/discharge cycle on the controller based on manufacture specs and well depth.

For an electric submersible pump, place the generator downwind and a minimum of 20ft away of the well. Start the generator and then plug the pump into the generator.

Set up pump control and drawdown meter on selected well as noted in equipment manuals. Begin purging. Collect, transport, and dispose of purge water in accordance with the criteria specified by the project work plans. The optimum pumping rate will need to be established for each well to be sampled. The steps below should be followed:

1. Measure the initial water level.

2. Begin pumping at an approximate rate of 100 mL/min.

3. After one to two minutes of pumping, measure the water level to determine drawdown. If little or no drawdown has occurred, the pumping rate may be increased. Typical pumping rates range from 100 mL/min to 500 mL/min. Note: ASTM recommends that when sampling for VOC analysis, pumping rates should not exceed 250 mL/min.

4. If turbidity increases significantly or drawdown exceeds the allowable values, pumping should be decreased (or even stopped if necessary). According to NMED guidance, the water level should be checked at minimum every five minutes during purging.

5. Pumping rate should not exceed 500 mL/min.

Once the pumping rate has been established, begin recording parameters (pH, specific conductance, temperature, and turbidity) at standard intervals (the interval should be the time it takes to clear the volume of the flow cell at the chosen pumping rate).

Physical parameters (pH, specific conductance, and temperature) of the purge water will be measured when purging begins and then periodically throughout the purging procedure. These measurements will be recorded in the Field Log Book. Purging is considered complete when pH, specific conductivity, and temperature measurements have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans). Standard tolerances for successive readings are as follows:

- pH within 0.1 standard unit;
- Specific conductance within 10%;
- Temperature within 0.5^{o} C; and
- No trends among the successive readings.

If stability is not reached within the removal of three well volumes, then purging is continued until a maximum of five cased well volumes have been removed. If stability is not reached within removal of five well volumes, the Sampling Team Leader will, at their discretion, elect to collect the sample or discontinue the effort.

Inspect the sampling bottles (obtained from the analytical laboratory prior to the sampling event) to be used to ensure that they are appropriate for the samples being collected, are undamaged, and have had the appropriate types and volumes of preservatives added. The types of sample containers to be used and sample preservation requirements will be provided in the project work plans.

5.4 Sampling with various devices

For a bladder pump, turn on the pump and adjust the pressure/discharge cycle on the pump controller so that the water will flow smoothly and without agitation into the sample containers.

For an electric submersible pump, turn on and adjust the flow rate of the pump by using the check-valve on the discharge line so that the water will flow smoothly and without agitation into the sample bottles.

Collect the sample directly into the provided sample bottle (container), allowing the discharge to flow gently down the inside of the bottle, minimizing aeration of the sample. Completely fill the bottle. Samples collected for metals and general water chemistry analysis should be filled to the base of the bottleneck.

The samples should be collected in the order of volatility, collecting the most volatile samples first, followed by the least volatile samples. The volatile samples should be collected during one full discharge cycle. Do not partially fill a volatile sample during one cycle and complete the filling during the next cycle.

Samples that require filtering should be collected last. The samples should preferably be filtered using a disposable vacuum filterization unit. The required filter mesh should be stipulated in the project work plans. The standard filter size is 0.45 microns.

Cap the bottle and attach custody tape across the cap so that any attempt to remove the sample or open the sample bottle will be evident. Fill out and attach the sample label to the bottle per WTS-SOP No. 2.1. The sample will be assigned a sample number per WTS-SOP No. 2.2.

Document the sampling event on the Field Log Book.

As soon as possible after sample collection, place the sample in a separate, appropriately sized, airtight, seam sealing, polyethylene bag (i.e., Ziplock™ or equivalent). Seal the bag, removing any excess air. Place the bagged sample inside the shipping container.

Handle and ship the sample according to the procedures outlined in WTS SOP No. 2.1, following appropriate custody procedures described in WTS SOP No. 1.1. Samples stored temporarily on site will be maintained per WTS SOP No. 2.3.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Log Book

LITHOLOGIC LOGGING

1.0 PURPOSE

The purpose of this procedure is to define the requirements necessary for borehole and sample logging. The major objective of this procedure is to provide a uniform set of guidelines that will aid in developing consistency among sample descriptions and sample techniques. The importance of accurate, complete, clear, and concise logs cannot be overemphasized.

2.0 BACKGROUND

Borehole logging is used to determine the geologic relationships of subsurface soil and rock formations. The relationship of geologic formations and features is important in describing groundwater flow and in determining probable contaminant migration pathways.

3.0 RESPONSIBILITIES

The Field Geologist is responsible for on-site monitoring of drilling and soil sampling operations, for recording (logging) pertinent information regarding the geologic materials penetrated during the operations, and for ensuring that the well and sample numbering system is consistent with the site specific sampling and analysis plan.

4.0 EQUIPMENT

4.1 Required Equipment

- Clipboard
- Drilling record forms
- Portable organic vapor detector
- Field logbook, straight edge and black permanent ink
- Weighted engineer's tape
- Folding rule or tape measure
- Sand gauge
- Color chart
- Acid bottle
- Water level indicator
- Site map
- Copy of drilling contract
- Waterproof marking pen
- Sample jars or bags

4.2 Optional Equipment

- Hand lens
- Brunton or equivalent compass
- Pocket penetrometer
- Equipment pouch
- Flagging tape
- Cooler and water bottles
- Flashlight
- Rock hammer

5.0 PROCEDURE FOR FILLING OUT SOIL BORING/WELL LOG

This form is intended for use in the field during the drilling, sampling, and logging process for soil borings and wells. Most of the items can be neatly and legibly included in the field; however, some items, such as the graphic log column, may be reserved for completion in the office. The purpose of the log is to clearly document the events and findings of the drilling activity. All pertinent data related to boring/drilling operations must be concisely recorded as objectively as possible. The geologist or engineer has the option to resubmit this form in a deliverable as a completely redrafted/typed form, or as a combination of information applied in the field and in the office. Regardless, the original field log should be retained in the permanent file. Any alterations or changes between the office copy and the original should be justified. To complete the boring or well logs:

- Fill out information on header of the log noting either boring or well number, if well is to be installed. Use the sampling site identification number.
- Note number under "Location".
- Note start and end date of boring or well installation under "Date", use MM/DD/YY format.
- Briefly describe wind direction, speed, and temperature under "Weather".
- The logging geologist or engineer should include his name under "Logged by", include three initials.
- The driller's name and drilling company should be included under "Drilled by", include three initials for the driller's name.
- "Drilling method" should contain information such as hollow-stem auger and auger inside diameter. If using rotary methods, include size of bit and rotary method used.
- "Sampling method" should be described as length of sampler and type, i.e., 2.5´ split spoon. The sampling method should be described such that it is easily translatable to one of the following codes at time of data entry:

B	Bail
C	Composite grab
G	Single grab
P	Pump
S	Split-spoon core sampling
T	Shelby tube core sampling
U	Soil auger
X	Composite core sample
Z	Scraping from physical surface
1	Magnetometer (UXO survey)
2	Well sampler
9	Trip and rinse blanks

- "Gravel pack" should include the depth interval of gravel pack installation, sieve filter size, and type, e.g., 50´-39´, 20-40 Colorado silica.
- "Seal" The seal should describe the depth interval of seal above the gravel pack and type. The seal should also describe the depth interval of grout slurry, e.g., 39´ - 34´ - Bentonite pellets, 34´ - 0´ - Bentonite/grout slurry

5.1 Under the header of casing, the casing description will require the following:

- "Type" Schedule 40 polyvinyl chloride (PVC), stainless steel etc.
- "Diameter" The information supplied here will be reported in inches (usually 4 inch).
- "Length" The length of casing or riser should include stick-up at the surface.

5.2 Under the heading of screen, the well screen will require the following information:

- "Type" Schedule 40 polyvinyl chloride (PVC), stainless steel etc.
- "Slot" The screen slot size. For silts and fine-grained sands, the slot size will be 0.01 inch. For sands medium to coarse grained, the slot size will be 0.02 inch.
- "Diameter" The diameter for well screens reported in inches (usually will be 4 inch).
- "Length" The length of the well screen in reported feet.
- "Hole Diameter" The diameter of hole cut by either a rotating bit or auger cutting head. Reported in inches.
- "Total Depth" The total depth drilled (in feet). If sampled deeper than depth drilled, this should be noted at the bottom of the log.
- "Location Map" A sketch of the boring location should be constructed in this corner.

5.3 Topographical setting will be one of the following:

DEPR	Local depression
DTCH	Drainage ditch
DUNE	Dunes (mound, ridge, or hill of windblown sand; bare or covered with vegetation)
FLAT	Flat surface
HLSD	Hillside slope
HLTP	Hilltop
PDMT	Pediment (broad, gently sloping erosion surface)
TRCH	Trench (a long, narrow excavation, natural or artificial)
VALY	Valley - flat valleys of all sizes

- "Surface cover" will be bare, wooded, or grassy.
- Below the header are lithology/remarks and sample classifications. The following sample classifications should be described as follows:
- "Moisture Content" (Clays and Sands)
- Dry
- Damp
- Moist (compactable)
- Wet (not compactable)
- Saturated
- "Sorting" (Sands only)
- Very well
- Well
- Moderately
- Poorly
- Very poorly
- "Density" or consistency (CONSS) (Sands and Clay) Density is described by the number of drops required by a 140 lb. hammer over 30 inches to drive a 2-inch outside diameter, 1 3/8 inch inside diameter, split-spoon 6 inches. The following is a description of soil consistency (density):

Sand or Gravel	Blows per Foot	Silt or Clay	Blows per Foot	Thumb Penetration
VL (Very Loose)	0-4	VSO (Very Soft)	0-2	Very easy-inches
L (Loose)	4-10	SO (Soft)	2-4	Easily inches
MD (Medium Dense)	10-30	M (Medium Soft)	4-8	Moderate effort-inches
D (Dense)	30-50	ST (Stiff)	8-15	Indented easily
VD (Very Dense	> 50	VST (Very Stiff)	15-30	Indented by nail
		H (Hard)	> 30	Difficult by nail

5.4 Other descriptions may include:

- NC (Non-cemented)
- PC (Poorly cemented)
- "Plasticity" Plasticity refers to the case in which cohesive soils are molded. The following describes the plasticity terms.
- EXTREMELY HARD, resistant to pressure, not broken by hand
- NONPLASTIC, not wire formable
- SLIGHTLY PLASTIC, wire formable but soil remains easily deformed
- PLASTIC, wire formable, moderate pressure required
- VERY PLASTIC, wire formable, much pressure required
- "Sample Number" In this column, record the number order that the sample was taken.
- "TIP Reading" Refers to "Total Ionizables Present". Record the headspace reading here and the type of instrument used, i.e., HNU, OVM, etc.
- "Sample Recovery" After obtaining a split-spoon sample or Shelby sample, measure the length of recovered sample to the nearest 0.01´ and record level.
- "Penetration Resistance" The blow counts for every 6 inches of driving the sample are to be recorded under this heading.
- "Color" The Munsell soil color or Geological Society of America soil color codes (COLOR) are a combination of the hues, values, and colors listed below:
- Hue: 2Y, 2YR, 5B, 5BG, 5G, 5GY, 5P, 5PB, 5R, 5RP, 5Y, 5YR, 7R, 7YR, 10G, 10GY, 10R, 10Y, 10YR, N
- Value: 0 - 9
- Color: 0 - 8 (not used when hue is "N"). A Munsell color chart will be available for color determination.

"USCS Classification/Lithology/Grain Size, Modifications/Remarks". The predominant lithology or lithologies should be identified first in capital letters, followed by qualifying adjectives that define grain size, color (using a Munsell chart), mineralogy, structural/textural features, bedding and laminations. For mixed lithologies within a common interval, provide relative percentages of the two or more lithologies within parenthesis following the lithologic name. For example, Sand (fine-medium [60%]) brownish yellow (10 yr. 6/6), and Gravel coarse (40%) very pale brown (10 yr. 7/3). Any obvious features related to evidence for contamination, such as odor or staining, should be documented. Drilling comments and occurrences should also be noted under this section. The acceptable codes, based on Unified Soil Classification System (USCS) augmented by lithology and special codes, are identified in Table 1. Codes for grain size (soil) are listed on the following page:

Action or Measurement		Acceptable Entries	
Code	**Description**	**Code**	**Description**
GRAIN	Grain size (soil)	For soils:	
		C	Coarse
		CF	Coarse to fine
		F	Fine
		FM	Fine to medium
		LG	Large
		vM	Medium
		MC	Medium to coarse
		SMALL	Small
		VC	Very coarse
		VF	Very fine

Rock texture codes are available, but have not been included here since they are not expected.

5.5 Soil Classification and Lithology.

Action or Measurement		Acceptable Entries	
Code	**Description**	**Code**	**Description**
USCS	Unified Soil Classification System augmented by lithology and special codes		Separate dual USCS codes by a hyphen.
		USCS Codes:	
		CH	Fat clay, inorganic clay of high plasticity
		CL	Lean clay, sandy clay, silty clay, or low to medium plasticity
		GC	Clayey gravel, gravel-sand-clay mixtures
		GM	Silty gravel, gravel-sand-silt mixtures
		GP	Gravel, poorly graded, gravel-sand mixtures, little or no fines
		GW	Well graded gravel-sand mixture, little or no fines
		MH	Silt, fine sandy or silty soil with high plasticity
		ML	Silty and very fine sand, silty or clayey fine sand or clayey silt with slight plasticity
		OH	Organic clays of medium to high plasticity, organic silts
		OL	Organic silts and organic silty clays of low plasticity
		PT	Peat or other highly organic soil
		SC	Clayey sand, sand-clay mixtures
		SI	Shells
		SM	Silty-sand, sand-silt mixtures
		SP	Sand, poorly-graded, gravelly sands
		SW	Sand, well-graded, gravelly sands
		WD	Wood
USCS	Unified Soil Classification System augmented by lithology and special codes		Separate dual USCS codes by a hyphen.
		Special:	
		ASH	Ash
		ASPHLT	Asphalt (road material
		CONC	Concrete
		CRLMSN	Crushed limestone
		FILL	Unknown man-made landfill material
		LC	LC Lost core
		NR	NR No recovery
		NTLOGD	Not logged
		RUBBLE	Construction debris rubble or demolition fill
		VOID	Void or cavity
WSTAT	Final status of the well	CB	Well filled with grout: cement-bentonite
		FB	Well filled with bentonite
		FC	Well filled with concrete
		FG	Well filled with gravel
		FS	Well filled with soil
		NC	Well filled with grout: neat cement
		O	Open well
		OP	Open well with piezometer or observation well installed
		WD	Well damaged

Action or Measurement		Acceptable Entries	
Code	**Description**	**Code**	**Description**
MODIF	Lithology modifications	B	Boulders
		BDWX	Badly weathered
		CAL	Calcareous
		CARB	Carbonaceous
		CC	Concretions
		CEM	Cemented
		CHE	With chemicals (based on headspace reading)
		CL	Clayey
		CS	Clay strata or lenses
		DCOLOR	Discolored
		FAULT	Faulted
		FECC	Iron concentrations
		FILL	Disturbed soil
		FRACT	Fractured
		FRIA	Friable
		G	Gravelly
		HPL	Highly plastic
		IRNST	Ironstained
		LIG	Lignite fragments
		MICA	Micaceous
		ML	Silty
		MOT	Mottled
		O	Organic matter
		ODOR	Odiferous
		OX	Oxidized
MODIF	Lithology modifications	PL	Plastic
		ROUND	Rounded
		RT	Rootlets
		S	Sandy
		SDL	Sandstone lenses
		SDS	Sandstone fragments
		SH	Shale fragments
		SHLN	Shale lenses
		SHLY	Shaly
		SIS	Silt strata or lenses
		SL	Slickensides
		SLF	Shell fragments
		SLWX	Slightly weathered
		SO	Solid
		THSK	Thin streaks
		TR	Trace
		TRCL	Trace of clay
		TRG	Trace of gravel
		TRML	Trace of silt
		TRMN	Trace of manganese
		TRS	Trace of sand
		WCL	With clay
		WFE	With iron oxide
		WG	With gravel
		WGML	With gravel and silt
		WLAM	With laminations
		WML	With silt
		WS	With sand
		WX	Weathered

6.0 REQUIRED FORMS/DOCUMENTATION

Soil Boring Log Forms

SOIL STOCKPILING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines for stockpiling of excavated soils. The details within this SOP should be used in conjunction with project work plans and/or related SOPs. The work plans may present additional project-specific requirements and procedures for soil stockpiling.

2.0 REFERENCES

None.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for assigning project staff to complete soil stockpiling activities, and for ensuring that this and any other appropriate procedures are implemented by project personnel. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for the periodic review of field generated documentation associated with soil stockpiling. If perceived variances occur, the Quality Assurance Officer is also responsible for issuing notices of nonconformance and requests for corrective action.

The Sampling Team Leader(s) assigned to this task is responsible for performing the task according to this SOP and other appropriate procedures identified in the project work plans. All staff members are responsible for reporting deviations from the procedures to the Project Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

None.

5.0 PROCEDURE

5.1 General

Stockpiling of soils is overseen by various regulatory agencies. Prior to initiating excavation activities, ensure that the procedures and requirements for compliance with applicable federal, state, and local regulations regarding stockpiling of soils have been reviewed and understood. The standard procedures for short-term and long-term stockpiling are described below. The project work plans will also present the following information pertaining to soil stockpiling:

- Any additional requirements or procedures to be followed
- Equipment to be used
- Stockpile locations.

5.2 Short-term Stockpiling

Upon initiation of excavation activities, soil will be segregated on a site-specific basis. Potentially clean soils will be stored in a separate short-term stockpile at the site. Soil that is suspected or known to be contaminated will be short-term stockpiled at the site separately from the clean soil.

The short-term stockpiles will be placed upon two layers of impermeable sheeting (such as polyvinyl chloride, polyethylene, etc.). For short-term storage, the separated soils may also be placed in bins or drums for subsequent transport to long-term stockpiles, per the project work plans.

Each pile will be covered with impermeable sheeting at the end of each workday. The covering will be secured at both the top and base of the stockpile. Plastic sheeting will be utilized to limit soil aeration and the release of windborne dust and particulates. The cover will also limit access by rainwater, resulting in possible contamination of surface water runoff from the stockpile. If bins or drums are used for short-term storage, impermeable sheeting should be used to cover the bins and the covers to the drums should be secured and seated at the end of each workday.

Short-term stockpiling activities will be documented by the Project Technical Coordinator or field geologist on the Field Logbook.

5.3 Long-term Soil Stockpiling

When space and logistics allow, long-term stockpiles will be constructed on a concrete or asphalt base. Two layers of impermeable sheeting will be placed on top of the concrete or asphalt. All sheeting will be folded at joining edges with a three-foot overlap to prevent seepage.

A berm will be erected around each stockpile. Boards or hay bales can be used to construct the berm. The material used to construct the berm will be placed under the two layers of impermeable sheeting to provide containment of any liquids that might leach from the soil.

Soil will be segregated by contaminant type (i.e., separate stockpiles for storage of soils impacted by gasoline, diesel, halogenated hydrocarbons, metals, etc.).

Each stockpile will be visibly labeled.

Covering of each pile with impermeable sheeting will be completed at the end of each workday. The covering will be secured at both the top and base of the stockpile. The sheeting will be utilized to limit soil aeration and the release of windborne dust and particulates. This cover will also limit access by rainwater, resulting in possible contamination of surface water runoff from the stockpile.

The Project Technical Coordinator or field geologist will document on the Field Logbook long-term stockpiling activities.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

HOLLOW STEM AUGER DRILLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for field personnel to use during the supervision of drilling operations involving hollow stem auger techniques. Additional specific hollow stem auger drilling procedures and requirements will be provided in the project work plans and/or related SOPs.

2.0 REFERENCES

None

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all hollow stem auger-drilling activities are conducted and documented in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for the implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to hollow stem auger drilling requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to hollow stem auger drilling activities is responsible for completing their tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from the procedures to the Project Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Hollow Stem Auger Drilling

A drilling method using rotating auger flights (typically in 5-foot joints) with a bit on the bottom of the lead flight (sometimes called the “lead auger”). The flights consist of a hollow pipe and an outer spiral plate, that when rotated, forces soil cuttings upward along the borehole wall to the surface. The auger string is advanced by rotation, with pressure exerted by the rig, forcing the bit to cut the soil at the bottom and direct cuttings to the augers.

A retractable plug with a pilot bit is placed at the bottom of the auger string to prevent cuttings from entering the hollow stem. When the plug is retracted, a sampler may be sent through the hollow center to sample soil at the bottom of the borehole without requiring the augers to be removed. A wireline sampler may also be attached to the inside of the lead auger for coring as the borehole is advanced.

This method is commonly used for drilling and sampling of soil borings, collection of soil gas and screening-level water samples, and installation of some smaller diameter wells. The well casing string may be placed through the hollow stem.

The hollow stem auger drilling method has advantages over other drilling techniques in certain circumstances, and disadvantages in others. This method is highly suitable for unconsolidated and consolidated fine-grained soils. Hollow-stem auger drilling can achieve the most rapid rates of penetration in soft sticky clay-dominated soils. However, coarse and consolidated gravels and hard bedrock may be too dense for adequate drill penetration. Soil cuttings are typically disaggregated and remolded, making bedding, fabric, and soil property determination difficult.

The most reliable method for logging of soils during hollow stem auger drilling is by collecting relatively intact samples through the hollow stem. An advantage of the hollow stem auger method is that soil samples can be readily obtained from the bottom of the hole without requiring the removal of the auger string (unlike air or mud rotary methods).

This drilling method may be used to install monitoring wells (limited by diameter) as there is good depth control, and the auger can be progressively pulled as well construction materials are added to the borehole. The methodology may also be used to drill out monitoring wells for abandonment.

Another advantage of the hollow stem auger method is that air or mud is not required as circulating media. Therefore, there is limited to no potential for flushing of soil samples collected for chemical analyses, and a reduction in volumes of investigated derived wastes requiring costly handling and management procedures. Auger-type rigs can be significantly smaller than other types of rigs, making them the most suitable for some jobs with significant space constraints, including overhead clearance.

Disadvantages of the hollow stem auger method include a typical maximum depth of 100 to 200 feet (may be less depending on soil conditions). Hard soil horizons or very coarse gravel (cobbles and boulders) may be impenetrable with this method.

5.0 PROCEDURE

This section contains procedures and requirements for hollow stem auger drilling. The selection and implementation of hollow stem auger drilling techniques must incorporate site-specific conditions and requirements. Consequently, the project work plans will identify the following:

- The purpose of each borehole (e.g., to install monitoring well, soil sampling, well abandonment, etc.)
- Specific methodology for drilling, including equipment and cuttings/fluid containment
- Specific locations, depths, and diameters of boreholes
- Objectives and types of sampling and/or logging of borehole
- Details of mobilization/demobilization and decontamination of equipment
- Appropriate health and safety guidelines and personnel protective equipment
- Additional procedures or requirements beyond those covered in this SOP

5.1 Drilling Site Mobilization

5.2 Rig Decontamination and Preparation

All drilling and sampling equipment should be decontaminated before drilling as per MSOP Nos. 6.0 and 6.1, and the project work plans.

The driller and rig geologist/engineer should inspect the drilling equipment for proper maintenance and appropriate decontamination prior to each time the rig is mobilized to a site. All clutches, brakes and drive heads should be in proper working order. All cables and hydraulic hoses should be in good condition. All auger joints and bits should also be in good condition (e.g., no cracked or bent blades, bits are not excessively worn, etc.).

Any observed leakage of fluids from the rig should be immediately repaired and the rig decontaminated again before it is allowed to mobilize.

5.3 Site Preparation

The logistics of drilling, logging, sampling, cuttings/fluid containment, and/or well construction should be determined before mobilizing. The site should be prepared as per the project work plans.

Before mobilization, the Field Geologist should assess the drilling site with the driller. This assessment should identify potential hazards (slip/trip/fall, overhead power lines, etc.), and determine how drilling operations may impact the environment (dust, debris, and noise). Potential hazards should be evaluated and corrected, or the borehole location changed or shifted, as per the project work plans.

The Project Technical Coordinator or appropriate designee should ensure that all identifiable underground utilities around the drilling location have been marked and the borehole location appropriately cleared per the project work plans. At a minimum, copies of the site clearance documents should be kept on-site.

5.4 Mobilization and Set-Up

Once the site is prepared, the rig is mobilized to the site and located over the borehole location. The rig is leveled with a set of hydraulic pads attached to the front and rear of the rig. The driller should always raise the mast slowly and carefully to prevent tipping or damaging the rig, and avoiding obstructions or hazards.

Appropriate barriers and markers should be in place prior to drilling, as per the site health and safety plan. Visqueen (plastic, 6-mil thickness minimum) will be placed beneath the rig to contain any leakage of hydraulic fluids.

Appropriate cuttings and other investigation-derived waste containment should be set on site prior to commencement of drilling.

5.5 Health and Safety Requirements

Tailgate Safety Meetings should be held in the manner and frequency stated in the health and safety plan. All personnel at the site should have appropriate training and qualifications as per the health and safety plan.

During drilling all personnel within the exclusion zone should pay close attention to rig operations. The rotating auger blades can snag or catch loose clothing and literally screw someone into the ground.

Establishing clear communication signals with the drilling crew is mandatory since verbal signals may not be heard during the drilling process. The entire crew should be made aware to inform the rig geologist/engineer of any unforeseen hazard or when anyone is approaching the exclusion zone.

5.6 Drilling Procedures

5.7 Breaking Ground

Prior to the commencement of drilling, all safety sampling and monitoring equipment will be appropriately calibrated per the project work plans.

The Field Geologist should inform the driller of the appropriate equipment (e.g., cookie cutter, etc.) to be used for penetration of the surface cover (e.g., asphalt, concrete, cement, etc.). In the event of breaking ground where a shallow subsurface hazard may exist (unidentifiable utility, trapped vapors, etc.), the driller should be informed of the potential hazard and drilling should commence slowly to allow continuous visual inspection and/or monitoring and, if necessary, to stop for probing.

5.8 Borehole Drilling

During drilling operations, and as the borehole is advanced, the rig geologist/engineer will generally:

- Observe and monitor rig operations;
- Conduct all health and safety monitoring and sampling, and supervise health and safety compliance;

- Prepare a lithologic log from soil samples or cuttings; and
- Supervise the collection of, and prepare soil, soil vapor, and groundwater samples.

As drilling progresses the rig geologist/engineer should observe and be in frequent communication with the driller regarding drilling conditions. This includes relative rates of penetration (indicative of fast or slow drilling) and chattering or bucking of the rig. These conditions, including the relative drilling rate, should be recorded on the boring log per MSOP No. 10.0. Drilling should not be allowed to progress faster than the rig geologist/engineer could adequately observe conditions, compile boring logs, and supervise safety and sampling activities.

The Field Geologist should also observe the rig operations, including the make-up and tightening of connections as additional auger joints are added to the auger string. Any observed problems, including significant down time, and their causes are recorded on the Field Logbook.

Cuttings and fluids containment during drilling should be observed and supervised by the Program Geologist, as per specifications in the project work plans.

The Field Geologist will oversee or conduct appropriate health and safety sampling and monitoring. If any potentially unsafe conditions are evident from the above drilling observations and the health and safety sampling and monitoring, the Field Geologist may suspend drilling operations at any time and take appropriate actions as per the health and safety plan. In the event suspension of drilling activities occur:

- The Project Technical Manager must be informed of the situation;
- Appropriate corrective action must be implemented before drilling may be continued; and
- The observed problem, suspension, and corrective action are entered on the Field Logbook.

During drilling the rig geologist/engineer will compile a boring log as per MSOP No. 10.0. The log will be compiled preferably from soil samples recovered while drilling. Logs should only be compiled from cuttings if this is the only option. Observations of drilling conditions are also entered on the log as discussed above and in MSOP No. 10.0. If total depth was reached prematurely due to refusal, the cause of refusal should be noted on the boring log and the Field Logbook.

Subsurface soil samples may be collected with a split spoon sampler or Shelby tube during drilling per MSOP No. 3.1. The Field Geologist will supervise the sampling. Soil samples (drive samples) can be readily obtained at discrete intervals with these methods.

Soil organic vapor (SOV) sampling may be conducted at discrete intervals during hollow stem auger drilling. This is done by stopping at the desired depth and driving a sample probe through the hollow stem into the soil ahead of the bit and then collecting a vapor sample. The sampling should be supervised by the rig geologist/engineer.

Ground water screening (grab) samples can be obtained at discrete intervals during drilling. One method is to auger to the bottom of the selected interval or zone and pull the auger back to the top of the interval, allowing ground water through the open borehole. A water sample is then collected with a bailer run through the inside of the augers. Another method is to stop the augers at a selected interval or zone and advance a hydropunch sampler beyond the lead auger to retrieve a water sample.

5.9 Borehole Abandonment

If the borehole is to be abandoned once drilling is completed, the abandonment will follow procedures outlined in the project work plan. The abandonment will be supervised by the rig geologist/engineer.

5.10 Monitoring Well Completion

If a monitoring well is to be installed in the borehole, the well completion will follow procedures outlined in MSOP No. 8.1. The rig Field Geologist will supervise the well installation activities.

5.11 Demobilization/Site Restoration

After drilling, sampling, well installation or borehole abandonment is completed the hollow stem rig is rigged down and removed from the borehole location. The rig geologist/engineer or appropriate designee will supervise the demobilization/site restoration. All debris generated by the drilling operation will be removed and appropriately disposed.

The site should be cleaned (ground washed if necessary) and surface conditions restored as per the project work plans. All abandoned borings should be topped off and completed as per the project work plans. All monitoring wells will also have their surface completions finished as per the project work plans.

Any remaining hazards as a result of drilling activities will be identified and appropriate barriers and markers put in place, as per the health and safety plan. All soil cuttings and fluids will be properly contained, clearly labeled, and maintained as per the project work plans.

The Field Geologist or appropriate designee should inspect the site to make sure that post-drilling site conditions are in compliance with the project work plans.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

Boring Log

FIELD QUALITY CONTROL (QC) SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for conducting field quality control (QC) sampling. Field QC sampling is required to assist in verifying the quality and integrity of samples collected during a given sampling event. Additional specific field QC sampling procedures and requirements will be provided in the project work plans and/or related SOPs.

2.0 REFERENCES

EPA, September 1987, Compendium of Superfund Field Operations Methods, EPA 540/P-87/001a, OSWER 9355.0-14.

EPA, August 1988, EPA Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA, Interim Final OSWER Directive 9355.3-01.

3.0 RESPONSIBILITIES

The Project Technical Manager and Technical Coordinator are responsible for ensuring that all sample collection activities are conducted in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformances, etc.) if quality issues are identified.

The Sampling Team Leader(s) assigned to environmental and QC sampling activities is responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures. All staff members are responsible for reporting deviations from procedures to the Project Technical Coordinator.

4.0 DEFINITIONS/MATERIALS

4.1 Field QC Sample

A field QC sample is a physical sample collected during or for a specific sampling event. The purpose of this sample is to evaluate the quality and integrity of original samples collected during the specific sampling event.

5.0 Procedure

This section contains the requirements for field QC sampling. Field QC sampling is required to provide data to verify the quality and integrity of environmental samples collected during a given sampling event.

The details within this SOP should be used in conjunction with project plans. These plans will generally provide the following information:

- Sample collection objectives
- Numbers, types and locations of environmental (non-QC) samples to be collected
- Numbers and types of supportive QC samples to be collected
- Any additional QC sampling requirements or procedures beyond those covered in this SOP, as necessary.

5.1 Quality Control Sampling Requirements

Field QC samples may consist of different media. Typical QC samples are as follows:

- Trip blank (TB)
- Equipment rinsate (ER)
- Field blank (FB)
- Field duplicate (FD)

Trip blanks are analyte-free water, shipped from and returned unopened to the laboratory in the same shipping containers for volatile organic, and at times gasoline hydrocarbons. The blanks are prepared at the laboratory using ASTM Type II DI Water, sent to the project location, carried with the sampling team(s) during sampling, and shipped to the laboratory for analysis with the environmental samples.

Trip blank samples are commonly collected and analyzed at a rate of one per sample cooler containing samples for volatile organic analyses or the gasoline fraction of petroleum hydrocarbons. The number or rate of trip blanks to be collected and the specific analyses to be conducted for the trip blanks will be provided in the project work plans.

Equipment rinsate samples are collected from the final rinse water during decontamination of groundwater, soil, or waste sampling equipment. This type of equipment includes bailers, split-spoon samplers, soil sample sleeves, hand augering equipment, surface soil sampling equipment, purge and sample pumps, etc.

Rinsate samples are generally collected at a rate of one per day per sampling team during the sampling event. Equipment rinsates are usually collected from dedicated sampling equipment only upon installation. The number or rate of equipment rinsate samples to be collected for a particular project will be specifically developed and documented in the project work plans. The specific chemical analyses to be conducted for the rinsate samples will also be developed and documented in the project work plans.

Field blanks are prepared from the water that is used for decontamination. One sample from each sampling event and each water source or lot number is generally collected and analyzed for all parameters of interest for the project. Upon collection, a description of the water source for the field blank sample should be documented in the Field Logbook.

The number or rate of field blank samples to be collected for a particular project will be specifically developed and documented in the project work plans. The specific chemical analyses to be conducted for the field blank samples will also be developed and documented in the project work plans.

For soils, field duplicate samples are generally collected by co-located sampling (e.g., using successive sample tubes from the same split-spoon sampling run) or by splitting samples. Field duplicate water samples are commonly collected by retaining consecutive samples from the sampling device (e.g., bailer or sample pump discharge line). Field duplicate water samples may also be generated by splitting a collected volume; however, this practice may lead to a loss in volatile organic compounds and is not common practice for volatile analyses.

Field duplicate samples are commonly collected at a rate of 10 percent per media sampled. However, the number or rate of field duplicate samples to be collected for a particular project will be specifically developed and documented in the project work plans. The specific chemical analyses to be conducted for the field duplicates will also be developed and documented in the project work plans.

The type and number of QC samples collected for a particular project is based on specifications provided in project specific documents, i.e., the project work plans. Field QC samples are to be collected at appropriate times during a sampling event.

All field QC samples will be collected in proper containers with appropriate preservation per the project work plans.

The collection of field QC samples consisting of various media (e.g., soil, groundwater, etc.) will follow procedures in sample collection SOPs for the respective media and any other applicable procedures in the project work plans. For example, the collection of a groundwater field duplicate QC sample will follow procedures specified in the groundwater sampling SOP (MSOP No. 9.0). Equipment rinsate samples are collected directly while rinsing the sampling equipment following appropriate procedures in MSOP No. 9.0 and the project work plans. Field blank samples are collected by pouring decontamination water directly into sample containers following appropriate protocol in MSOP No. 9.0 and the project work plans.

Field QC samples will be labeled and numbered as described in MSOP Nos. 2.1 and 2.2 respectively and the project work plans.

The field QC samples will also be maintained under custody per MSOP No. 1.1, and be appropriately stored, handled and shipped per MSOP Nos. 2.0 and 2.3.

6.0 REQUIRED FORMS/DOCUMENTATION

Field Logbook

Chain of Custody Form

MANAGEMENT OF INVESTIGATION-DERIVED WASTE

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes guidelines and procedures for the proper management of investigation-derived waste (IDW) generated during environmental activities under contract number DAAD07-95-C-0125. Management includes waste minimization, hazardous waste determination, storage, labeling and transportation to the White Sands Missile Range Hazardous Waste Minimization Center.

During environmental investigations at the White Sands Missile Range (WSMR), WTS sampling crews may generate potentially contaminated IDW, including but not limited to the following types of materials:

- Saturated and unsaturated soil
- Groundwater
- Non-aqueous phase liquid (NAPL)
- Decontamination water
- Personal Protective Equipment (PPE) and miscellaneous refuse

Deviations from this procedure should be detailed in site-specific waste management plans approved by the New Mexico Environment Department (NMED).

2.0 REGULATORY AUTHORITY

The NMED has consolidated authority for all remedial investigations and corrective actions at the WSMR under the Hazardous Waste Bureau (HWB). The bureau regulates these activities under the **New Mexico Hazardous Waste Act** (NMSA 1978, sections 74-4-1 through 14), the corresponding regulations (Title 20 of the New Mexico Administrative Code, Chapter 4.1), and the **New Mexico Solid Waste Act** (NMSA 1978, sections 74-9-1 through 74-9-42) and its corresponding regulations (Title 20 of the New Mexico Administrative Code, Chapter 9.1). The federal regulations governing hazardous waste, 40 CFR 260-273 (also known as RCRA) have been adopted by New Mexico almost in their entirety and are referred to in this document.

The transportation of hazardous waste (and some non-hazardous waste) is regulated under the DOT **Hazardous Material Regulations** (49 CFR 171-178). **The New Mexico Hazardous Waste Act** and the corresponding regulations refer the reader to the DOT Hazardous Material Regulations when addressing transportation of hazardous waste beyond manifesting requirements. The transportation of other non-hazardous waste is regulated under the **New Mexico Solid Waste Act** (NMSA 1978, sections 74-9-1 through 74-9-42) and its corresponding regulations (Title 20 of the New Mexico Administrative Code, Chapter 9.1).

3.0 REFERENCES

State of New Mexico, 1983. *Hazardous Waste Act (NMSA 1978, sections 74-4-1 through 14)*. Santa Fe, New Mexico.

New Mexico Environment Improvement Board, June 2000. *New Mexico Hazardous Waste Management Regulations (20 NMAC 4.1)*. Santa Fe, New Mexico.

State of New Mexico, 1991. Solid *Waste Act (NMSA 1978, sections 74-9-1 through 42)*. Santa Fe, New Mexico.

New Mexico Environment Improvement Board, November 1995. *New Mexico Solid Waste Management Regulations (20 NMAC 9.1)*. Santa Fe, New Mexico.

U.S. Department of Environmental Protection, 1999. *Hazardous Waste Regulations (40 CFR Parts 260-273).* Washington D.C.

U.S. Department of Transportation, 2001. *Hazardous Materials Regulations (49 CFR Parts 171-178).* Washington D.C.

EPA, 1991. Memo from S. Lawrence (Director of Office of Solid Waste) to John Ely addressing the EPA's "Contained-In Policy".

EPA, 1998, Management of Remediation Waste Under RCRA, EPA Publication Number 530-F-98-026.

Forsythe, G. (Environmental Compliance Division, WSMR), July 10, 2002. Email to Don Emig: Transporting items across U.S. 70.

4.0 RESPONSIBILITIES

The project Task Manager and Task Coordinator are responsible for ensuring that all investigation-derived waste is managed in accordance with this SOP and any other appropriate procedures or related SOPs. This will be accomplished through staff training and by maintaining quality assurance/quality control (QA/QC).

The Quality Assurance Officer is responsible for periodic review of field-generated documentation associated with this SOP. The Quality Assurance Officer is also responsible for implementation of corrective action (i.e., retraining personnel, additional review of work plans and SOPs, variances to QC sampling requirements, issuing nonconformance memorandums, etc.) if quality issues are identified.

The project Sampling Team Leader assigned to environmental and QC sampling activities is responsible for completing tasks according to specifications outlined in this SOP and other appropriate procedures.

All staff members are responsible for reporting deviations from procedures to the Project Task Coordinator.

5.0 REQUIRED MATERIALS

- Field logbook: surveyor's book or field book, bound and ruled/gridded, record book with sequentially numbered and waterproof pages.
- Indelible black ink pens.
- Paint pens for marking drums
- Drum Labels

6.0 PROCEDURES

6.1 Waste Management Procedures Overview

These procedures are conservative in their approach to waste management so that they may ensure the protection of human health and the environment and comply with regulatory requirements that are applicable or relevant and appropriate requirements (ARARs). They include the management of waste from the point of generation to the transfer of responsibility at the WSMR Hazardous Waste Minimization Center (HWMC).

The HWMC is responsible for the transportation and disposal of all wastes from the WSMR. The center makes the final waste determination for all waste streams using information provided by their customers. The center is the repository for all of the waste determination analytical data, waste profiles, manifests and certificates of disposal for the WSMR.

6.2 Waste Minimization

To the extent that it is practical, environmental investigations will follow waste minimization procedures.

Guidelines for waste minimization are:

- Minimize materials that are introduced into any exclusion zone in an investigation area.
- Combine similar wastes throughout an investigation area in a single container wherever possible.
- Combine decontamination water from multiple sites in one container.
- Use a container of the appropriate size (e.g., use a 5-gallon drum for small amounts of waste unless a 55-gallon drum is needed to hold all the waste).
- Decontaminate and reuse material and equipment whenever practical.
- Minimize the volume of decontamination water generated.
- With solid environmental media and materials, ensure that waste is tightly packed to minimize the number of containers.
- Use less hazardous substances whenever possible.

6.3 Waste Determinations

The initial waste determination may be established using the guidelines outlined below. This determination should be used to properly manage the waste until the final waste determination is made by the HWMC. A copy of the analytical data and supporting documentation shall be provided to the HWMC upon completion of the initial waste determination. The center will notify the project Task Coordinator if they do not concur with the initial waste determination. If there is a discrepancy, the two parties shall meet and review the conclusions and supporting data. Appropriate corrective actions shall be subsequently taken to ensure that the waste is being properly managed.

6.3.1 Background

Investigation derived waste (IDW) originates from solid waste or environmental media. Solid waste as defined in 40 CFR 261.2 is <u>any discarded material</u> that is not excluded by 261.4(a) or that is not excluded by variance granted under 260.30 and 260.31. The reader should familiarize himself or herself with the exclusions, but it is not expected that they will apply. Examples of IDW that is solid waste are personal protective equipment, disposable equipment, non-aqueous phase liquid and decontamination water.

The EPA describes environmental media as being soil, groundwater or sediment (EPA, 1991). The presumption is that they were not discarded and therefore do not meet the definition of solid waste. The EPA has established and upheld in court of law, a policy, which addresses the applicability of RCRA to contaminated environmental media. This policy is known as the “contained-in-policy”. Simply put, the environmental media will be considered a solid waste, if it “contains” a solid waste. Examples of IDW that is environmental media are soil cuttings and purge water.

6.3.2 Regulatory Requirement

RCRA compels the solid waste generator under 40 CFR 262.11, to determine if that waste is a hazardous waste using the following method:

- He should first determine if the waste is excluded from regulation under 40 CFR 261.4.
- He must then determine if the waste is listed as a hazardous waste in subpart D of 40 CFR part 261.

NOTE: Even if the waste is listed, the generator still has an opportunity under 40 CFR 260.22 to demonstrate to the Administrator that the waste from his particular facility or operation is not a hazardous waste.

- For purposes of compliance with 40 CFR part 268, or if the waste is not listed in subpart D of 40 CFR part 261, the generator must then determine whether the waste is identified in subpart C of 40 CFR part 261 by either:
    - Testing the waste according to the methods set forth in subpart C of 40 CFR part 261, or according to an equivalent method approved by the Administrator under 40 CFR 260.21; or

- Applying knowledge of the hazard characteristic of the waste in light of the materials or the processes used.

- If the waste is determined to be hazardous, the generator must refer to parts 261, 264, 265, 266, 268, and 273 of this chapter for possible exclusions or restrictions pertaining to management of the specific waste.

6.3.3 Waste Analysis

It is the policy of the HWMC to make waste determinations based on analytical data and supported by generator knowledge. They also require that the analytical data be no older than one year.

The sample collected for waste analysis should be representative of the material being evaluated. Acquiring a representative sample can include compositing and statistical analysis.

Waste analysis should be performed for those analytes that are suspected to be present based on site information and/or generator knowledge. The approved testing methods are indicated in 40 CFR 261 Subpart C. When generator knowledge is absent a full waste characterization should be performed. This would include running the toxicity characteristic leaching procedure for the entire Table 1 constituents listed in 40 CFR 261.24 and ignitability, corrosivity and reactivity.

6.3.4 Methodology

Waste determinations will be established as soon as practical after the waste is generated.
The determination is made using the three-step process outlined below. Sites that have not been previously investigated are inherently problematic. It often requires substantial individual judgment in making waste management decisions. It is recommended that the person responsible for waste management handle the material as though it were hazardous waste, if sufficient information is not available at the time of generation. This would include labeling the drums as hazardous waste and managing them accordingly. Refer to section 6.5.1 of this procedure for further instruction on proper labeling of containers lacking adequate waste determination.

Step 1: <u>Is the waste a solid waste</u>?

The EPA's "contained-in policy" should be referred to for direction in determining whether environmental media is a solid waste. The policy provides that environmental media will be considered a solid waste if it contains a listed waste or exhibits the characteristics of a hazardous waste.

The EPA has not defined what volume or concentration of a listed waste constitutes "contained-in". They have advised that the determination be made in consultation with the regulatory authority and be based on conservative risk-based screening levels.

This document advises the use of the universal treatment standards (UTS) provided in 40 CFR 268.48 for determination as to whether the media contains the chemical(s), which gave origin to the listing. These standards are utilized to determine whether underlying hazardous constituents require further treatment as required by the Land Disposal Restrictions in 40 CFR Part 268 prior to disposal. This document presumes that the UTS would provide adequate screening for waste disposal purposes. Any material left onsite at a concentration below the UTS, would still be subject to risk based cleanup criteria for corrective action. Therefore this procedure presumes that the environmental media contains a listed waste if the UTS are exceeded for the chemical that gave origin to the listing.

If the environmental media does not contain a listed waste or exhibit the characteristic of a hazardous waste, it shall be considered to contain a solid waste when any constituent exceeds the appropriate detection limit or established background level for organic and inorganic naturally occurring compounds. Other investigation-derived waste is a solid waste at the point at which it is discarded.

Step 2: <u>Is the solid waste a hazardous waste?</u>

Once the waste has been declared a solid waste, it is necessary to determine whether it is hazardous. The process is the same whether or not it is environmental media. The only difference being whether the "mixture rule" or the "contained-in" policy applies.

Review the site history and interview current and former employees to determine whether a listed (F, K, P or U) waste caused the contamination. The EPA has stated that one may assume a listed waste did not cause the contamination if the documentation for making such as determination is unavailable or inconclusive and the facility owner/operator has made a good faith effort to do so (EPA, 1998). If a listed waste caused the contamination, then the (non-environmental media) solid waste will be considered a hazardous waste, based on the "mixture rule". Environmental media containing by a listed waste is considered a hazardous waste based on the "contained in policy".

Analyze the waste for the Subpart C hazardous waste characteristics (ignitability, corrosivity, reactivity and toxicity). If the levels exceed the values provided in 40 CFR 261.21 thru 261.24 the material exhibits a characteristic of a hazardous waste and shall be managed as such.

Step 3: <u>Does the waste contain an underlying hazardous constituent?</u>

Identification of underlying hazardous constituents (UHC) is an important part of waste profiling in order to satisfy the land disposal restrictions. Although the management activities covered in this procedure does not address disposal options, gathering this information up front is an important step.

Sufficient laboratory analysis should be performed to determine whether other contaminants are present in the waste. The analysis should be based on generator knowledge of the waste and include those contaminants that may reasonably be expected. The results should be provided to the HWMC for evaluation as UHCs when considering disposal options.

6.3.5 Storage of IDW

Waste may be stored in a variety of portable containers, such as 5-gallon buckets, 55-gallon drums, rolloff boxes, and baker tanks. The specifications of each device will depend on the hazardous waste determination.

Containers used to store hazardous waste must meet the requirements of 40 CFR 262.34 (c) (1) (Accumulation), by being in good condition, being compatible with the waste and being closed except when adding or removing waste. Containers must also satisfy the DOT shipping requirements appropriate for the hazard classification. Refer to column 8 of the Hazardous Materials Table in 49 CFR 172.101. The containers will be marked with appropriate hazardous waste labels as prescribed in 40 CFR 262.34 (c)(1)(ii) and will be transported within 3 days of generation to the HWMC.

Non-hazardous solid waste must meet the requirements of 20 NMAC 9.1, Section 106 by being covered, reasonably clean and leak proof. The containers will be labeled, indicating the contents and potential health, safety, and environmental hazards associated with the waste (20 NMAC 9.1 Section 703) and will be shipped to the HWMC for disposal within 45 days of generation in accordance with Section 712 of 20 NMAC 9.1.

IDW that has been classified as hazardous waste "pending analysis" must be moved to a permitted 90-day storage facility within three days of generation and stored until analytical results have been received and reviewed. It is imperative that analytical results be received sufficiently in advance of the 90-day limit to allow for disposal within that time period.

Drums used for storage of liquid waste will not be completely filled. At least 6 inches of space will be left at the top of each drum to allow for expansion of waste due to freezing. All containers must be covered and sealed daily before field personnel leave the site.

6.4 Container Labeling and Marking

All containers used to store investigation-derived waste at the White Sands Missile Range will be labeled by the end of each workday. Containers will be assigned numbers sequentially. Duplicate numbers will be avoided by reviewing the Field Logbook before assigning a number to an IDW drum. Containers will be marked on the side and lid using a paint marker. Marking will include the following:

- Container number
- Dates of first use and last use
- Site Identification (include SWMU #, sample type, sample No.)
- Level of PPE worn when IDW was generated

Non-hazardous waste containers will be labeled using the green label (figure 1). The contents will be written in the space provided at the bottom.

Hazardous waste containers will be labeled using the yellow label (figure 2). The proper shipping name will be filled in the space provided at the bottom of the label. The contents of the container (ie. decontamination water, soil cuttings) will be marked on the side and top of the container, as practical, with the other information listed above.

Containers of IDW that do not have a hazardous waste determination will be labeled as Hazardous Waste using the label in Figure 2 and a Pending Analysis label shown in Figure 3.

Figure 1

Figure 2

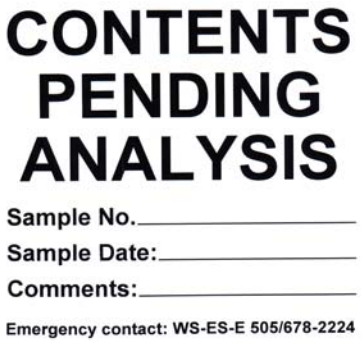

Figure 3

6.5 Field Logbook

The field operations leader will keep all container inventory information in the Field Logbook. The Field Logbook will contain the following information

1. Unique container ID number
2. Site ID
3. Container contents
4. Dates:
   - Container filled
   - Sample collected
   - Container transfer to HWMC
   - Analytical results received
5. Hazardous waste determination
6. Date the containers were turned over to the Hazardous Waste Minimization Center

6.6 Alternate Disposal of Environmental Media

Environmental media determined to be non-hazardous waste may be placed back within the area of investigation provided that the concentration of contaminants are below (in order of preference):

- Established naturally occurring organic and inorganic background levels.
- Human Health Standards for groundwater (20 NMAC 6.2 Section 3103).
- NMED Residential and/or DAF 20 Soil Screening Levels (whichever is lower).
- EPA Region IX Preliminary Remediation Goals and DAF 20 Soil Screening Levels.

Environmental media will not be placed within the area of investigation even if the above criteria are met, if it is known to exceed established ecological risk criteria.

6.7 Record keeping

The Investigation Contractor will maintain completed Field Logbooks and waste characterization data packages that they generate.

6.8 Transportation

WTS may transport hazardous and non-hazardous waste within the boundaries of the White Sands Missile Range without a manifest, bill of lading, placarding, DOT container marking or Hazardous Material Transporter registration. WTS may also cross non-range roads to transport hazardous and non-hazardous waste between contiguous properties of WSMR, without being subject to the DOT Hazardous Materials Regulations or the Uniform Hazardous Waste Manifest (the manifest) requirements of RCRA (G. Forsythe, 2002).

WTS will not transport the waste along non-range roads, even within the boundaries of the WSMR. If this is necessary, WTS shall require these transportation services be provided by the HWMC.

If the waste will be transported offsite, a manifest must be prepared. The manifest is a form used to track the movement of hazardous or non-hazardous waste from the point of generation to the point of ultimate disposition ("cradle to grave") (40 CFR Part 262, Subpart B). The manifest generally requires the following information;

- Name, address and US EPA ID No. of the generator, transporter, and the destination facility
- U.S. DOT description of the waste being transported and any associated hazards
- waste quantity
- name and phone number of a contact in case of an emergency
- special handling or hazard information
- Generators Certification (Signature required by authorized Gov't POC)
- other information required either by EPA or the state

In all cases the "Generator" shall be White Sands Missile Range and the manifest should be signed by the authorized Government point of contact. **UNDER NO CONDITION SHOULD A WTS EMPLOYEE SIGN AS OR FOR THE GENERATOR ON A MANIFEST.**

PREPARATION, REVISION, AND APPROVAL OF PLANS AND PROCEDURES

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the methods and responsibilities associated with the preparation, revision, and approval of quality-affecting documents.

2.0 REFERENCES

None.

3.0 RESPONSIBILITIES

The Program Manager has the responsibility to assure that standard operating procedures and plans that are required for work assignment orders are prepared by qualified personnel and are reviewed and approved by authorized personnel, prior to the implementation of the work assignment order activities.

The Quality Assurance Officer is responsible for the preparation and maintenance of SOPs. He/she reviews and approves SOPs. He/she is also a part of the approval cycle for the technical planning documents (e.g., Work Plan, Sampling and Analysis Plan, etc.).

4.0 DEFINITIONS

4.1 Standard Operation Procedures (SOP)

A set of implementing procedures that prescribe the actions necessary to complete a work operation in accordance with accepted practices for quality and safety.

5.0 PROCEDURE

5.1 Preparation

The Program Manager determines the need for establishing a procedure describing how to perform quality-affecting activities. He/She also initiates revisions to these documents due to programmatic requirement changes, audit findings, or corrective actions, as applicable.

Procedures, fieldwork variance, and drawings will include appropriate qualitative and quantitative acceptance criteria for determining satisfactory work performance and quality compliance.

5.2 Format

The SOPs will adhere to a consistent format in accordance with the following guidelines.

Revision Block - This area will contain the document identification, section or procedure number, revision number, date, and pages. This information will appear consistently on each page of the document in the upper right-hand corner.

Title Block - This area will contain the title of the SOP and will appear on the first page only.

5.3 Contents

Procedures required to implement work assignment order activities will include the information listed below. When any of these items are not required or are inappropriate to the SOP, they will be noted by the word "none".

1.0 **Purpose** - Describe the purpose of the SOP. Be as specific as possible; do not generalize.

2.0 **References** - Identify pertinent documents or procedures that interface with the SOP being prepared. Reference to specific documents that are directly applicable to the SOP (e.g., Chemical Data Quality Management Plan (CDQMP), Sampling and Analysis Plan (SAP), Field Sampling Plan (FSP), Health and Safety Plan (HSP) etc.) is acceptable.

3.0 **Responsibilities** - Assign responsibility for accomplishing activities, be specific in context. Include appropriate reporting requirements for assuring that important activities have been satisfactorily accomplished.

4.0 **Definitions/Materials** - Define words and phrases having a special meaning of application within the SOP. List materials and equipment required for the procedure(s) being performed.

5.0 **Procedure** - Identify the sequence of activities to be followed for accomplishing activities, be specific in context. Incorporate examples of forms or documents that are required to be completed as a result of the procedure implementation.

6.0 **Required Forms** - List all forms that are required for the successful implementation of the specific SOP.

5.4 Approval

The signature of the Program Manager, Quality Assurance Officer and others as deemed necessary on the Table of Contents/Log of Revisions or cover page will signify the documents and revisions listed are authorized for use. For SOPs, the Program Manager and Quality Assurance Officer will sign the Table of Contents/Log of Revisions Page of the procedure manual indicating their approval.

5.5 Manual Change Requests

Personnel responsible for complying or interfacing with the requirements of the approved plans, SOPs may request revisions to these documents via a Manual Change Request memo. Manual Change Requests are different from fieldwork modifications, as they are used to suggest improvements to existing processes or systems and are not structured to adjust the plans and procedures based on changing site conditions. Originators of the Manual Change Request are responsible for forwarding a Manual Change Request to the Program Manager for dispositioning.

The Program Manager is responsible for reviewing all Manual Change Requests and either accepting or rejecting them. If a Manual Change Request is accepted, the Program Manager will indicate this acceptance by signing and dating the Manual Change Request. He/she will forward a copy of the signed Manual Change Request to the originator for their files. The Program Manager will maintain a copy of accepted Manual Change Request for logging and revision inclusion.

If a Manual Change Request is not accepted, the Program Manager will indicate this by marking, signing and dating the Manual Change Request. Non-accepted Manual Change Requests will be maintained in the project files.

5.6 Revisions

Revisions to approved plans will be documented and will receive the same level of review, approval, and control as the original document.

The Program Manager using the Fieldwork Variance form will issue fieldwork variances. When twelve (12) months have elapsed for a Field Work Modification Form or six (6) have been issued, whichever comes first, the Program Manager will issue new revisions to the affected documents to incorporate the Field Work Variances.

6.0 REQUIRED FORMS/DOCUMENTATION

Manual Change Request

QUALITY INSPECTIONS AND INSPECTION RECORDS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the methods and responsibilities for the performance and documentation of Quality Control inspection of activities performed during delivery order activities to ensure compliance with established requirements.

2.0 REFERENCES

None.

3.0 RESPONSIBILITIES

The Program Manager and the Quality Assurance Officer will select the most qualified individual(s) to perform the QC inspection. This determination will be made based on the nature of QC inspection.

4.0 DEFINITIONS

4.1 Inspection

Examination or measurement to verify whether an item or activity conforms to a specified requirement(s).

5.0 PROCEDURE

5.1 Qualification of Inspectors

Personnel performing inspection activities will have the necessary expertise in the area to be inspected but will be sufficiently independent of the activity performed.

Prior to performance of inspection activities, personnel designated for that responsibility would review and be thoroughly familiar with the procedures, regulations, etc., governing the activities to be inspected.

5.2 Field Inspection Plans and Reports

Activities requiring inspection (i.e., Preparatory Phase, initial Phase and Follow-up Phase) will have a definable features of work matrix prepared for that activity. Inspection(s) will be performed for definable features of work that are identified for each delivery order and will be performed consistent with ongoing delivery order activities. The definable features of work matrix will identify the items and activities to be inspected and will provide or reference the specification section and paragraph which specifies the requirements for each activity or item.

If a Nonconformance Report is required for activities being inspected, a reference will be provided on the Daily QC Report. The Daily QC Reports will be issued identifying inspections performed. The report will be completed by the Quality Assurance Officer (or designee) and will address each inspection performed during the course of the daily activities and submitted to the Program Manager.

Items or activities not conforming to inspection acceptance criteria will be resolved and when determined necessary documented on a Nonconformance Report. Daily QC Reports will be logged and sequentially numbered. Each Daily QC Report will be signed by the inspector certifying that the activities listed within the report have been completed in accordance with the project planning documents to the best of his/her knowledge, and submitted for review by the Program Manager.

6.0 REQUIRED FORMS/DOCUMENTATION

Definable Features of Work Matrix

Daily QC Report