National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
White Sands Test Facility
P.O. Box 20
Las Cruces, NM 88004-0020

March 13, 2019

Reply to Attn of: RE-19-042

Mr. John E. Kieling, Chief
New Mexico Environment Department
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Subject: Response to NMED Disapproval SWMU 49 (700 Area Landfill) Phase I Investigation Work Plan and Historical Information Summary

NASA White Sands Test Facility (WSTF) received NMED's November 29, 2018, *Disapproval SWMU 49 (700 Area Landfill) Phase I Investigation Work Plan (IWP) and Historical Information Summary (HIS)*, in which NMED provided eight comments related to NASA's December 28, 2017 *SWMU 49, 700 Area Landfill Phase I IWP and HIS.* NMED directed NASA to respond to the Approval by May 31, 2019 with a response letter that cross-references where NMED's modifications were addressed, as well as respective replacement and electronic redline-strikeout pages indicating where changes were made.

Enclosure 1 provides a printed table that cross-references where NMED's modifications were addressed in the Phase I IWP and HIS. Enclosure 2 provides a printed copy of the final Phase I IWP. Enclosure 3 includes an electronic copy of the response letter and table, redline-strikeout version of the revised Phase I IWP and HIS, and final versions of the revised Phase I IWP and HIS in PDF format on CD-ROM.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with 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 known violations.

If you have any questions or comments concerning this submittal, please contact Antonette Doherty at 575-524-5497.

Timothy J. Davis
Chief, Environmental Office

3 Enclosures

cc:
Mr. Gabriel Acevedo
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Comments for Disapproval of the 700 Area (SWMU 49) Landfill Phase I Investigation Work Plan		
NMED Comment Number	**NMED-Requested Modification to IWP**	**NASA Response/Modification to IWP**
1. Historical Information Summary (HIS), Section 7.10, Indication of Releases to the Environment, Page 47 and 48	**NMED Comment:** White Sands Test Facility (WSTF) quarterly groundwater monitoring database information indicates periodic detections of Freon 11, trichloroethylene (TCE), and tetrachloroethylene (PCE) have also been detected in 700 Area groundwater monitoring wells. The detections are consistent with disposal of solvents at SWMU 49 prior to 1985, as documented in the HIS. Freon 11, Freon 113, TCE, and PCE have been identified as primary contaminants of concern (COCs) at WSTF. In addition to Freon 113, discuss detections of Freon 11, TCE, and PCE in groundwater monitoring wells 700-A-253, 700-D-186, 700-J- 200, and 700-H. Include additional tables in the revised HIS tabulating groundwater sampling results for Freon 11, TCE, and PCE in each monitoring well. Revise the HIS for accuracy.	NASA revised Section 6.6 of the HIS (Historical Information Summary) to include a discussion of Freon 11, TCE, and PCE detections in 700 Area groundwater monitoring wells 700-A-253, 700-D-186, 700-J-200, and 700-H. NASA included Tables 6.2, 6.3 and 6.4 to summarize analytical results and detections. NASA also revised Section 7.10 of the HIS to include Freon 11, TCE, and PCE.
2. Section 2.4, Preliminary Site Conceptual Exposure Model, Page 6	**NMED Comment:** As previously provided in other work plan submittals, include an additional table in the revised Work Plan that comprehensively lists all identified COCs for SWMU 49 based on the HIS findings. The identification of all COCs with the potential to contribute to site contamination is critical to development of the conceptual site model and any resulting sampling program for site investigation. Discuss and reference the table in the revised Work Plan.	Potential non-hazardous and hazardous wastes disposed of in the 700 Area landfill are identified in Section 2.2 of the Phase I IWP (Investigation Work Plan). Based on the limited scope of the first phase of the investigation as described in IWP Section 1.1, NASA believes this section provides an adequate discussion of preliminary COPC (Contaminants of Potential Concern) and believes that a comprehensive list is not applicable to the Phase I IWP. However, to address NMED's comment, NASA revised Section 2.4 of the IWP to introduce preliminary COPC at the 700 Area landfill. NASA also included a statement in Section 2.4 clearly indicating that the Phase I investigation will only characterize VOC (Volatile Organic Compounds) and TPH (Total Petroleum

Comments for Disapproval of the 700 Area (SWMU 49) Landfill Phase I Investigation Work Plan		
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		Hydrocarbons) in the shallow subsurface as part of the shallow SVS (soil vapor survey). NASA also added Table 2.1 to provide the list of preliminary COPC requested by NMED. Table 2.1 provides all COPC based on HIS findings as requested, and includes the COPC identified for the WSTF 200, 300, and 400 Areas.
3. Section 4.3, Decision Inputs, Page 11	**Permittee Statement:** "Information generated during this investigation will support further decision-making should additional investigation or corrective action be deemed necessary." **NMED Comment:** The soil vapor and geophysical survey proposed in the Work Plan will only provide qualitative data. This data must be used to develop an additional Phase II work plan for a comprehensive subsurface investigation resulting in the collection of quantitative subsurface contamination data at SWMU 49 for comparison to applicable screening levels. Residual impacts to groundwater from SWMU 49 have also been documented during groundwater monitoring at the 700 Area landfill. Therefore, additional subsurface investigation will be required following completion of the Phase I investigation activities. Revise the Work Plan accordingly.	NASA revised the text in Section 4.3 to indicate that the qualitative data collected for the 700 Area Landfill Phase I investigation will be used to support the development of a Phase II Work Plan. The Phase II Work Plan will address future management of the 700 Area landfill closure and the strategy for the collection of quantitative subsurface contamination data.
4. Section 5.2, Shallow Soil Vapor Survey, Page 13	NMED Comment: HIS and Section 2.2, Operations and Potential Wastes information, indicates petroleum hydrocarbon waste was disposed at SWMU 49 and included diesel, gasoline, hydraulic fluid, lubricating oils, and motor oils. Revise the sampling plan to also include the screening analysis and reporting for Total Petroleum Hydrocarbons as	NASA revised Section 5.2 and other applicable sections of the IWP to include the screening analysis and reporting for TPH as part of the Phase I shallow SVS.

Comments for Disapproval of the 700 Area (SWMU 49) Landfill Phase I Investigation Work Plan		
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	was previously provided during the 200 Area Phase I investigation. Revise the Work Plan accordingly.	
5. Section 5.2.2, Shallow SYS Boring Installation, Page 14	NMED Comment: Decontamination using detergent wash and potable rinse water of the conduit pipe used to prevent boring collapse at each module sampling location and the rotary hammer bit used to advance each sample location boring was proposed. However, no equipment blank samples have been included in the proposed sampling plan. Revise the Work Plan to include equipment blank sampling of the conduit pipe at a frequency of 10 percent of the proposed Phase IA and IB SVS sampling program. The equipment blank samples must be analyzed for Volatile Organic Compounds and gasoline-range, diesel-range, and oil-range organics.	NASA revised the text in Section 5.2.2 of the IWP to include the collection of equipment blank samples from the conduit pipe at a frequency of 10 percent of the pipe used for the Phase IA and IB shallow SVS sampling program. The equipment blank samples will be analyzed for VOCs and gasoline-range, diesel-range, and oil-range organics.
6. Section 5.3, Electromagnetic Induction Survey [EMI], Page 16	NMED Comment: Due to the use of the EMI survey as the base data collection method for defining the ground penetrating radar (GPR) and magnetic gradient survey areas, provide specifics on the EMI device proposed for use during the investigation and the device depth range. Ensure that the chosen EMI device and method will provide comprehensive coverage for the vertical extent of the landfill based on the findings of the HIS and any other available information. Additionally, ensure the resulting survey information collected during the EMI, GPR, magnetic gradient, and passive seismic surveys provide comprehensive information on the lateral and vertical extent of the landfill, materials disposed in the landfill, subsurface lithology, and underlying geologic structure. Otherwise, propose additional geophysical survey methods (e.g., resistivity survey) that will provide high resolution	NASA provided additional information relative to the proposed EMI (electromagnetic induction) survey device for the investigation in Section 5.3.2. NASA has not identified the specific EMI device to be used, and expects that the specific device will be identified during the competitive procurement process for the geophysical contractor(s). The EMI device and method identified for the survey will be selected to provide comprehensive coverage for the vertical extent of the landfill trenches. Potential devices are discussed in Section 5.3.2 of the IWP. Based on the quality of results for the initial survey, alternate devices may be considered. Upon request, the specific EMI device recommended for the investigation will be provided to NMED for evaluation following the award of

Comments for Disapproval of the 700 Area (SWMU 49) Landfill Phase I Investigation Work Plan		
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	subsurface information and imagery across the landfill and surrounding area. Revise the Work Plan accordingly.	geophysical contract and prior to initiation of field activities.
7. Section 5.9, Site Restoration and Grading, Page 22	NMED Comment: The designated SVS sample locations and proposed extent of the survey area depicted in Figure 4.1, 700 Area Landfill Base Survey Grid, indicate the potential for disturbance of the geosynthetic clay liner (GCL) at some of the landfill cells. Provide an additional discussion of the procedures to be uti1izcd for repair of any portions the GCL damaged during field survey activities. Revise the Work Plan accordingly.	Additional text has been added to Section 5.9 of the Work Plan describing the procedures that will be uti1izcd for repair of the GCL (geosynthetic clay liner) in the event of damage during shallow SVS field activities.
8. Section 9.0, Data Management Tasks, Page 24	Permittee Statement: "NMED will be consulted during the review and evaluation of Phase I data option to commencement of Phase II field activities. Presentation and detailed discussion of the results of the Shallow Soil Vapor Survey will be included in the 700 Area IR." NMED Comment: The Permittee's statement has imparted a level of ambiguity regarding initiation of Phase II investigation activities. For clarity, the results of the Phase I investigation at SWMU 49 must be submitted to NMED as an investigation report for NMED review and approval. Following NMED approval of the Phase I investigation report, a separate work plan for Phase II investigation activities at SWMU 49 will be required for NMED review and approval. Revise the statement and any affected sections of the Work Plan accordingly.	The wording in Section 9.0 and Section 11.0 was clarified to indicate the results of the SWMU 49, 700 Area Phase I investigation will be submitted to NMED as an Investigation Report. Following NMED approval of the Phase I Investigation Report, a separate work plan for Phase II investigation activities will be submitted to NMED for review and approval.

National Aeronautics and Space Administration

SWMU 49, 700 Area Landfill Phase I Investigation Work Plan

Revised March 2019

NM8800019434

NASA Johnson Space Center White Sands Test Facility

SWMU 49, 700 Area Landfill Phase I Investigation Work Plan

Revised March 2019

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with 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.

Timothy J. Davis
Chief, NASA Environmental Office

3/28/19
Date

National Aeronautics and Space Administration

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Executive Summary

This investigation work plan (IWP) presents a planned Phase I field investigation at the National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF) 700 Area landfill, listed as Solid Waste Management Unit (SWMU) 49) in the New Mexico Environment Department (NMED) Hazardous Waste Permit (Permit; NMED, 2016). The 700 Area landfill was operational at WSTF between 1965 and 1997. A Notice of Intent (NOI) to close the 700 Area landfill was placed in the Operating Record on February 3, 1998, and NASA submitted the final closure certification to NMED on August 5, 1998 (NASA, 1998a). A post-Closure care (PCC) Plan for the 700 Area landfill was implemented on July 31, 1998, and is in effect for 30 years. The plan includes requirements for groundwater monitoring, soil vapor monitoring, PCC quarterly inspections and maintenance for landfill cover integrity, adequate drainage, fencing for the landfill boundary, and vegetative cover (NASA, 1999). NASA is currently reviewing potential options for an effective long-term solution for closure of the 700 Area landfill. The Permit (NMED, 2016) requires the development and submission of an IWP for the 700 Area landfill in conjunction with a historical information summary (HIS), to be submitted by December 29, 2017.

The proposed Phase I investigation will utilize non-invasive techniques that are designed to provide a detailed insight into the 700 Area landfill. The investigation will provide a conceptualization of the 700 Area landfill through a series of field surveys to evaluate: the distribution of volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH) in soil vapor (if present); the location and dimensions of waste disposal trenches; the location of metallic debris within the trench; and, additional information relative to subsurface geology with particular reference to the alluvial-bedrock interface. The investigation will provide supplementary information to support determination of the most effective strategy to mitigate potential future liability related to the landfill.

The Phase I investigation covers the area constituting the footprint of the 700 Area landfill, which is traversed by a standardized preliminary field survey grid constructed using 90-foot (ft) x 90-ft grid cells that will be utilized as the base grid for the shallow soil vapor and geophysical surveys. Individual survey lines will change in density depending on the type of survey performed. The detailed final grids will be developed in consultation with experienced subcontractors selected for each survey.

The Phase I investigation will focus on the shallow upper portion of the vadose zone that incorporates the 26 individual landfill trenches identified in the HIS (NASA, 2017e). Trenches were primarily excavated along the width of the landfill area in a northeast-southwest direction with reported dimensions of approximately 20 ft x 20 ft x 600 ft. In addition to the shallow vadose zone investigation, the deeper vadose zone in the vicinity of the alluvial-bedrock interface between 110 ft and 180 ft below ground surface (bgs) will be evaluated. The Phase I investigation survey methods will comprise a two-stage (Phase IA and IB) shallow soil vapor survey (SVS) and four geophysical surveys: an electromagnetic induction (EMI) survey; ground penetrating radar (GPR) survey; magnetic gradient survey; and, a passive seismic survey.

The Phase IA and IB SVS will be used to define the distribution of soil vapor VOCs and TPH in the shallow subsurface within the footprint of the 700 Area landfill. Phase IA will utilize a systematic grid approach based on 90-ft by 90-ft grid cells across the landfill footprint to identify preliminary targets of interest. In conjunction with the Phase IA survey, three geophysical surveys will specifically address the shallow subsurface: an EMI survey will be performed to establish spatial distribution of soil conditions within the landfill; a GPR survey will be performed to delineate the dimensions of landfill trenches; and, a magnetic gradient survey will be performed to locate and map the distribution of metallic objects. These surveys will utilize the baseline grid developed for the Phase IA SVS, with modifications made relative to line length and spacing (density). The final grids will be developed by geophysical subcontractors during the development of each field survey. A fourth geophysical survey will comprise a passive seismic survey that will be used to evaluate and improve conceptualization of the deeper vadose zone including the bedrock surface below the landfill. Following performance of the geophysical surveys, a supplemental Phase IB SVS survey will be performed that biases samples to specifically target the areas of greatest interest relative to potential soil vapor contamination within the landfill cells.

The Phase I investigation will be performed coincidentally with continuation of the ongoing PCC monitoring programs. The optimum strategy for 700 Area landfill closure will be determined based on the results of the Phase I investigative activities. If required, the scope of a supplemental Phase II investigation will be determined after completion of the Phase I investigation report (IR) and NMED’s subsequent review and approval of the IR. The start date and schedule for the 700 Area landfill fieldwork is dependent on NMED approval of 700 Area landfill IWP and HIS. The proposed schedule requires that NASA submit the 700 Area landfill IR to NMED 360 days following approval of the 700 Area landfill HIS and IWP.

Table of Contents

List of Figures and Tables

List of Acronyms

°	Degrees
2-D	Two-dimensional
3-D	Three-dimensional
A-50	Aerozine-50
ASTM	American Society for Testing and Materials
ATV	All-Terrain Vehicle
BEHP	Bis(2-ethylhexyl) phthalate
bgs	Below Ground Surface
CME	Corrective Measures Evaluation
CoC	Chain-of-Custody
COPC	Constituents of Potential Concern
cu yd	Cubic Yard
EDD	Electronic Data Deliverable
EMI	Electromagnetic Induction
EPA	Environmental Protection Agency
ft	Feet/foot
GCL	Geosynthetic Clay Liner
GMP	Groundwater Monitoring Plan
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HHF	Hardscrabble Hill Fault
HIS	Historical Information Summary
HSM	Health and Safety Manager
IDW	Investigation-Derived Waste
in.	Inch(es)
IPA	Isopropyl Alcohol
IR	Investigation Report
IWP	Investigation Work Plan
J	Estimated
JDMB	Jornada del Muerto Basin
MEK	Methyl ethyl ketone
mi	Mile(s)
mm	Millimeter
MMH	Monomethylhydrazine
N2O4	Nitrogen Tetroxide
NASA	National Aeronautics and Space Administration
NDMA	N-nitrosodimethylamine
NMED	New Mexico Environment Department
NOI	Notice of Intent
ODU	Open Detonation Unit
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyls
PCC	Post-Closure Care
PCE	Tetrachloroethene
PDF	Portable Document Files
PID	Photoionization Detector
PPE	Personal Protective Equipment

PSS	Passive Seismic Survey
QA/QC	Quality Assurance/Quality Control
R	Rejected
RCRA	Resource Conservation and Recovery Act
SAM	San Andreas Mountains
SCEM	Site Conceptual Exposure Model
SHP	Safety and Health Plan
SVOC	Semi-volatile Organic Compounds
SVS	Soil Vapor Survey
SWB	Solid Waste Bureau
SWMU	Solid Waste Management Unit
TBD	To Be Determined
TCE	Trichloroethene
TDS	Total Dissolved Solids
TPH	Total Petroleum Hydrocarbons
UDMH	Unsymmetrical Dimethylhydrazine
VOC	Volatile Organic Compounds
WSTF	White Sands Test Facility

1.0 Introduction

This investigation work plan (IWP) describes the approach for a planned investigation of the 700 Area landfill at the National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF; Figure 1.1). The 700 Area landfill is identified as Solid Waste Management Unit (SWMU) 49 in the New Mexico Environment Department (NMED) Hazardous Waste Permit (Permit; NMED, 2016). The WSTF 700 Area is located within the remote northeast part of WSTF (Figure 1.2). The 700 Area landfill has been described as a "modified landfill" (NASA, 1978), a sanitary landfill, and a "Class B landfill," which was "a sanitary landfill serving a population of less than 3,000" (NASA, 1991). The landfill was established to dispose of industrial and commercial non-hazardous waste.

The 700 Area landfill is located in Section 26, Township 20 South, Range 3 East and is a 24-acre trapezoid-shaped piece of land, with the long axis oriented northwest-southeast that was designed to contain solid waste for disposal within excavated cells or trenches. Access to the 700 Area is provided by gravel roads (Road P and Cereus Drive) from Apollo Boulevard, the main paved access road through WSTF (Figure 1.3). The 700 Area landfill was operational at WSTF between 1965 and 1997. Design and operational details for the landfill are provide in the Historical Information Summary (HIS; NASA, 2017e).

1.1 Objectives and Scope

The Phase I investigation is expected to improve conceptualization of the 700 Area landfill through the performance of a series of field surveys designed to identify the distribution of volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH), location and dimensions of landfill trenches, distribution of metallic objects, and additional information relative to the nature of the alluvial-bedrock interface in the subsurface. The investigation will provide supplemental information that is required to effectively address the primary objective of removing or mitigating potential future liability related to the landfill. The primary requirements for mitigating future liability are to: minimize exposure to site workers, the public, and wildlife; and, limit migration of contaminants to groundwater such that regulatory limits are not exceeded.

Final disposition of the landfill will be determined following the completion and evaluation of this Phase I field investigation. In the interim, NASA will continue with ongoing Post-Closure Care (PCC) activities until a decision is made based on consideration of the additional investigation results.

1.2 Regulatory Requirements

NASA submitted a Notice of Intent (NOI) to close the 700 Area landfill on February 3, 1998. The final closure certification was submitted to NMED on August 5, 1998 (NASA, 1998c). The Closure and PCC Plan for the 700 Area landfill was implemented on July 31, 1998, and is in effect for 30 years. The plan includes requirements for groundwater monitoring, soil vapor monitoring, PCC quarterly inspections and maintenance for landfill cover integrity, adequate drainage, fencing for the landfill boundary, and vegetative cover (NASA, 1998a).

The WSTF Resource Conservation and Recovery Act (RCRA) Hazardous Waste Permit (NMED, 2016) requires the development and submission of an IWP that addresses the upcoming work to be performed at this location. Initially, the due date for submittal of the IWP for SMWU 49 was December 30, 2015 (NMED, 2009). On November 17, 2015, NASA submitted a *Class 1 Permit Modification Request* (NASA, 2015) to the NMED HWB requesting a new due date for submittal of the IWP and HIS of December 29, 2017. NMED approved the Permit Modification Request on December 16, 2015 (NMED, 2015).

1.3 Landfill Closure and Post-Closure Care Monitoring

As part of the closure process, all the historical 700 Area landfill covered cells were located by trenching in April 1996 (HIS; NASA 2017c). Ten soil samples were also collected in the landfill prior to April 15, 1996 to evaluate natural WSTF clay in preparation for closure. In May 1996, NASA decided to use a geosynthetic clay liner (GCL) instead of local WSTF clay to ensure the proper low hydraulic conductivity barrier required.

NASA submitted the Landfill Closure and PCC plan to NMED on July 5, 1996 (NASA, 1996). The closure plan provided landfill survey details: "The 26 cells were located and surveyed utilizing the following methods: survey data resurrection; trenching using a backhoe and ripper; site investigations of observed settling; aerial photographs; and interviewing WSTF employees familiar with early landfill operations." Figure 1.4 shows the identified cells within the landfill. "The area of cells requiring cover within the 24.32 acres is estimated to be 173,046 square feet (ft^2; 3.97 acres)." NMED Solid Waste Bureau (SWB) personnel provided NASA with Environmental Protection Agency (EPA) computer software that was used to demonstrate the performance of the landfill cover and liner that were included in the 700 Area landfill Closure Plan. The final cover consisted of the GCL positioned between two 2-inches (in.) layers of select fill (screened to 1/4 in. and less in diameter) above and below to prevent any large rocks from damaging its integrity. The select fill and approximately 10 in. of uncompacted screened local material (topsoil) was used to complete the cover (NASA, 1996).

The Landfill Closure and PCC plan was approved by NMED SWB on August 22, 1997 (NMED, 1997a). From the solid waste annual report submitted to NMED; "NASA continued to transfer the majority of WSTF- generated solid waste off site by utilizing an independent contractor…" (NASA, 1998a). By November 1997, NMED personnel indicated in a landfill inspection that the landfill was no longer receiving any solid waste, that NASA was in the process of bidding package preparation for actual closure, and that waste was being picked up by Silva Sanitation (NMED, 1997b). An NOI to close the 700 Area landfill was placed in the Operating Record on February 3, 1998, and NASA submitted the final closure certification to NMED on August 5, 1998 (NASA, 1998b). Closure activities were conducted by a subcontractor and included:

- Shaping, grading, and compacting the landfill cells and area;
- Constructing berms and a drainage channel;
- Installing the GCL over each cell area on Figure 1.4 positioned between two 2-in. layers of selected fill;
- Installing 10 in. of topsoil;
- Completing final grading;
- Fencing the landfill; and
- Reseeding the landfill area.

The PCC Plan for the 700 Area landfill was implemented on July 31, 1998, and is in effect for 30 years. NMED officially approved the implementation of the PCC plan on August 14, 1998 (NMED, 1998). At this time, NMED personnel conducted a landfill closure inspection and observed no violations (NMED, 1998). The plan includes requirements for groundwater monitoring, soil vapor monitoring, PCC quarterly inspections and maintenance for landfill cover integrity, adequate drainage, fencing for the landfill boundary, and vegetative cover.

Since landfill closure, WSTF has performed quarterly inspections, semi-annual groundwater monitoring, and annual methane gas monitoring as part of the regularly scheduled PCC of the 700 Area landfill. Landfill inspections have identified occasional issues with the closure cap, resulting in the need to perform closure cap maintenance such as vegetation removal or repair of the closure cap. NASA provides the details of landfill closure cap repairs to the NMED SWB following each cap repair. The most recent report was submitted on June 1, 2017 (NASA, 2017c) and deemed in compliance by the SWB on July 7, 2017 (NMED, 2017). The results of groundwater detection monitoring are provided in semi-annual reports to the SWB, most recently on December 20, 2017 (NASA, 2017d). The results of annual methane monitoring are provided to the SWB in each Solid Waste Management Annual Report. NASA submitted the most recent annual report, for calendar year 2016, to the SWB on February 13, 2017 (NASA, 2017a).

2.0 Background

2.1 Operational History

The WSTF 700 Area landfill began operation between 1963 and 1965; the last waste was received on October 27, 1997 (HIS; NASA 2017c). NASA registered the 700 Area landfill with the New Mexico Environmental Improvement Division on October 19, 1978. The specific wastes and their quantities disposed in the landfill are not well documented, although evidence of the nature of the waste is available in spill reports and employee interviews for the deposition of hazardous substances.

Prior to the 1985 establishment of a full-time Environmental Department at WSTF, the only wastes shipped off site for disposal were vehicle batteries (1963 to present) and polychlorinated biphenyls (PCBs; 1980 to present). Any wastes generated at WSTF prior to 1985, including hazardous wastes, were disposed of on site. In general, liquid wastes were managed in surface impoundments and solid wastes were disposed of in the 700 Area landfill. Older cells installed prior to 1985 on the southeastern half of the 700 Area landfill are more likely to have been associated with the disposal of hazardous wastes (HIS; NASA 2017c).

2.2 Operations and Potential Wastes

The operations performed at the 700 Area landfill between 1963 - 1997 can be summarized as follows:

- For the years 1963 – 1985 there were no requirements for landfill waste management documentation, therefore uncertainty exists regarding the type and amount of “hazardous” waste disposed.
- For the years 1985 – 1997 landfill waste management documentation was required and “hazardous” waste disposal was mitigated.
- The exact total volume of waste at the landfill is unknown. The total volume of waste within the landfill has been estimated as 78,000 cubic yards (cu. yd.) within the HIS (NASA, 2017e), based on an estimate of 3,000 cu. yd. per cell and 26 total cells that were surveyed. This volume is approximated as the cells are not all uniform in size, and the survey may not have identified all cells.
- Office and construction waste comprised the majority of the waste.

Based upon information gathered for the HIS (NASA, 2017e), the following non-hazardous wastes are, or potentially could be, present at the landfill:

- Non-hazardous laboratory waste.

- Office waste.
- Scrap wood.
- Yard waste.
- Cafeteria waste.
- Animal carcasses.
- Drilling mud, additives, and cuttings

Based upon information gathered for the HIS (NASA, 2017e), the following hazardous wastes or hazardous constituents are, or potentially could be, present at the landfill (likely disposed of prior to 1985)

- Ash (in situ from trash burned in cells).
- Explosives residue.
- Infectious waste (sharps, blood, etc.).
- Chemical or petroleum contaminated soils (lead, benzene, arsenic, cadmium, chromium, solvents).
- Contaminated debris (such as soft goods, hardware, and clean-up materials) contaminated with fuels (unsymmetrical dimethylhydrazine [UDMH], Aerozine-50 [A-50], monomethylhydrazine [MMH], and hydrazine), and oxidizer (nitrogen tetroxide [N2O4]), also unused or off-spec containers of the above.
- All 200 Area laboratory chemicals (e.g., Trichlorofluoromethane [Freon 11], 1,1,2-Trichloro-1,2,2-trifluoroethane [Freon 113], trichloroethene [TCE], tetrachloroethene [PCE], other solvents, isopropyl alcohol [IPA], other alcohols, acetone, methyl ethyl ketone [MEK], phosphorus, etc.).
- Hydrocarbons (e.g., diesel, gasoline, hydraulic fluid, lubricating oils, motor oils, etc.).
- Teflon grease.
- Mercury (from lamps and soft goods from spill cleanup).
- Small amounts of metals (stainless steel, carbon steel, titanium, aluminum, iron, mercury, copper, tin, gold, silver, chromium).
- Fluorescent lights (lead, cadmium, mercury) and ballasts (containing PCBs).
- Asbestos containing construction debris and insulation.
- Paints and primers (chromium, lead, barium, benzene, MEK, ignitable wastes).
- Epoxies, resins, oils, adhesives, plastics, caulking, floor finish (solvents; possibly containing PCBs).
- Batteries (corrosive, lead, cadmium).
- Photographic papers/negatives (silver [silver bromide]), etching plates (copper, metals).
- Automotive wastes (tires, brake parts, filters, antifreeze, and used oil).
- Aerosol cans (barium, benzene, MEK, TCE, PCE, ignitable, corrosive, reactive wastes).
- Broken or inoperable equipment/meters (metals, possibly asbestos and PCBs).
- Pipes/plumbing (metals).

2.3 Previous Monitoring Results

Details of previous groundwater and methane monitoring data for the 700 Area landfill is provided in the HIS (NASA, 2017e). In October 1994, NASA submitted a landfill groundwater monitoring system plan that was subsequently approved by NMED. On July 28, 1997, NASA provided analytical data, compliance status, and statistical analyses for constituents detected above background levels or assessment monitoring levels (AMLs) for the 700 Area landfill. Constituents listed were Freon 113, fluoride, total dissolved solids (TDS), sulfate, and Bis(2-ethylhexyl) phthalate (BEHP). NASA reported that Freon 113 concentrations were statistically above background levels in well 700-A-253; however, Freon 113 was not a listed hazardous constituent. BEHP was reported as the only hazardous constituent statistically above the AML in well 700-A-253.

Following a request by NMED to initiate an assessment monitoring program, NASA submitted a 700 Area Solid Waste Landfill Monitoring Well Installation and Groundwater Characterization Work Plan on January 19, 1999 (NASA, 1999). The groundwater sampling plan included sampling wells 700-A-253, 700-D-186, 700-B-510, 700-E-458, 700-F-455, BW-6-355, newly proposed 700 Area wells 700-H, and 700-J-200, and upgradient well 300-D-153. NASA concurrently conducted a BEHP investigation of other groundwater monitoring wells at WSTF and of fluids used in drilling groundwater wells. Evaluations of monitoring well data indicated that the BEHP detections had poor correlation to other contaminant plume profiles observed at WSTF. NASA installed dedicated sampling equipment in the 700 Area groundwater monitoring wells at WSTF, and BEHP concentrations dropped. BEHP and other phthalates were also detected in drilling fluids commonly used for well installation at the time.

In March 2000, NASA requested to return to detection monitoring at the 700 Area landfill from assessment monitoring (NASA, 2000), which was approved by NMED (NMED, 2000). Freon 113 continues to be detected at low levels within groundwater monitoring well 700-A-253 and at higher levels in 700-D-186; however, this constituent does not require assessment monitoring since Freon 113 is not listed as a hazardous constituent in the NMAC regulations. In February 2011, cadmium was detected at 0.0031 mg/L and confirmed at 0.003 mg/L in May 2011 above the AML of 0.0025 mg/L. At NMED's request, NASA provided a cadmium time-concentration graph to determine if cadmium concentrations were increasing over time. Cadmium concentrations have fluctuated from not detected to above the AML since 2011. Other constituents such as sulfate and TDS are detected above AMLs in 700 Area groundwater monitoring wells. NASA has provided information to the SWB that allowed for the determination that these constituents are from a source other than the landfill.

NMED personnel determined that NASA should begin methane monitoring during a 700 Area landfill closure consultation in February 1995. In preparation for landfill closure, ten methane monitoring wells were installed around the landfill perimeter (Figure 1.4). Each monitoring well consists of a 7-ft long, 1.25-in. diameter well point with 30 in. of #60 mesh screen set into a 6-ft deep, 4-in. diameter augured hole with a sand pack and bentonite seal.

Methane monitoring of the permanent landfill methane gas wells (MW-1 through MW-10) was conducted quarterly from 1996 to 1999. All results from these methane gas sampling events were non-detect (<5.0 ppm methane). On January 21, 1998, there was one detection of methane gas in well MW-5 of 7.6 ppm. In April 1998, all wells were measured at 0% LEL except MW-5, which could not be located following placement of the closure cap. Well MW-5 was apparently destroyed during cover and closure activities. WSTF facilities personnel repaired the well by removing the dirt from the pipe, installing an additional joint of pipe for well stick-up, filling the annulus to surface with bentonite. The concentration of methane was then measured at 0%. NMED also approved changing the methane monitoring frequency from quarterly to annually. Between October 1999 and December 2016 methane has not been detected at the 10 landfill methane monitoring wells. Methane monitoring results are provided to the SWB in the annual report (NASA, 2017a)

2.4 Preliminary Site Conceptual Exposure Model

A preliminary site conceptual exposure model (SCEM) was developed to provide an understanding of the potential for exposure to hazardous contaminants at the sites based on the source of contamination, the release mechanism, and the exposure pathway(s) as these relate to residential, industrial and construction exposure scenarios. Figure 2.1 summarizes and presents the SCEM in diagram form. Incomplete exposure pathways are denoted by dashed lines to potential receptors, and complete exposure pathways are denoted by solid lines.

2.4.1 Contamination Sources

The potential contamination sources are hazardous materials that may have been disposed of in the 700 Area landfill (Section 2.2). Table 2.1 provides a comprehensive list of preliminary contaminants of potential concern (COPC) that may have been disposed of in the 700 Area landfill based on the operations and potential wastes identified in Section 2.2, and the lists of COPC generated for other test areas at WSTF (primarily the 200, 300, and 400 Areas). This represents the list of contaminants that may be contained within the 700 Area landfill closure cells; however, the list of constituents under investigation for the Phase I IWP are limited to VOCs and TPH for the shallow soil vapor survey (Sections 4.0 and 5.0). During this Phase I investigation, the area covered by the landfill footprint (Figure 1.4) will be investigated using a variety of survey methods.

2.4.2 Release Mechanisms

Contamination can potentially be released from the landfill through the individual trenches that were used as a shallow repository for the waste materials. Waste materials may have been transported deeper into the vadose zone, and possibly groundwater, through leaching promoted by precipitation and infiltration.

2.4.3 Exposure Pathways

Four potential landfill exposure pathways are listed: 1) ingestion of groundwater; 2) incidental ingestion of soil or waste materials; 3) inhalation of volatile contaminants or particulate emissions (dust); and 4) dermal contact with soil or waste materials. There are no current or future residential land use scenarios anticipated in the vicinity of the 700 Area landfill. WSTF is a controlled test site located on the U.S. Army White Sands Missile Range and there are no encroaching residential areas. Therefore, there are no complete exposure pathways identified for the residential exposure scenario in this SCEM (Pathways 1, 2, 3, and 4).

The groundwater underlying much of WSTF is known to be contaminated and its future use and potential risk to receptors are part of an ongoing site-wide evaluation and corrective actions. The only water supply wells for the site are located several miles to the west and down hydraulic gradient from the 700 Area landfill. The supply wells are monitored regularly for the presence of any site-source contaminants. A risk assessment of the groundwater itself will not be conducted as part of this Phase 1 investigation. Ingestion of groundwater (Pathway 1) is not considered a completed exposure pathway for the residential, industrial, or construction worker exposure scenarios.

The landfill materials remain intact in the shallow subsurface in the 700 Area. Since the materials exist underground, and have been covered with a Closure cap the exposure pathways of potentially contaminated soil or waste materials (ingestion, inhalation, dermal) for the industrial exposure scenario is not considered complete (Pathways 2, 3, and 4).

Environmental Department field technicians (Construction Workers) will be performing a passive soil vapor survey during this investigation, which includes the installation of shallow soil vapor probes to depths of 2 to 3 ft below ground surface (bgs). A potential exposure pathway exists for that population to ingest, inhale, or come into dermal contact with potentially contaminated soil (Pathways 2, 3, and 4). This potential exposure will be mitigated by the use of personal protective equipment (PPE) during the shallow soil boring and sampling activities.

2.4.4 Potential Receptors

The Phase I investigative activities will include a limited shallow subsurface investigation that will provide complete release and exposure mechanisms to field scientists and technicians (construction workers). NASA will utilize procedures detailed in Section 5.8 to mitigate construction worker exposure.

3.0 Site Conditions

3.1 700 Area Landfill Closure Description

The 700 Area landfill is an approximately 24-acre (reported as 24.32 acres in the Closure Plan [NASA, 1996]) trapezoid-shaped piece of land, with the long axis oriented northwest-southeast, designed to contain solid waste for disposal within excavated cells or trenches, and has a trench depth between 14 ft and 20 ft (Figure 1.4). The design capacity of the landfill is estimated at between 55,044 cu yd to 72,000 cu yd with a ratio of waste to cover material of 8.5 to 1. The total volume of the 700 Area landfill has been estimated as 78,000 cu yd, based on an average estimate of 3,000 cu yd per cell and 26 total cells that were surveyed and covered during closure (HIS; NASA 2017c). The average waste volume estimate takes into account the variability in trench dimensions and estimates from the landfill operators that 20 percent of the cell volume consists of natural soil, at least two feet of which is final cover.

The Open Detonation Unit (ODU) was a ramped open trench used for waste explosives treatment and disposal operations, It was located adjacent to the northeast side of the 700 Area Landfill Closure (Figure 1.4). The dimensions of the unit were 46 ft by 9 ft by up to 6 ft deep. The unit began operation in 1987 and was under interim status until the unit was permitted in 1993. The most recent waste disposal activity at the RCRA-permitted ODU was performed on March 23, 1999. In late 1999, NASA decided to permanently close the unit. Closure activities originally began on August 20, 2002. NMED approved the clean closure of this unit on August 12, 2005 (NMED, 2005). Disposal of excavated soil from the original ODU closure occurred on January 19, 2006. Final ODU backfill activities began on March 2, 2006 and were completed on March 3, 2006. NMED regulatory personnel inspected the closure on March 7, 2006 (NASA, 2006).

3.2 Surface Geology

The surface geology at the 700 Area landfill consists of Quaternary piedmont slope facies of the Camp Rice Formation. The Camp Rice represents part of the widespread upper Santa Fe Group alluvium (Seager, 1981) derived from the adjacent San Andres Mountains (SAM) to the east. The piedmont slope deposits comprise coalescent alluvial fans that originated from Bear Canyon, a major east-west-trending transverse canyon in the southern SAM located 1 mile (mi) east southeast of the 700 Area landfill.

Santa Fe Group alluvial deposits comprise variably sized gravel clasts within a sand, silt and clay sized matrix. The alluvium is consolidated to unconsolidated, poorly sorted and locally contains discontinuous cemented caliche horizons a few inches in thickness. The most proximal outcropping lithologic units are located approximately 1 mi to the east southeast in the Bear Canyon area and comprise Pennsylvanian to Permian age limestone, sandstone, siltstone and shale.

3.3 Subsurface Geology

3.3.1 Stratigraphy

Unconformably overlying older Santa Fe Group alluvium in the vadose zone is the Quaternary alluvium of the Camp Rice Formation and younger piedmont slope alluvium. These younger alluvial units are syntectonic with a period of younger Basin and Range faulting. Several subsurface faults in the vicinity of the landfill have been inferred from seismic and well log data (Reynolds, 1988; Maciejewski, 1996; NASA, 1996).

Bedrock lithology in the vicinity of the 700 Area landfill comprise lower units of Permian Hueco Limestone and Tertiary (Eocene or Oligocene) Orejon Andesite (Seager, 1981) that consists of purple or green ash-flow tuffs and lava flows. The Permian Hueco Limestone and Tertiary Orejon Andesite bedrock are juxtaposed across inferred fault contacts. The bedrock surface below the 700 Area landfill forms an eroded and relatively flat bedrock pediment surface, based on existing borehole lithological and geophysical data. The bedrock surface decreases in elevation and increases in depth bgs from east to west across the landfill from 110 ft (well 700-J-200) to 180 ft (well 700-D-186).

3.3.2 Structure

Two styles of geologic deformation are present in the vicinity of the 700 Area landfill. The oldest and less prevalent deformation consists of west to northwest-trending folding and faulting associated with the Late Cretaceous to Early Tertiary Laramide Orogeny. This compressional deformation style is present east of the 700 Area landfill, exposed along Bear Canyon, and defined by Seager (1981) as the Bear Peak Fold and Thrust Zone. Thrust faults of the Bear Peak Fold and Thrust zone are interpreted to extend northwestward along strike in the subsurface and pass north of the northern boundary of the landfill. The second and more recent deformational style consists of extensional northwest-trending Late Tertiary Basin and Range normal faulting. The local expression of this structural style is the Rio Grande Rift. Basin and Range normal faulting began in the Rio Grande Rift between 26 and 32 million years ago (Seager, 1981).

Based on available borehole information, deformation near the landfill appears to be limited to Basin and Range normal faulting. Two inferred normal faults that strike northwest are located in the vicinity of the landfill with displacements of approximately 50 ft that downfault a small block of Tertiary Orejon andesite bedrock into Paleozoic limestone bedrock (Hueco Formation) at depth below the 700 Area landfill. Paleozoic limestones are located on the northeast and southwest sides of the fault block (intercepted by wells 700-J-200 and 700-D-186, respectively). Adjacent and to the west of the landfill, a third normal fault (potentially the extension of the Hardscrabble Hill Fault [HHF]) significantly drops the Paleozoic limestone to depth below the base of well 700-H installed in andesite by at least 530 ft as indicated by the thickness of andesite intercepted. The lack of surface expressions of normal faulting in the vicinity of the landfill suggests that the inferred subsurface normal faults near the landfill are related to an early period of extensional basin-range faulting, with beveling of the surface before deposition of the alluvium.

3.3.3 Geological Interpretation

Line of cross-section A-A' is presented in plan view in Figure 3.1, and extends southeast to northwest between WSTF upgradient well 300-D-153 (located 6,000 ft southeast of the landfill) and well 700-B-510 (located 3,500 ft west of the 700 Area landfill). Figure 3.2 presents the geological cross-section along line A-A'. Individual borehole and well completion characteristics of the wells in the vicinity of the 700 Area landfill are provided in Table 3.1. The surface elevation for the wells listed in Table 3.1 decreases from east to west moving down topographic gradient from the SAM into the southern Jornada del Muerto Basin. The elevation of bedrock also decreases from east to west in the direction of dip of the pediment slope. The bedrock surface appears to be relatively smooth and beveled through erosion, evidenced by existing boreholes installed in the area that do not suggest significant offset of the bedrock surface.

Between wells 300-D-153 in the 300 Area and 700-J-200 east of the 700 Area landfill, bedrock comprises micritic limestones of the lower member of the Permian Hueco Formation that predominantly strike N5°E to N45°E and dip 28° to 42° to the northwest based on surface outcrops in the 300 Area. These bedding plane attitudes may continue below the landfill unless the area is affected by the Laramide faulting documented in the Bear Canyon area by Seager (1981). Well 700-J-200, located approximately 500 ft east of the landfill, intercepts strongly hornfelsed (metamorphosed) limestone bedrock within the upper 60 ft, which becomes argillaceous and unaltered at depth.

Well 700-A-253, located adjacent to the landfill on the south side, intercepts 60 ft of Tertiary Orejon Andesite bedrock that overlies micritic limestone of the Hueco Formation. The microcrystalline texture of this andesite suggests a chilled margin to a volcanic flow or intrusive body, and this unit is inferred to be responsible for the metamorphism of hornfelsed limestone at well 700-J-200. Further northwest of the landfill along A-A', micritic limestone bedrock of the Hueco Formation is again intercepted at well 700-D-186 located adjacent and west of the landfill. The reoccurrence of limestone bedrock is inferred to be related to a faulted and uplifted horst block. The 700-D-186 limestone is reported to be well fractured from lithologic descriptions.

Westbay®[1] multiport well 700-H, located approximately 1,000 ft downgradient (west) of the landfill, was installed within a borehole drilled to 730 ft bgs. Andesite bedrock was intercepted at 200 ft bgs and continued to the total depth of drilling, a thickness of 530 ft. A significant fault contact is therefore inferred between wells 700-D-186 and 700-H west of the landfill that juxtaposes the Hueco Limestone and the Orejon Andesite. As a result of the significant displacement evidenced by the absence of limestone bedrock at well 700-H, the fault may represent a northern continuation or splay of the HHF, a north to northwest-trending regional fault with up to a few thousand feet of inferred displacement. The HHF is exposed at surface on Hardscrabble Hill approximately 4 mi south of the landfill. The structure is not observed on shallow seismic cross-sections due to the erosion and beveling of the bedrock pediment surface subsequent to faulting.

3.3.4 Hydrogeology

The aquifer in the vicinity of the 700 Area landfill is hosted within the Paleozoic limestone and Tertiary andesite bedrock, typically at depths up to 30 ft below the bedrock surface. There is little to no primary porosity in the bedrock; therefore, any porosity and groundwater flow is within secondary bedding solution channels and fractures within the limestone, and secondary fractures within the andesite induced through structural episodes. Monitoring wells in the vicinity of the 700 Area landfill (700-J-200, 700-A-

[1] Westbay is a registered trademark of Nova Metrix Ground Monitoring (Canada) Ltd.

253, 700-D-186, 700-H, and 700-B-510; Table 3.1) are screened below the static potentiometric surface in order to maximize groundwater flow from fractured zones. The groundwater monitoring system near the landfill consists of one upgradient well (700-J-200), two landfill PCC point-of-compliance wells located at the landfill boundary (700-A-253 and 700-D-186), and two downgradient wells (700-H and 700-B-510). The wells are conventional single screen wells and are located in the uppermost aquifer with the exception of 700-H, which consists of three Westbay sampling ports designed for vertical characterization along a deeper aquifer profile. The details of these well construction designs are discussed in the site-wide Groundwater Monitoring Plan (GMP; NASA, 2017b).

The screened intervals within the 700 Area groundwater monitoring wells were placed at the uppermost intervals where lithologic and geophysical log information identified the presence of secondary porosity fracture zones capable of generating sufficient water for collection of groundwater samples. Monitoring wells screened at the potentiometric surface do not always yield sufficient amounts of groundwater for samples, and may become dry during low recharge periods. The position of these zones with respect to the static potentiometric surface in the vicinity of the landfill is variable (Table 3.1).

Groundwater flow in the vicinity of the 700 Area landfill is from east to west based on the latest (November 2017) groundwater depth measurements (Figure 3.3). The relatively steep groundwater gradient in the area is approximately 0.1 ft/ft, promoted by the significant decline in surface topography and the bedrock pediment along the western SAM pediment slope (NASA, 2017b). Groundwater flow in this area is calculated to have a velocity of 0.3 to 1.6 ft per day. The volume is however restricted based on low hydraulic conductivities within the aquifer determined from slug testing at monitoring wells 700-H and 700-B-510, and observations from the dry borehole installed at the 700-G location.

4.0 Scope of Activities

Field activities planned for this Phase 1 investigation focus on: evaluating the distribution of VOCs and TPH (if present) in shallow soil vapor below the landfill cap; refining the location and orientation of individual trenches within the landfill; acquiring additional information relative to the metallic objects and their distribution within the landfill trenches; and, improving the conceptualization of the bedrock surface below the landfill. The Phase I investigation is expected to achieve these objectives utilizing the following techniques:

- Shallow soil vapor survey (SVS): to evaluate the distribution of soil vapor VOCs and TPH that may be emanating from landfill contents;
- Electromagnetic induction (EMI) survey: to establish spatial distribution of soil conditions, primarily the disturbed areas below the landfill Closure cap;
- Ground penetrating radar (GPR) survey: to further delineate the locations and dimensions of individual landfill trenches and to identify the location of metallic objects;
- Magnetic gradient survey: to locate and map the distribution of metallic objects of significant size; and,
- Passive seismic survey: to improve conceptualization of the alluvial-bedrock interface below the landfill, including displacement of the bedrock that may represent faulting.

The Phase I investigation will employ a preliminary standardized survey grid that utilizes 90 ft x 90 ft cells (Figure 4.1). Each survey method will utilize this grid as a starting point in developing the line densities for the final grid that will be based on the method requirements and primary objectives of the survey. In order to meet the technical requirements of each survey method and to provide the best quality data from each survey, specific survey grids will be established in consultation with the subcontractor selected during the competitive procurement process.

The Phase I investigation is not expected remove long-term environmental liability created by the continued presence of potential hazardous wastes or hazardous constituents in the landfill; however, it will provide essential information pertaining to evaluation of the scenarios for final landfill disposition. Improvement of the waste characterization through the Phase I investigation will support the landfill evaluation process and streamline decisions to improve the cost effectiveness of future investigation or potential corrective actions at the landfill.

4.1 Problem Statement

The problem statement is summarized in the Permit (NMED, 2016; Section VII.H.1.b), which states that the IWP "…shall include schedules for implementation and completion of specific actions necessary to determine the nature and extent of contamination and the potential migration pathways of contaminant releases to the air, soil, surface water, and ground water." The Phase I investigation initiates this process and serves to enhance the information available to support future actions at the 700 Area landfill.

4.2 Decision Statement and Alternative Actions

The primary decision is whether additional corrective actions are warranted at the 700 Area landfill due to the presence of a residual contamination source(s). Alternative actions for the decisions include:

- Consider a "Corrective Action Complete" status determination.
- If a "Corrective Action Complete" status determination cannot be made using the information obtained during the investigation, determine if further investigation of the unit is required.
- Perform a corrective measures evaluation (CME) for the site(s) to identify remedial options for mitigation of source(s) of continuing contamination (if required).

4.3 Decision Inputs

COPC concentrations measured in the vadose zone soil and local groundwater are the primary inputs to the decision. Wastes or hazardous constituents potentially present at the landfill that were likely disposed of prior to 1985 (Section 2.2) were identified using two primary information sources:

- Detailed information pertinent to the establishment and operational history of the 700 Area landfill documented in the HIS (NASA, 2017e) through a variety of historical documents and reports, personnel interviews, and personnel questionnaires.
- Analytical data sets for samples collected during previous investigations at WSTF test areas in that generated materials potentially disposed of in the 700 Area landfill, including soil, soil vapor, and groundwater samples.

The qualitative data collected for the 700 Area Landfill Phase I investigation will be used to support development of a 700 Area Landfill Phase II Work Plan. The Phase II Work Plan will address future management of the 700 Area landfill closure and the strategy for the collection of quantitative subsurface contamination data.

4.4 Study Boundaries

The horizontal boundaries of the study represent the known footprint of the 700 Area landfill as determined by photography, historical research, and field surveys of the site (Figure 1.4). This investigation specifically addresses the area contained within the footprint of the 700 Area landfill, and immediately adjacent areas as necessary.

The vertical boundaries of the study primarily represent the shallow vadose zone that incorporates the 26 known landfill trench locations. Most of the trenches were dug along the width of the landfill area (NE-SW) with maximum planned dimensions of 20 ft x 20 ft x 600 ft. Several trenches are positioned in the long dimension, along the outside edges of the landfill but within the footprint. The average depth of the cells has been reported to be 14 ft (HIS; NASA 2017c). The overall depth for the investigation will be refined and potentially increased using the results of passive seismic survey. Using an extension of the grid lines on the standard grid (Figure 4.1), the passive seismic survey will be used to expand the investigation to a depth that incorporates the alluvial-bedrock interface at between 110 ft and 180 ft bgs.

5.0 Investigative Methods

5.1 Survey Grid

The survey grid provided in Figure 4.1 will be used to guide data collection efforts during the Phase 1 investigation. Global positioning system (GPS) coordinates will be recorded for the intercepts along each grid line and the shallow SVS sampling locations using Trimble satellite tracking system equipment to an accuracy of approximately 8 millimeters (mm; 0.3 in.) horizontally and 15 mm (0.59 in.) vertically. To simplify coverage of the 700 Area landfill, the principal (long) axis of the SVS grid was oriented northwest-southeast, parallel to the principal axis of the landfill (Figure 4.1). SVS grid traverses were oriented perpendicular to the principal axis in a northeast-southwest direction. Each grid point will be staked and flagged in the field in preparation for shallow boring installation. This survey grid will be used as the basic grid for the shallow SVS and the geophysical surveys, however grid coverage or line density will be modified as necessary to accommodate the technical and data quality requirements of each survey. Specific survey grids will be established in consultation with the subcontractor selected during the competitive procurement process.

5.2 Shallow Soil Vapor Survey

Shallow SVS sampling will be performed using soil vapor sample modules installed in shallow soil borings in two separate phases designed so that results from the first phase (Phase IA) can be used to help define the second phase (Phase IB). In the event that selected soil properties (e.g. porosity and moisture) are required by the soil vapor analytical laboratory as part of the analytical process, selected soil samples will also be collected from the soil placed on top of the GCL at each cell and from undisturbed soil outside the footprint of the cells.

Soil vapor modules are adsorbent modules comprised of adsorbents contained or secured in a porous housing. The Phase IA SVS will screen for VOCs and TPH that may indicate the presence of residual contaminant mass in the landfill. The Phase IB SVS is expected to utilize a sampling bias that focuses on the results of the Phase IA SVS and geophysical surveys to enhance coverage of potential areas of interest. Elevated soil vapor contaminant mass could directly indicate residual contamination within the landfill.

The Phase IA SVS will utilize a standard grid configuration with 90 ft x 90 ft cells with overall dimensions of approximately 700 ft along the short axis (northeast-southwest) by 1,550 ft along the long axis (northwest-southeast; Figure 4.1), traversing the entire landfill footprint and incorporating all 26 trenches previously identified in the HIS (NASA, 2017e). Individual sampling nodes will be centered on each of the grid cells. The grid generally comprises eight cells in width (short axis) by 17 cells (long axis) in length, which will be labeled as sampling points 1 through 138 (Figure 4.1). Phase IB will incorporate supplemental SVS sampling points that will be established following the evaluation of the Phase IA sampling results, and performance of the EMI, GPR and magnetic gradient surveys. It is expected that evaluation of the results of these surveys will support the development of specific target areas for potential VOC anomalies (identified by the Phase IA SVS) within individual trench locations (refined through the EMI, GPR, and magnetic gradient surveys).

The anticipated shallow SVS soil vapor module samples to be collected are summarized below:

- 138 samples – Phase IA systematic grid.
- 13 samples – Phase IA existing monitoring well locations, including three conventional groundwater monitoring wells (700-A-253, 700-D-186, and 700-J-200) and ten existing shallow methane monitoring wells (MW-1 through MW-10 [with MW-5 damaged and unavailable]).
- TBD – Phase II biased sampling points based on the results of the Phase I SVS, GPR survey, and magnetic gradient survey.
- TBD – Field quality control samples (to be collected with both Phase IA and IB sample sets). Duplicate samples will be analyzed at a rate of 10% for samples collected in the field. For field duplicates, a second set of adsorbents housed in the soil vapor module will be analyzed. Trip blanks will be collected at a rate of 5% to document potential exposures that are not part of the signal of interest (e.g., impact during sampler shipment, installation or retrieval, and storage). Trip blanks are identical to the modules installed in the field, and will remain unopened during all phases of the project.

As part of the initial Phase IA investigation, conventional monitoring wells 700-A-253, 700-D-186, and 700-J-200 screened across the uppermost contaminated groundwater table will be equipped with soil vapor sampling modules as a control to compare shallow SVS results to a sampling environment where known groundwater contaminant concentrations contribute to soil vapor through off-gassing (Figure 4.1; Table 3.1). The ten shallow methane monitoring wells will also be evaluated using modules. Sample modules will be suspended inside the upper 2 ft of monitoring well casing and the well subsequently sealed with the well cap or other impervious material. Contamination in these wells is verified through periodic sampling as part of the WSTF groundwater monitoring program. The monitoring well results will be utilized for comparative purposes as they provide a direct conduit to the groundwater table. Analytical results for the sample modules installed within monitoring wells will not be included within the shallow soil vapor survey dataset planned for use in developing soil vapor contours.

The soil vapor sample module laboratory will analyze samples utilizing EPA Method 8260 or equivalent for VOCs and TPH. For passive, sorbent-based sampler such as a universal passive sampler, a semi-quantitative result can be developed by calculating the concentration per volume if the soil porosity, soil moisture content, and exposure time for the soil vapor sample modules is known. The soil vapor sample module analytical laboratory default unit of measurement is mass (grams of contaminant). Results will be presented on isoconcentration maps utilizing the mass in micrograms (µg), typically with a detection limit of 0.02 µg.

5.2.1 SVS Method and Materials

The use of sample modules for soil vapor sampling and screening surveys have been the subject of an EPA environmental technology verification report (Billets, 1998). The EPA indicated that the technology can provide useful, cost effective data for environmental problem solving. Sample modules are passive soil vapor samplers that collect a broad range of VOCs and semi-volatile organic compounds (SVOCs). Sample module analyses include the suite of chlorinated solvents and chlorofluorocarbons that may be present within the 700 Area landfill. Each sample module contains two passive collection units called sorbers. Each sorber contains an equal amount of sorbent materials (polymeric and carbonaceous resins). These granular adsorbent materials are used because of their affinity for a broad range of VOCs and SVOCs. The sorbers are constructed of inert, hydrophobic, microporous expanded polytetrafluoroethane that allows vapors to move freely across the membrane and onto the sorbent material. The microporous structure also protects the granular adsorbents from physical contact with water and soil particulates. Sample modules are typically installed to a depth of between 2 to 3 ft bgs. Samplers are manually inserted into each boring using a stainless steel push rod. The samplers will be retrieved by hand using an attached string or cord, and analyzed using EPA Method 8260 by the soil vapor sample module analytical laboratory.

The passive soil vapor collection technique can be more effective in identifying lower soil vapor contaminant concentrations due to the increased exposure time as compared to a one-time sampling strategy where a discreet volume of soil vapor is collected (for example SUMMA canister grab samples). Native soils in the 700 Area consist of silty to sandy alluvial gravels with porosities typically between 30 to 40%. Individual landfill cells and fill materials will also have significant porosities. Although 12 in. of topsoil was used to cover the GCL liner, SVS sample modules will be installed to depths below the liner and will not be impacted by this low porosity barrier.

Because of the considerable amount of time that has passed since the landfill last received solid waste, soil vapor concentrations in the vadose zone are anticipated to be low relative to concentrations that would characterize a continuing source or a single and more recent point source. The passive soil vapor collection technique will employ an extended exposure time of 14 days (pending confirmation and approval by the SVS analytical laboratory).

5.2.2 Shallow SVS Boring Installation

Shallow SVS boring locations in the field will be predominantly on top of the 700 Area landfill closure and will be accessed on foot. Shallow SVS soil borings will be installed using an electric or battery-powered hand-held rotary hammer drill. Each boring will be drilled in two stages as described below.

Soils near the ground surface at many sample locations are characterized by relatively loose and unconsolidated material. It is expected that borings will be prone to collapse in this setting, so a modified ¾-in. diameter by 16-in. carbide hammer bit (approximate) fitted with a drive collar will be used to advance a ¾-in. inside-diameter by 15-in. length section of stainless steel conduit pipe into the ground with approximately 4 in. of conduit stickup. Prior to cutting individual sections, each length of conduit pipe will be decontaminated using detergent wash and potable rinse water. Equipment blank samples will be collected from 10 percent of the Phase IA and IB SVS conduit pipes. The equipment blank samples will be analyzed for VOCs and gasoline-range, diesel-range, and oil-range organics.

Each of the borings will be subsequently drilled to a total depth of approximately 32 in. using a 5/8-in. diameter by 36-in. carbide hammer bit (approximate). The depth of the boring will be confirmed using a measuring rod. The soil borings will be temporarily protected at surface by covering the conduit pipe with a plastic bag secured in place with electrical tape. The rotary hammer bit and measuring rod will be cleaned of any solid soil material and rinsed with de-ionized water between each boring installation.

Due to the accessible nature of the 700 Area landfill, significant adjustment of the SVS grid sample points is not anticipated. Modified locations will subsequently re-surveyed in the field, the locations imported to the SVS grid base map, and the deviation recorded in the field logbook.

5.2.3 Soil Vapor Module Deployment

Phase IA SVS grid node locations will be recorded with the serial number of the individual soil vapor module installed at each location using an installation and retrieval logbook. Dedicated chemical resistant gloves (latex or nitrile) will be worn by field personnel while installing and retrieving the modules. Each sampling location depth will be measured prior to soil vapor module installation. Any collapse incurred within the boring will be recorded during the module emplacement; however, all borings will remain open to a minimum depth of 20 in. bgs. If a boring collapses to a depth shallower than 20 in. bgs, a replacement boring will be installed adjacent to the collapsed boring using the methods previously described. Each module will be taken from a correspondingly numbered glass vial and inserted into the base of the boring using a ¼-in. diameter stainless steel rod. The module serial number, corresponding field ID, sample type, date and time, observations, sample environment, soil type, etc. will be recorded in the field logbook as each module is installed.

5.2.4 Soil Vapor Module Sampling and Recovery

Each soil vapor module will be suspended on a length of string inside the boring to facilitate retrieval. Each boring opening will then be sealed at the surface with a cork that fits snugly into the conduit pipe at the sample location. The soil vapor modules will be installed within the borings for 14 days. After this residence time, the sampling modules will be retrieved and placed into the corresponding glass vial in which they were shipped from the laboratory. The time and date of soil vapor module retrieval will be recorded at each sample location. In order to keep the residence time constant, the soil vapor modules will be removed in the same order and at a similar rate as they were emplaced. Custody seals will be placed on each glass vial after they are sealed and containers will be managed in accordance with the established WSTF sample management process. The modules will then be shipped to the laboratory for chemical analysis.

When the Phase IA and Phase IB shallow SVS sampling is complete, the ¾-in steel conduits will be removed from the borings. Soil vapor borings installed directly in soil will be backfilled with a small volume of native landfill materials following retrieval of the sampling modules and the completion of sampling.

5.2.5 Sample Management and Interpretation

Sample management techniques specific to the soil vapor module laboratory will be utilized. Procedures presented in WSTF internal instructions for environmental sample management will be followed during sample management operations wherever possible. Phase IA and IB sample modules will be shipped to WSTF in single batches by the contracted soil vapor module laboratory. Individual sample modules are contained separately within 40 milliliter glass vials. Soil vapor module samplers can typically be used within three months of receipt.

Sample modules will be stored and transported at all times in accordance with specific requirements of the soil vapor analytical laboratory. Trip blanks will be retained with the other modules during storage and travel to and from the field. During the period of field exposure between installation and collection, trip blank modules will be stored in a secure container at the 700 Area landfill. Each sample module and glass vial container will be labeled with a unique serial number and sealed with a custody seal. Sample module shipments will be returned by overnight carrier for laboratory analysis. Samples will be managed using an internal WSTF chain-of-custody form and an external chain-of-custody form provided by the laboratory.

Following evaluation of sample results from the initial Phase IA SVS grid, GPR survey, and magnetic gradient survey, the Phase IB SVS sampling will be performed. Up to 150 additional supplemental SVS points are anticipated. The set of Phase IB SVS borings and modules will be biased at tighter spacing between the existing grid nodes to provide greater detail where the initial Phase IA SVS and geophysical survey results indicate anomalous concentrations within a more refined trench scenario. The Phase IB SVS sampling will be performed as soon as possible after Phase 1A SVS sampling, in order to maintain as much consistency as is feasible between the two data sets. This will provide duplicity in the data, and tie the surveys together. By holding variables such as exposure time, installation depth, and analytical procedures constant from one survey to the next, the results from the two surveys will be comparable. The results will be combined onto one set of maps providing a comprehensive view of the subsurface soil vapor distribution.

5.3 Electromagnetic Induction Survey

5.3.1 Procedures and Goals

Industry-standard EMI devices are based on the measurement of the change in mutual impedance between a pair of coils on or above the earth’s surface. EMI instruments are comprised of two or more sets of coils that are electrically connected and separated by a fixed distance. The EMI equipment is portable and allows data to be collected as fast as the operator can walk. Subsurface conductivities are collected continuously as the operator surveys the site with the instrument. The survey that effectively defines the 700 Area landfill can be performed rapidly and effectively.

The principal value of the method is that it provides continuous, high resolution data at reasonable cost. The EMI will be connected to a data logger that simultaneously measures and records the terrain conductivity of the subsurface, and will detect metallic and non-metallic objects or features with conductivity varying from their surroundings. The EMI device will be utilized to simultaneously examine soil conditions and locate utilities, drums, and other buried metal debris, in addition to non-metallic burial features such as trenches from the contrast of conductivity between the disturbed earth and the undisturbed earth (similar to the GPR method discussed in Section 5.4).

The EMI survey grid will utilize the systematic base grid (Figure 4.1) as a starting point for field survey grid development. Utilizing both sets of grid lines will facilitate the development of three dimensional data. The spacing of grid lines will be considerably denser with a tighter spacing for the EMI survey in order to facilitate the identification of individual targets such as drums. Grid spacing will be established during the interaction with geophysical subcontractors during the procurement process.

5.3.2 Equipment

Industry-standard EMI equipment can be carried by hand or mounted to a trailer for towing, as ground contact is not required for operation. Vegetation and obstacles can be navigated around easily. The equipment includes a transmitter that generates a pulsed primary magnetic field, which induces eddy currents into nearby metal objects. The decay of these currents is measured by two receiver coils mounted on the coil assembly. The responses are recorded and displayed by an integrated computer based digital data logger. The EMI device will be connected to a GPS receiver so that accurate horizontal and vertical location information is recorded concurrently with the EMI log data.

The specific EMI equipment and method utilized for the survey will be selected in order to provide comprehensive coverage for the vertical extent of the landfill trenches. Based on the HIS, the vertical extent of the landfill is expected to be between 14 ft and 20 ft. The EMI equipment to be utilized for the investigation will be determined during the competitive procurement process for the geophysical contractor(s). In response to a recent NMED request (NMED, 2018) potential devices include, but are not limited to, the Geophex Ltd. GEM-2 and Geonics, Inc. EM-31 and EM-34.

The Geophex Ltd. GEM-2 electromagnetic instrument is a candidate for the EMI survey. The effective depth of exploration for the device is variable depending on ground conductivity, target volume, and ambient electromagnetic noise. The manufacturer estimates the GEM-2 is effective to a depth of 60 ft in resistive areas (consisting of sand, gravel, and asphalt), and 30 ft in conductive areas. For typical applications in low noise rural areas similar to the 700 Area landfill, the recommended depth is up to 30 ft, which is anticipated to provide sufficient vertical coverage. The Geonics, Inc. EM-31 terrain conductivity meter provides an alternate option, but typically provides more limited depth profiling up to 20 ft. The EM-31 meter will map any subsurface feature associated with changes in ground conductivity and is effective in areas of high surface resistivity. Alternately, the Geonics, Inc. EM-34 meter is preferred for greater depth profiling between 30 and 180 ft. The performance of the specific device will be evaluated during the initial EMI survey and an alternate will be considered if necessary.

5.3.3 Data Processing and Interpretation

Survey data generated by EMI will be stored in a data logger in the field as the survey is run, and will be downloaded daily to a laptop computer or other permanent storage for processing. All data will be given a preliminary review in the field for quality assurance purposes. After collecting EMI survey data, the operator will plot the data using commercially available software to visualize subsurface anomalies, targets, and/or potential soil issues. The EMI survey cannot provide exact information on the target's depth, shape, and orientation but the data is easy to view, process, and even immediately overlay on digitized maps. Subsequent geophysical methods described below (GPR and magnetic gradient surveys) can then target areas of interest to provide more detailed information on depths, size (dimensions/shapes), and orientation of targets in either two-dimensional (2-D) or three-dimensional (3-D) imaging.

5.4 Ground Penetrating Radar Survey

5.4.1 Procedures and Goals

The GPR method is a non-destructive, non-intrusive geophysical method that produces a continuous cross-sectional profile or record of subsurface metallic and non-metallic objects. Radar profiles generated by GPR methods are used for evaluating the location and depth of buried objects and to investigate the presence and continuity of natural subsurface conditions and features. The GPR survey at the landfill is intended to provide information regarding the locations and depths of landfill trenches, identification of changes in subsurface lithology, subsurface objects in landfill trenches, and to identify voids.

The GPR uses high-frequency-pulsed electromagnetic waves (from 10 to 3000 megahertz) to acquire subsurface information. Energy is propagated downward into the ground from a transmitting antenna and is reflected back to a receiving antenna from subsurface boundaries between media possessing different electromagnetic properties. The depth of penetration is determined primarily by the attenuation of the radar signal due to the conversion of electromagnetic energy to thermal energy through electrical conduction, dielectric relaxation, or magnetic relaxation losses. Conductivity is primarily governed by the water content of the material and the concentration of free ions in solution (salinity). Environments not conducive to using the radar method include high conductivity soils, sediments saturated with salt water or highly conductive fluids, and metal. The use of GPR methods at the landfill is warranted as subsurface soils exhibit low conductivities and moisture content, and the groundwater depth is 120 to 180 ft bgs.

The GPR survey areas/lines will be selected based on the results of the EMI survey. Areas of interest identified using EMI methods that require a more detailed definition of subsurface features will be selected for GPR survey. The GPR survey grid will utilize the systematic Phase IA shallow SVS and EMI survey base grid (Figure 4.1) as a starting point for field survey grid development.

5.4.2 Equipment

The GPR equipment utilized for the measurement of subsurface conditions normally consists of a transmitter and receiver antenna, a radar control unit, and suitable data storage and display devices. The radar control unit consists of a small micro-computer and standard operating system that controls the measurement process, stores the data, and serves as a user interface. The control unit synchronizes signals to the transmitting and receiving electronics in the antennas. The synchronizing signals control the transmitter and sampling receiver electronics located in the antenna(s) in order to generate a sampled waveform of the reflected radar pulses. These waveforms may be filtered and amplified and are transmitted along with timing signals to the display and recording devices.

5.4.3 Data Processing and Interpretation

The objective of GPR data presentation is to provide a display of the processed data that closely approximates an image of the subsurface, with the anomalies that are associated with the objects of interest located in their proper spatial positions. Individual GPR surveys will be tied to the Phase I survey base grid points to accurately locate identified subsurface objects. Data display is central to data interpretation, and is generally a function of the radar control and data logging unit. Producing a good display is an integral part of interpretation. There are three types of displays of surface data, including: 1) a one-dimensional trace, 2) a two dimensional cross section, and 3) a three dimensional display. A one-dimensional trace is of limited value until several traces are placed side-by-side to produce a two dimensional cross section, or placed in a three dimensional block view. The wiggle trace (or scan) is the building block of all displays. A single trace can be used to detect objects (and determine their depth) below a spot on the surface. By towing the antenna over the surface and recording traces at a fixed spacing, a record section of traces is obtained. The horizontal axis of the record section is surface position, and the vertical axis is round-trip travel time of the electromagnetic wave. A GPR record section is very similar to the display for an acoustic sonogram, or the display for a fish finder. Wiggle trace displays are a natural connection to other common displays used in engineering (e.g., an oscilloscope display), but it is often impractical to display the numerous traces that are measured along a GPR transect in wiggle-trace form. Therefore, scan displays have become the normal mode of two dimensional data presentation for GPR data. A scan display is obtained by simply assigning a color (or a variation of color intensity) to amplitude ranges on the trace.

A determination of the appropriate survey method (2-D or 3-D) will be established during the interaction with GPR subcontractors during the procurement process. The selected GPR subcontractor will provide copies of all images and interpretations of the survey upon completion. These documents will be archived in the project files, and select images and interpretations will be presented in the investigative report.

5.5 Magnetic Gradient Survey

5.5.1 Procedures and Goals

A magnetometer measures both the orientation and strength of a magnetic field. Magnetic gradient surveys measure small, local variations in the Earth’s magnetic field by using instruments that temporarily polarize protons in a container holding proton-rich fluids by applying an electrical current. When the current is removed, the protons realign corresponding to the magnetic field of the earth at that location and a reading is taken. These localized variations in the magnetic field can be measured with accuracies to 0.002% (Mariita, 2007).

Gradiometers utilize two magnetometers stacked one above the other to measure the magnetic field gradient rather than the total field strength. This relative measurement allows for the removal of background noise. Gradiometers accentuate the signal from shallow ferromagnetic objects while ignoring deeper features. They have been successfully used to locate buried ferrous objects such as drums, tanks, unexploded ordnance, and utilities. The depth of detection depends on the magnetic signature of the target object, so a ton block of iron may be located at a depth of 30 ft, while smaller ferrous debris (drum) might be located at a depth of 10 ft or shallower.

Because of the operating range in the shallow environment, magnetic gradient surveying has been demonstrated to be an effective tool in delineating old landfill boundaries, cell locations, and the presence of buried metallic wastes. Within New Mexico, the City of Albuquerque has successfully utilized magnetic surveys, in conjunction with other investigative methods, to map out at least two historical landfills within the boundaries of the city, the Nazareth Landfill (HGI, 2017a) and Los Angeles Landfill (HGI, 2017b).

At the 700 Area landfill, magnetic surveying will be used in conjunction with EMI and GPR to non-invasively characterize the lateral extents and thicknesses of buried waste and the depth of cover material over the waste cells. Magnetic measurements are highly sensitive to ferrous metals, a common component of the debris buried in landfill trenches. Upon obtaining survey data, a high-resolution, plan view map of the distribution of ferrous metallic objects within the cells will be generated. In addition, the magnetic survey will be used in conjunction with the EMI and GPR surveys to delineate the cells, due to inherent differences in profile signatures between the excavated trenches and undisturbed native soils.

Due to the variability in the widths of the landfill trenches and anticipated variability in the sizes of ferrous objects within them, it is proposed that survey lines be run across the width of the landfill area throughout its entire length at a line spacing of approximately 8 ft. At this density, approximately 21 line mi of survey are expected to provide enough coverage that no cells or ferrous debris the size of a 55-gallon drum will be missed. The survey grid for the Phase IA SVS will be utilized to orient the magnetic gradient survey, with subsequent refinement of the grid to the tighter line spacings. The magnetic survey grid will utilize the systematic Phase IA shallow SVS, EMI, and GPR base grid (Figure 4.1) as a starting point for field survey grid development. The spacing of grid lines will be considerably denser with a tighter spacing for the magnetic survey. Grid spacing will be established during the interaction with geophysical subcontractors during the procurement process.

5.5.2 Equipment

The equipment proposed for the magnetic gradient survey is a Geometrics®[2] G-858 axial gradiometer cesium magnetometer, or equivalent, with two probes positioned vertically in series (approximately 3 ft apart) to measure the magnetic gradient. The magnetometer will be utilized concurrently with GPS to continuously record the locations of readings with progression along the survey lines. Data loggers will record readings during data acquisition. The equipment will either be carried by a technician along each survey line or towed on a non-magnetic cart behind an All-Terrain Vehicle (ATV). Magnetic readings will be taken at 1 to 5-second intervals as the equipment is moved along the survey lines. Quality assurance tests, such as visual inspection, functionality, static response, vibration, and dynamic response will be performed daily to ensure the equipment is in satisfactory working condition. Magnetic survey data will be stored in a data logger in the field as the survey is run, and will be downloaded daily to a

[2] Geometrics is a registered trademark of Geometrics, Inc.

laptop computer or other permanent storage for processing. All data will be subject to preliminary review in the field for quality assurance purposes.

5.5.3 Data Processing and Interpretation

Geometrics MagMap™, or equivalent software, will be used to process the data and to generate a plan map of the distribution of ferrous anomalies in the landfill cells. These maps will be compared to maps of anomalies garnered from EMI and GPR data to evaluate the potential distribution of wastes and debris in the 700 Area landfill.

5.6 Passive Seismic Survey

5.6.1 Procedure and Goals

A passive seismic survey (PSS) involves the detection of natural low frequency earth movements and will be used with the purpose of discerning geological lithology and structure in the subsurface of the 700 Area. Passive seismic (also known as ambient noise surface wave tomography) utilizes background noise to generate vertical profiles through the ground. Variations in impedance contrast are mapped to show lithological and structural features. The technique can be applied to any scenario where softer layers overlie harder substrates, which is the case at the 700 Area landfill where alluvium overlies bedrock. Depending on the nature of the ambient noise and the physical properties of the subsurface lithologies, passive seismic can be used to support subsurface interpretations from near surface down to a few thousand feet in depth.

Passive seismic focuses on low frequency signals (0 to 10 hertz). The primary target layer for the PSS at the 700 Area landfill will be the Paleozoic Hueco limestone and Oligocene Orejon andesite bedrock surface. Enhanced interpretation of this surface will assist with the development of the subsurface site conceptual model in this area, and support site wide geophysical survey efforts. Data listening will be performed using multiple measurement points along linear transects that will be monitored for a period of several days.

Prior to running a complete survey, it is advisable to perform a "noise test," whereby approximately 30 seismic sensor nodes are laid out in a tight 2-D array. The nodes will be left deployed in the field for one to three weeks, collected, and the data analyzed in order to assist with the final spacing of geophones. The complete PSS will consist of a series of single seismic sensor nodes arranged in linear transects. The linear transects will be arranged across the 700 Area landfill into an appropriate grid pattern to generate a 3-D surface of the target horizon (bedrock).

The spacing of seismic sensor nodes influences subsurface resolution, and will be based upon the anticipated depth to the primary reflector (bedrock) at between 110 to 180 ft bgs. The vertical resolution for the PSS data set is typically about half the distance of the horizontal node spacing. The typical spacing for individual geophones is typically in the order of several tens of ft to a few hundred feet in order to provide best resolution for the anticipated depth of bedrock. Nearby wells 700-A-253, 700-D-186, 700-H, and 700-J-200 will be used as independent bedrock depth controls. The passive seismic survey grid will utilize the systematic Phase IA shallow SVS, EMI, GPR, and magnetic base grid (Figure 4.1) as a starting point for field survey grid development. The spacing of grid lines will be less dense, considerably wider-spaced, and extend further beyond the footprint of the 700 Area landfill than the other survey lines due to the greater target depth for this survey.

5.6.2 Equipment

The seismic sensor nodes act as seismic geophones that will be spaced based on the design and recommendation of the geophysical subcontractor. Monitoring points will comprise seismic sensor nodes that are placed at the surface or can be buried up to a few inches below the ground to shield them from the wind. Sensor nodes typically have a charge life of 30 to 45 days, but it is anticipated they will only be left in the ground for a few days to a few weeks. Several hundred nodes may be required to adequately cover the landfill and adjacent areas.

5.6.3 Data Processing and Interpretation

The conclusions for the PSS will be based on the spectral analysis of the observed seismic waves. Data are usually acquired in multiple points simultaneously, using synchronized PSS lines. The data will subsequently be processed to develop a 3-D velocity map.

5.7 Site Access and Maintenance of Closure Cap

The boundaries of the 700 Area landfill are fenced and the surface sparsely to moderately vegetated with desert shrubs and grasses, some of which may impede easy progression of equipment along planned survey lines. In order to establish the survey lines and ensure adequate access for survey equipment, some vegetation may be mowed or mechanically removed. Locations identified for the surveys will be assessed to determine the appropriate surface preparation to allow for successful operation of the associated equipment while ensuring the landfill cap is protected.

In addition, the GCL covering the landfill cells may be impacted if any equipment heavier than an ATV is driven over vulnerable cells. The shallow SVS and geophysical surveys can be completed by operators hand-carrying or towing equipment with an ATV. If vehicles larger than ATVs are required, NASA will limit their use to portions of the closure cap under which GCL is not installed.

5.8 Safety and Health Procedures

Field activities will be conducted in accordance with requirements of 29 CFR 1910, Occupational Safety and Health Administration (OSHA) Standards for Hazardous Waste Operations and Emergency Response (HAZWOPER, 2017). The Contractor’s Corporate-wide Safety and Health Plan (SHP) will be augmented with site-specific Job Hazard Analyses to address potential hazard foreseeable for the project; and, will be followed in accordance with applicable requirements of the standards. The augmented SHP will address safety and health issues pertaining to work activities, including known and reasonably anticipated hazards associated with project scope of work as well as contingencies for unexpected conditions. The requirements of the SHP will apply to prime and sub-tier contractors as well as personnel requesting access to controlled areas of the investigation site.

Project field personnel are required to be current in HAZWOPER training. In the event that new hazards are encountered that are not addressed by the SHP, the field team will stop work and contact the responsible health and safety personnel to develop additional guidance on means to eliminate or mitigate any new threats. As required by the Hazardous Waste Operations and Emergency Response (2017), the SHP, and project-specific addenda will address:

- A safety and health risk or hazard analysis for each site task and operation found in this IWP.
- Employee training assignments.
- PPE to be used by employees for each of the site tasks and operations being conducted.

- Medical surveillance and fitness for duty requirements (based on nature of the project scope and COPCs).
- Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used.
- Site control measures in accordance with the site control program.
- Decontamination procedures.
- An emergency response plan for safe and effective responses to emergencies, including the necessary PPE and other equipment.
- Pre-entry briefing. The SHP shall provide for pre-entry briefings to be held prior to initiating any site activity, and at such other times as necessary to ensure that employees are apprised of the SHP and that this plan is being followed.
- Inspections shall be conducted by responsible contractor personnel who are knowledgeable in occupational safety and health.

During the project, subcontractors must comply with OSHA and EPA standards applicable to this IWP and the SHP. Project subcontractor field personnel are required to be current in HAZWOPER training required 29 CFR 1910 (2017). Prior to the start of each day’s field activities, a Safety Tailgate Meeting will be conducted to review the planned activities of the day, potential hazards, and PPE required. Daily field activities will involve a minimum of two personnel working together. In the event of any injuries requiring first aid in the field, the person injured will report to the WSTF Clinic prior to the end of the work day. Any injuries or situations more serious than what could be mitigated using basic first aid will be handled by informing WSTF Emergency Services.

5.9 Site Restoration and Grading

Any suspected disturbance or damage to the GCL incurred during the Phase I shallow SVS field activities will be subject to repair during backfill of the associated soil boring. Following retrieval of the sampling module, the boring will be backfilled with powdered sodium bentonite and hydrated. This is a commonly accepted practice for the repair of landfill GCL liners, and has been performed previously at the WSTF 600 Area Closure (NASA, 2011). Any minor site grading will be completed using hand tools to prevent the ponding of water at the site location.

Following individual phases of the field investigation, all modifications or repairs to the landfill closure cap will be reported the NMED Solid Waste Bureau. Significant final restoration and grading activities at the 700 Area landfill will be performed following the completion of the last phase of fieldwork, receipt of the final analytical results, submittal of the investigation report to NMED, and receipt of concurrence from NMED.

6.0 Equipment Decontamination Procedures

It is anticipated that only solid waste will be generated during this investigation due to the shallow penetration of the SVS and non-invasive geophysical survey techniques. Any equipment that may penetrate the surface into a landfill cell will be decontaminated before and after use. General decontamination guidance available in ASTM International D 5088-15a (ASTM, 2015) will be followed for this project. Decontamination procedures will be performed by 40-hour HAZWOPER trained personnel wearing appropriate PPE under the supervision of the site supervisor or their designee.

6.1 Decontamination Area

An individual small-scale decontamination station will be constructed adjacent to the 700 Area landfill to support decontamination of the shallow SVS steel conduit pipe and rotary hammer drill bit that will be used for the shallow SVS. Contamination reduction or decontamination activities will be performed over a containment device that will retain waste generated during the decontamination process. It is anticipated that all waste will be managed as solid waste.

6.2 Decontamination Methods

Decontamination will be performed on the SVS steel conduit pipe and rotary hammer bit to minimize the potential for any cross-contamination between shallow SVS sample locations. Any residual soil on the SVS steel conduit pipe and rotary hammer drill bit will be removed using a wire brush adjacent to each borehole location. Shallow SVS sampling equipment will be decontaminated prior to exiting the 700 Area landfill area. Decontamination will involve hand washing the item with non-phosphate detergent, rinsing with WSTF potable water, and finally by rinsing with purified water. In the event field screening instruments are used to monitor the condition of the 700 Area landfill, dry decontamination followed by an alcohol free moist wipe will be used for moisture sensitive equipment such as a photoionization detector (PID).

7.0 Field Documentation Procedures

The WSTF Environmental Department field supervisor (geologist or engineer) will keep a record of daily Phase I investigation activities, a log of site personnel, safety briefings, wastes generated, etc. in a project specific logbook. Logbooks will have durable pages, bound and serial numbered. Entries will be made in ink with no erasures. Each day’s record will be reviewed and approved by another individual involved in the project. Logbook entries will include, as applicable, information such as:

- Standard Daily Header – project name, logbook number, date, weather conditions, team members present and their affiliations (including subcontractors), sample location identification, day’s task(s), daily safety meeting topics, PPE to be used, equipment in use, and any calibration information, if applicable.
- Daily activities (time and observations recorded) – site arrival and departure, visitors and the purpose of their visit, sampling information, soil type, soil conditions, decontamination (i.e., method, equipment cleaned), reference data sheets or maps, if applicable.
- Daily summary – action items, materials used, changes or deviations made from planned protocol, plan for next day.
- Signatures (field personnel and logbook reviewer).

In addition to the field logbook, shallow SVS sample locations will be recorded with the serial number of the individual soil vapor module installed at each location using an installation and retrieval log. This log includes the date, location, depth, sample type, identification number, sampler, and any circumstances, events, or decisions that could impact sample quality. Even though each case may be unique, the geologist's decision must be documented as to conditions that precipitated any decisions for the unsuitability of samples for analyses.

Evidential records for the entire project will be maintained in hard copy or electronic form and will consist of:

- Project IWP with any deviations redlined.

- Site-specific internal procedural documentation or plans.
- Project logbooks.
- Field data records (i.e., surveyed site location).
- Sample installation and retrieval logs.
- Correspondence with NMED.
- Final analytical data packages.
- Reports.
- Miscellaneous related records such as photos, maps, drawings, etc.

8.0 Investigation Derived Waste

Permit Attachment 20 (Section 20.2.13) requires that a description of IDW management be provided in an appendix to each work plan (NMED, 2016). Because a very limited amount of solid waste is expected to be generated during the Phase I investigation fieldwork, waste management procedures are presented in this section in lieu of a separate appendix.

All IDW generated as part of the investigation is anticipated to be characterized and managed as non-hazardous solid waste. This will include a limited volume of soil cuttings, or environmental media, that adheres to shallow SVS steel conduit pipe and the rotary hammer drill bits. The cuttings will consist of soils that were used to construct the clean landfill closure cap. These are characterized as non-hazardous and will be left in the immediate project area. Other IDW will include used disposable PPE (gloves), plastic sheeting, and rags, which are characterized as non-hazardous and will be disposed of as solid waste at a Subtitle D landfill. Waste water and soap solutions used for equipment decontamination are also characterized as non-hazardous and will be disposed of in the WSTF sanitary sewer system. The shallow SVS soil vapor module samplers will be returned to the laboratory for chemical analysis.

9.0 Data Management Tasks

Passive diffusion sampler serial numbers, grid locations, and trip blank serial numbers will be recorded in the field logbook. Analysis of the samplers will be performed in the laboratory by gas chromatography per US EPA Method 8260. Analyses of trip blanks are performed in addition to laboratory blanks (instrument, method, standards, etc.) to ensure quality assurance. Data validation will be supported by the laboratory surrogate recovery and trip blank analysis.

Processed data will be recorded in mass data tables, concentration values, and site isoconcentration maps utilizing the mass in µg showing compound distribution. The results of the Phase I investigation will be submitted to NMED in the Phase I Investigation Report. Following NMED approval of the Phase I Investigation Report, a separate work plan for Phase II investigation activities will be submitted to NMED for review and approval.

Significant deviations from the number and locations of shallow SVS samples indicated in the IWP will be discussed with NMED for concurrence. Geophysical field survey events will be managed in accordance with the requirements established by the knowledgeable contractors. If a survey cannot be conducted as planned, the site supervisor will be notified. Any deviations from the IWP or procedures will be documented and noted in the Phase I Investigation Report for review by the NMED.

10.0 Current Monitoring and Sampling Programs

The primary current monitoring program applicable to Phase I investigation fieldwork at the 700 Area landfill is NASA's ongoing groundwater assessment program. NASA routinely collects groundwater samples from a comprehensive network of monitoring wells at WSTF, including those near the landfill, in accordance with the NMED-approved GMP (NASA, 2017b). Groundwater samples are collected for the analysis of VOCs, N-nitrosodimethylamine (NDMA), bromacil, and metals. Groundwater samples collected from monitoring wells near the landfill (wells 700-A-153, 700-D-186, 700-H, and 700-J-200) are also analyzed for the constituents in Subpart A of 20.9.9.20 NMAC in accordance with the landfill PCC Plan (NASA, 1997).

NASA also performs annual methane monitoring at ten shallow soil vapor monitoring wells near the perimeter of the landfill (Figure 1.4) in accordance with the PCC Plan (NASA, 1997). Each monitoring well consists of a 7-ft long, 1.25-in. diameter well point with 30 in. of #60 mesh screen set into a 6-ft deep, 4-in. diameter augured hole with a sand pack and bentonite seal. Between May 1996 and December 2016, methane has been detected a single time above the instrument detection limit of 5 parts per million. A concentration of 7.6 parts per million was reported at well MW-5 on January 21, 1998. This well was accidentally destroyed in 1998 during closure cover installation activities, although the remaining wells are operational.

11.0 Schedule

The anticipated schedule for the SWMU 49, 700 Area landfill Phase I investigation fieldwork and reporting is as follows:

- NMED approval of the SWMU 49, 700 Area landfill IWP and HIS (to be determined).
- Complete Phase I investigation procurements and commence fieldwork - 60 days following NMED approval.
- Complete fieldwork components in the following general order and receipt of SVS analytical laboratory and geophysical subcontractor survey data all with a timeframe of 180 days following the start of fieldwork:
    - Phase IA systematic SVS on a standardized grid.
    - EMI to examine soil conditions and locate objects found beneath the surface and provide direction for GPR and magnetometer.
    - GPR to support trench delineation in subsurface.
    - Magnetic gradient survey to define metallic objects.
    - Passive seismic to investigate and discern geological lithology and structure.
    - Phase IB SVS designed with the support of results of the preceding Phase I SVS, EMI, GPR, and magnetic gradient surveys.
- Data compilation, review, and development of draft 700 Area landfill Investigation Report including internal reviews: 120 days after completion of Phase I fieldwork components and receipt of laboratory and geophysical subcontractor survey data.
- NASA Submits the SWMU 49, 700 Area Landfill Phase I Investigation Report to NMED: 360 days after approval of the 700 Area landfill HIS and IWP.

12.0 References

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Figures

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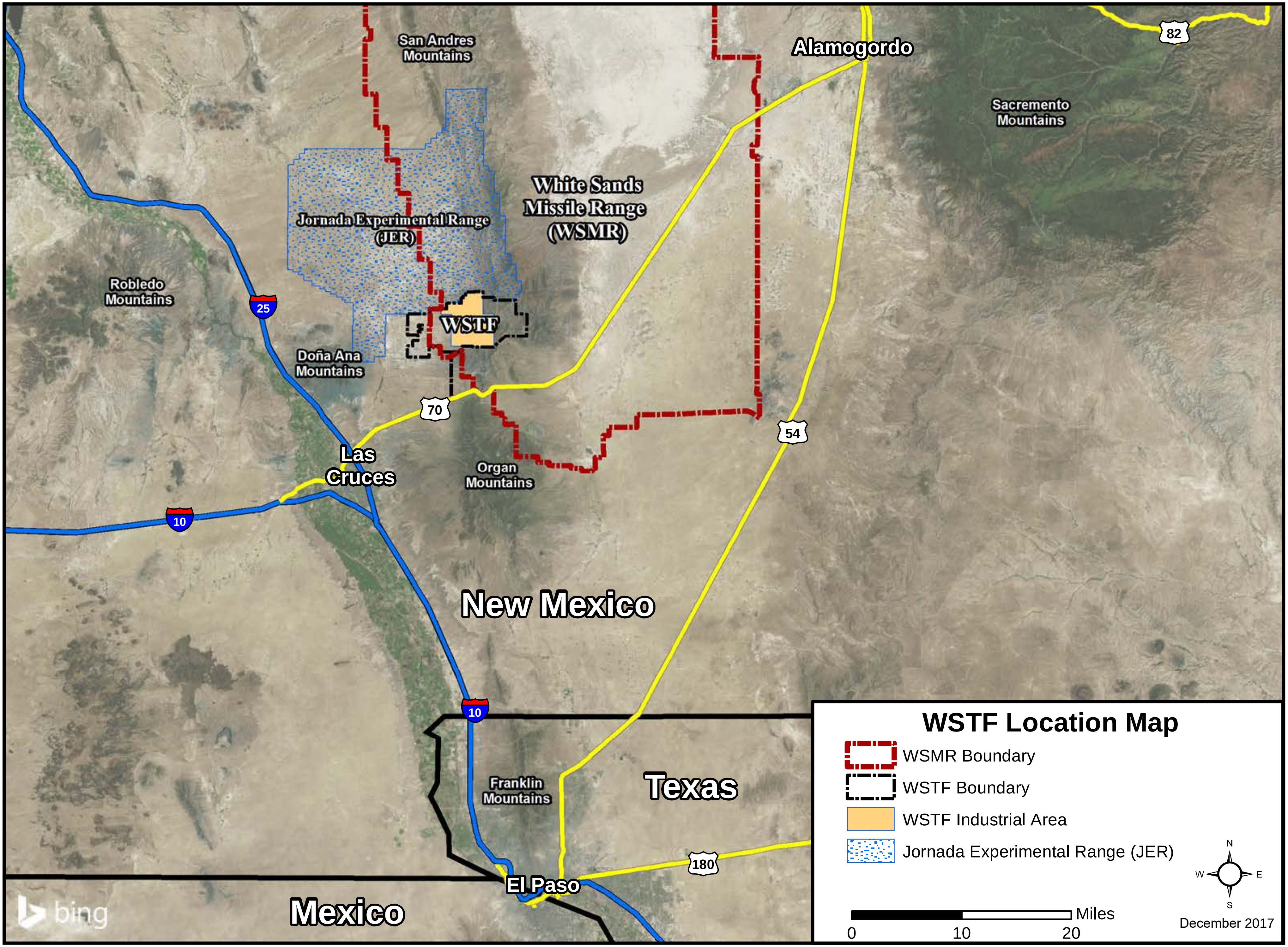


San Andres Mountains
Alamogordo
82
Sacremento Mountains
White Sands Missile Range (WSMR)
Jornada Experimental Range (JER)
Robledo Mountains
25
WSTF
Doña Ana Mountains
70
54
Las Cruces
Organ Mountains
10
New Mexico
10
Franklin Mountains
Texas
180
El Paso
Mexico
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
N
W
E
S
Miles
0
10
20
December 2017

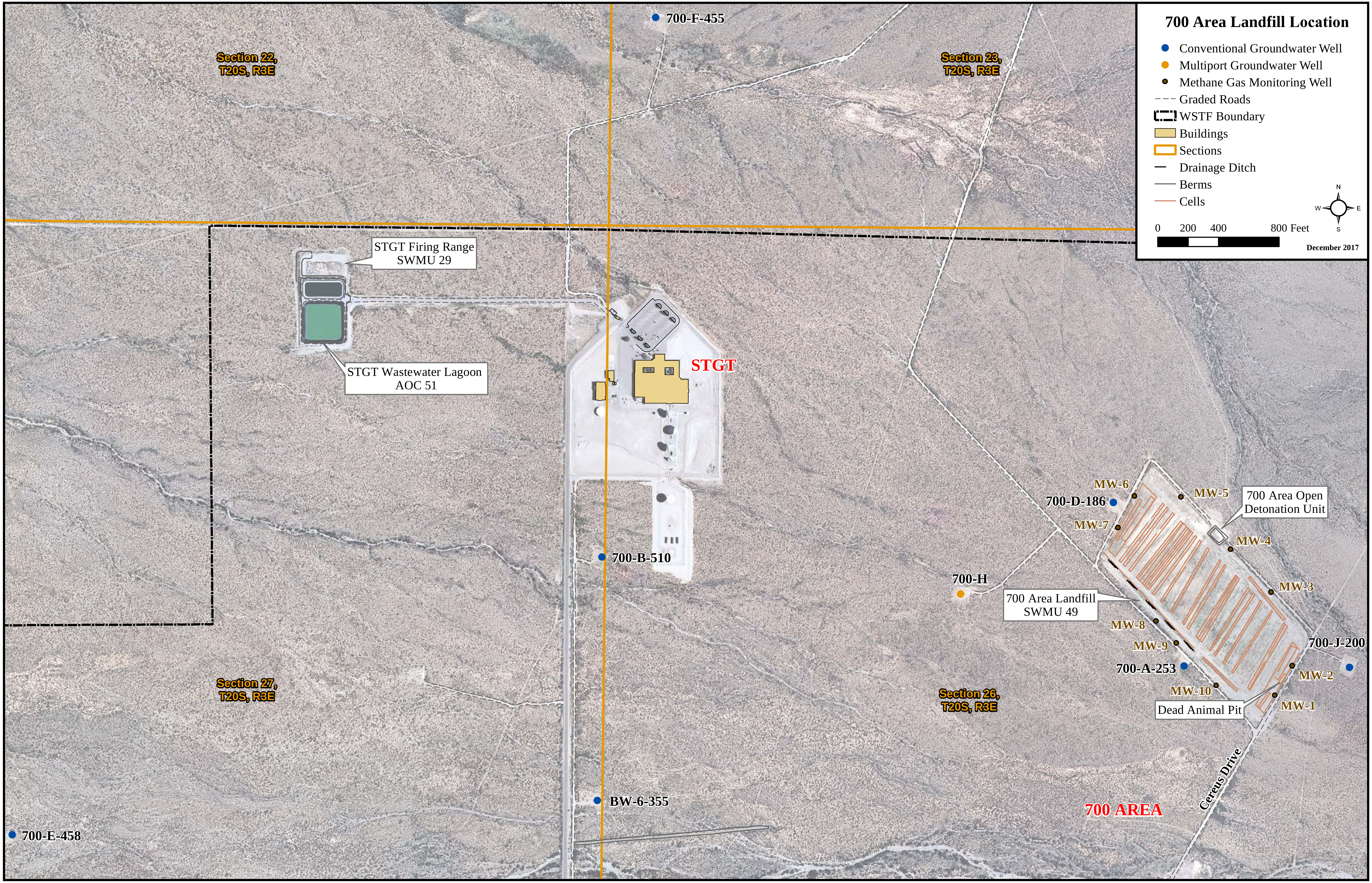
Figure 1.2 **WSTF Industrial Areas**

(SEE NEXT PAGE)

STGT Area
700 Area
500 Area
(Fuel, Oxidizer Storage)
300 Area
400 Area
STGT Access Road
Apollo Boulevard
800
Area
200
Area
Well Road
600
Area
100 Area
WSTF Industrial Areas
700 Area Landfill
Feet
0
800
1,600
N
W
E
S
December 2017

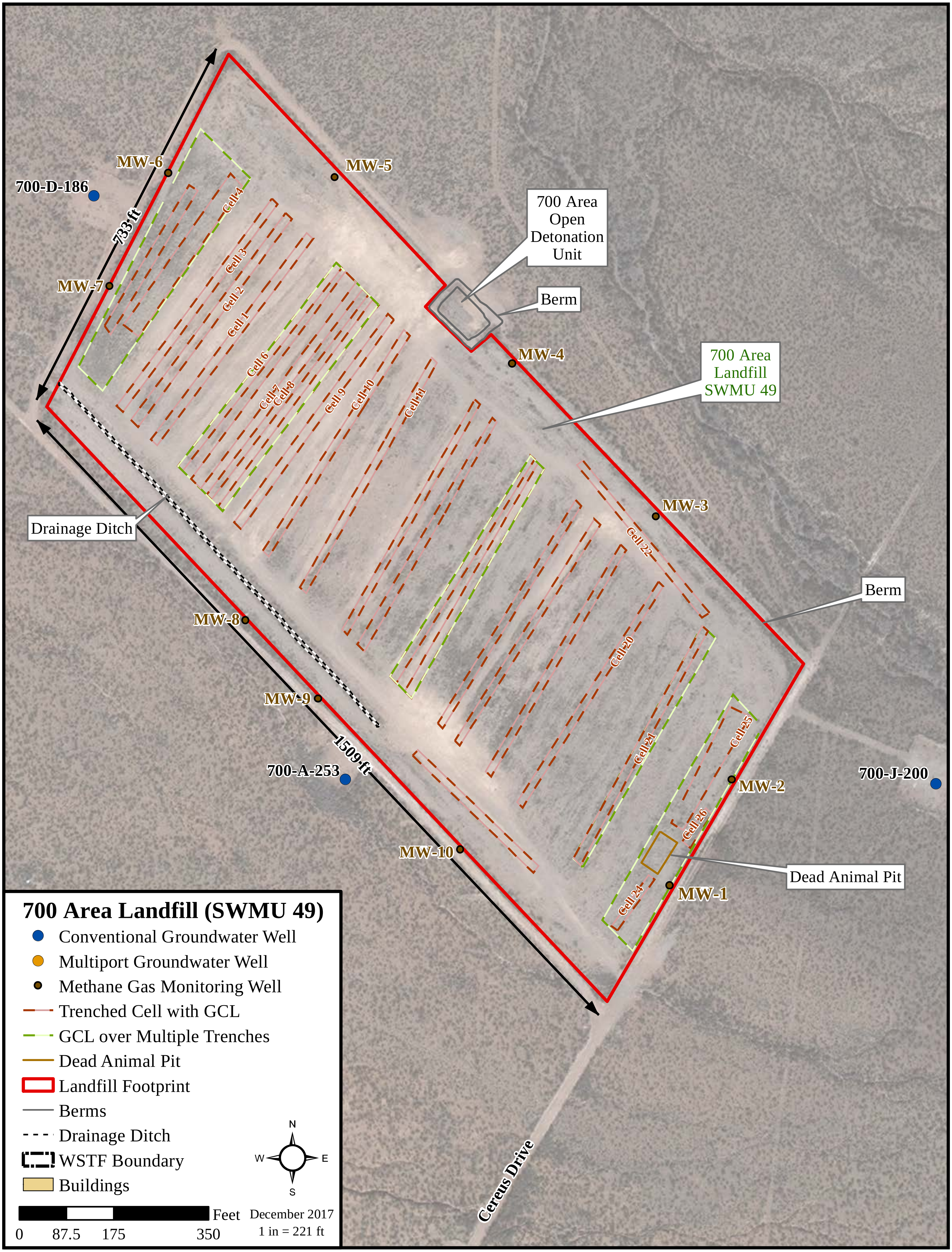
Figure 1.3 **700 Area Landfill Location Map**

(SEE NEXT PAGE)



700 Area Landfill Location
Conventional Groundwater Well
Multiport Groundwater Well
Methane Gas Monitoring Well
Graded Roads
WSTF Boundary
Buildings
Sections
Drainage Ditch
Berms
Cells
N
S
E
W
0 200 400 800 Feet
December 2017
Section 22, T20S, R3E
Section 23, T20S, R3E
Section 27, T20S, R3E
Section 26, T20S, R3E
700-F-455
STGT Firing Range SWMU 29
STGT Wastewater Lagoon AOC 51
STGT
700-B-510
BW-6-355
700-E-458
700-H
700-D-186
700-A-253
700-J-200
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
700 Area Open Detonation Unit
700 Area Landfill SWMU 49
Dead Animal Pit
700 AREA
Cereus Drive

(SEE NEXT PAGE)



700 Area Landfill (SWMU 49)
Conventional Groundwater Well
Multiport Groundwater Well
Methane Gas Monitoring Well
Trenched Cell with GCL
GCL over Multiple Trenches
Dead Animal Pit
Landfill Footprint
Berms
Drainage Ditch
WSTF Boundary
Buildings
0 87.5 175 350 Feet
December 2017
1 in = 221 ft
N
W
E
S
700 Area Open Detonation Unit
Berm
700 Area Landfill SWMU 49
Drainage Ditch
Berm
Dead Animal Pit
Cereus Drive
733 ft
1509 ft
700-D-186
700-A-253
700-J-200
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
Cell 1
Cell 2
Cell 3
Cell 4
Cell 6
Cell 7
Cell 8
Cell 9
Cell 10
Cell 11
Cell 20
Cell 21
Cell 22
Cell 24
Cell 25
Cell 26

Figure 2.1 **Site Conceptual Exposure Model**

(SEE NEXT PAGE)

Site Conceptual Exposure Model

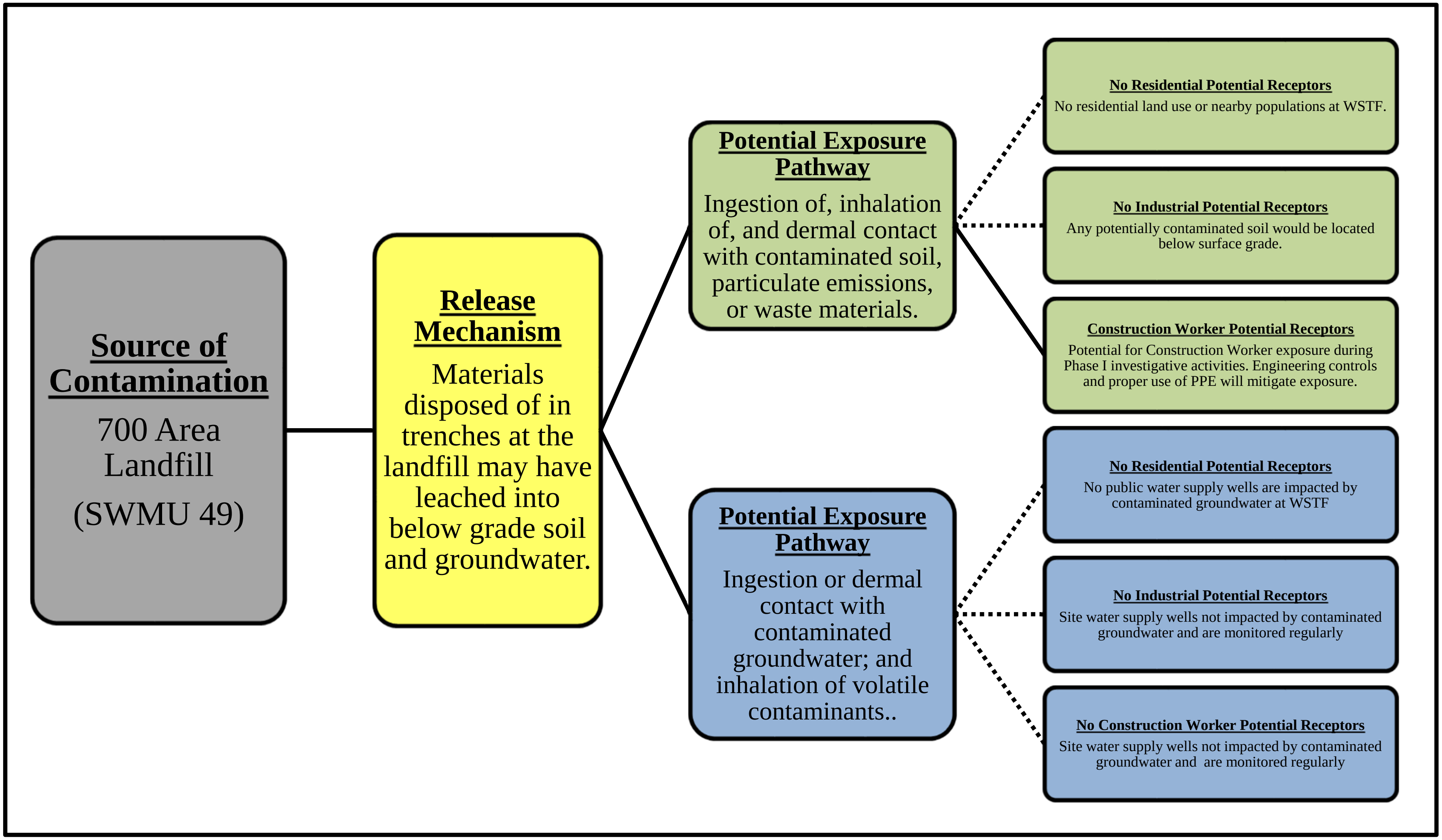
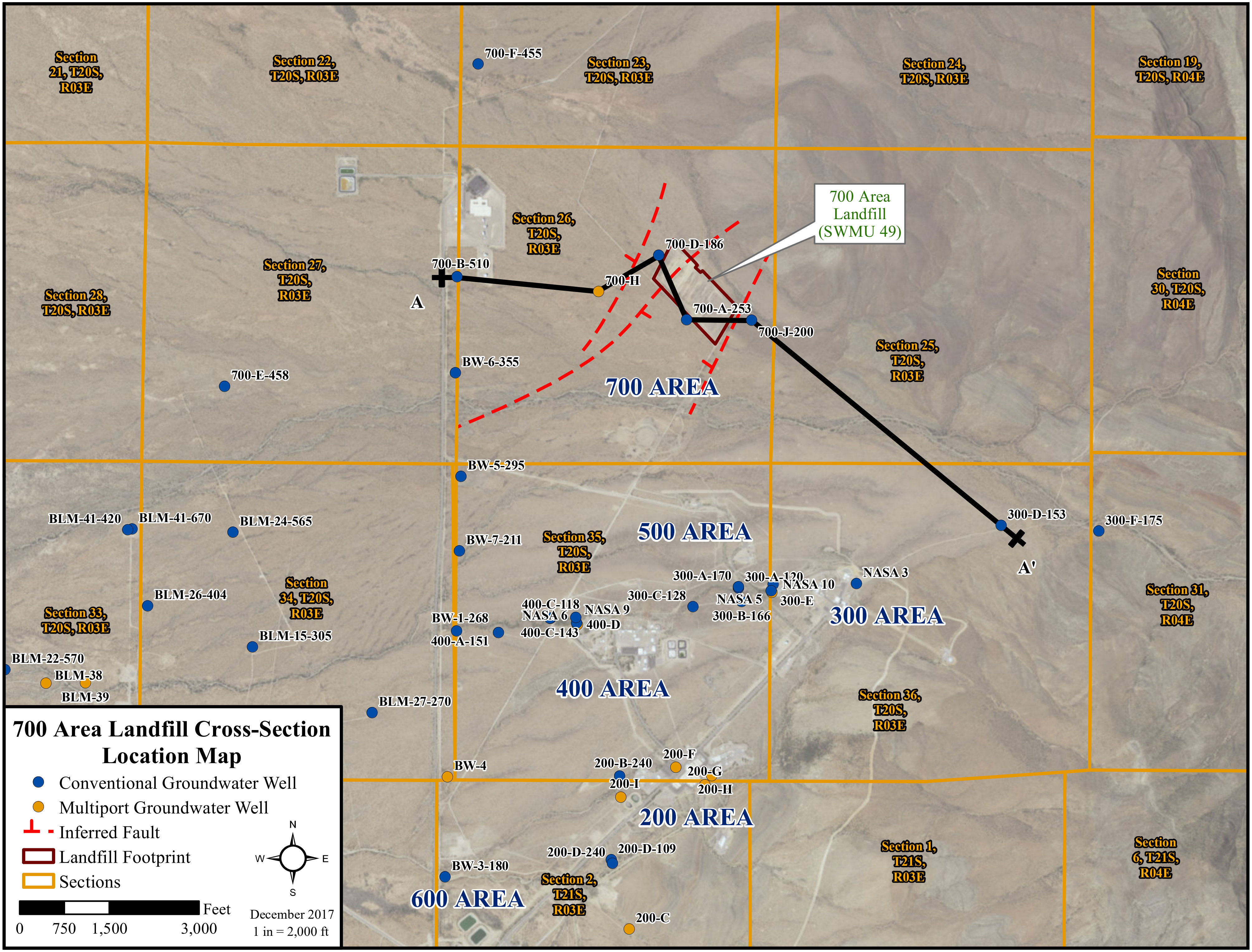


Figure 3.1 700 Area Cross Section Location Map

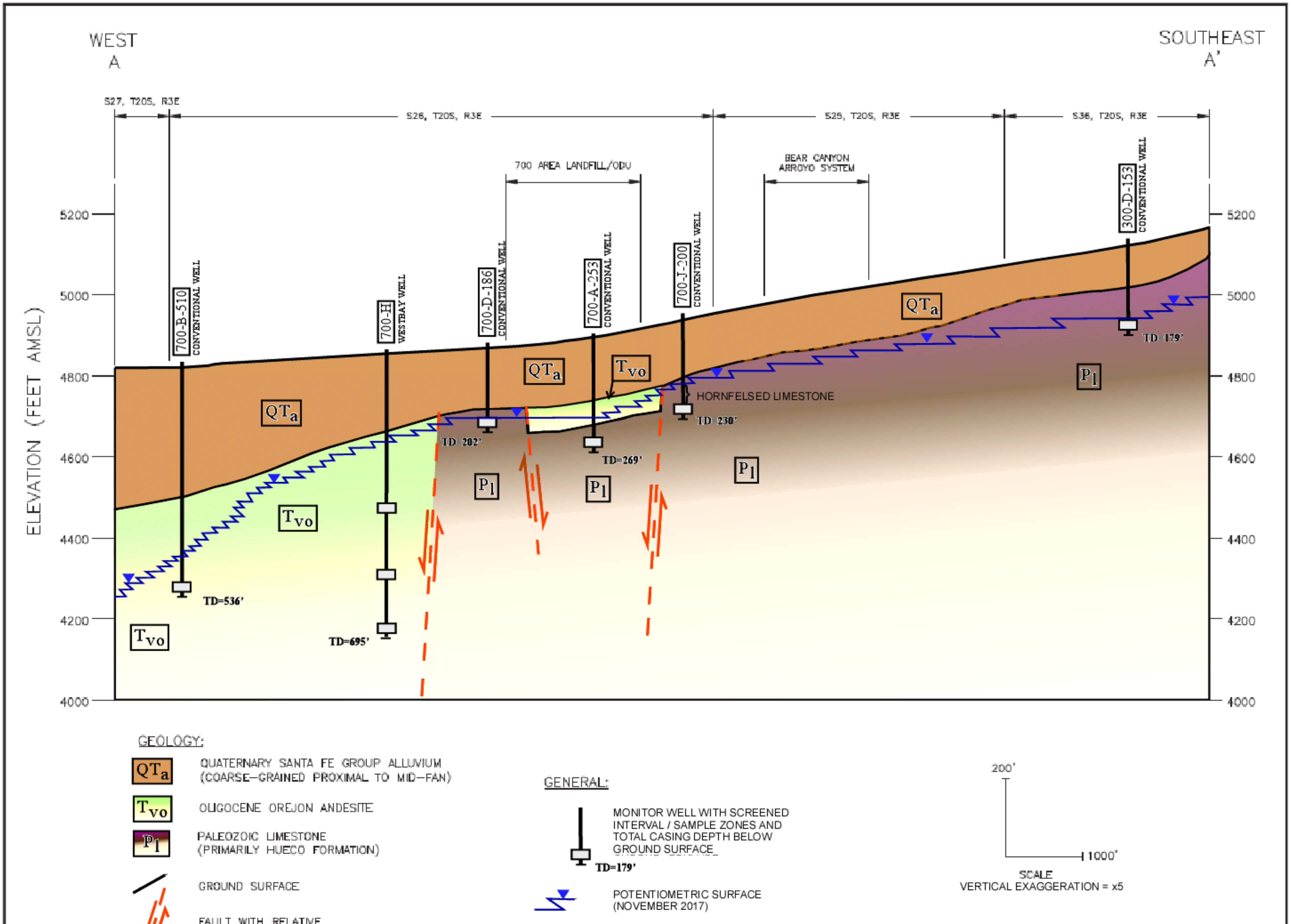
(SEE NEXT PAGE)



700 Area Landfill Cross-Section Location Map
Conventional Groundwater Well
Multiport Groundwater Well
Inferred Fault
Landfill Footprint
Sections
Feet
0
750
1,500
3,000
N
S
E
W
December 2017
1 in = 2,000 ft
700 Area Landfill (SWMU 49)
700 AREA
500 AREA
400 AREA
300 AREA
200 AREA
600 AREA
A
A'
Section 21, T20S, R03E
Section 22, T20S, R03E
Section 23, T20S, R03E
Section 24, T20S, R03E
Section 19, T20S, R04E
Section 26, T20S, R03E
Section 27, T20S, R03E
Section 28, T20S, R03E
Section 25, T20S, R03E
Section 30, T20S, R04E
Section 35, T20S, R03E
Section 34, T20S, R03E
Section 33, T20S, R03E
Section 31, T20S, R04E
Section 36, T20S, R03E
Section 1, T21S, R03E
Section 6, T21S, R04E
Section 2, T21S, R03E
700-F-455
700-D-186
700-B-510
700-H
700-A-253
700-J-200
BW-6-355
700-E-458
BW-5-295
BLM-41-420
BLM-41-670
BLM-24-565
BW-7-211
300-D-153
300-F-175
300-A-170
300-A-120
NASA 3
NASA 10
300-C-128
NASA 5
300-E
300-B-166
400-C-118
NASA 6
NASA 9
400-D
400-C-143
BLM-26-404
BW-1-268
400-A-151
BLM-15-305
BLM-22-570
BLM-38
BLM-39
BLM-27-270
BW-4
200-B-240
200-F
200-G
200-I
200-H
200-D-240
200-D-109
BW-3-180
200-C

Figure 3.2 700 Area Landfill Line of Cross-Section A-A'

(SEE NEXT PAGE)



700 Area Landfill Line of Cross-Section A-A'

Figure 3.3 700 Area Landfill Potentiometric Contour Map

(SEE NEXT PAGE)

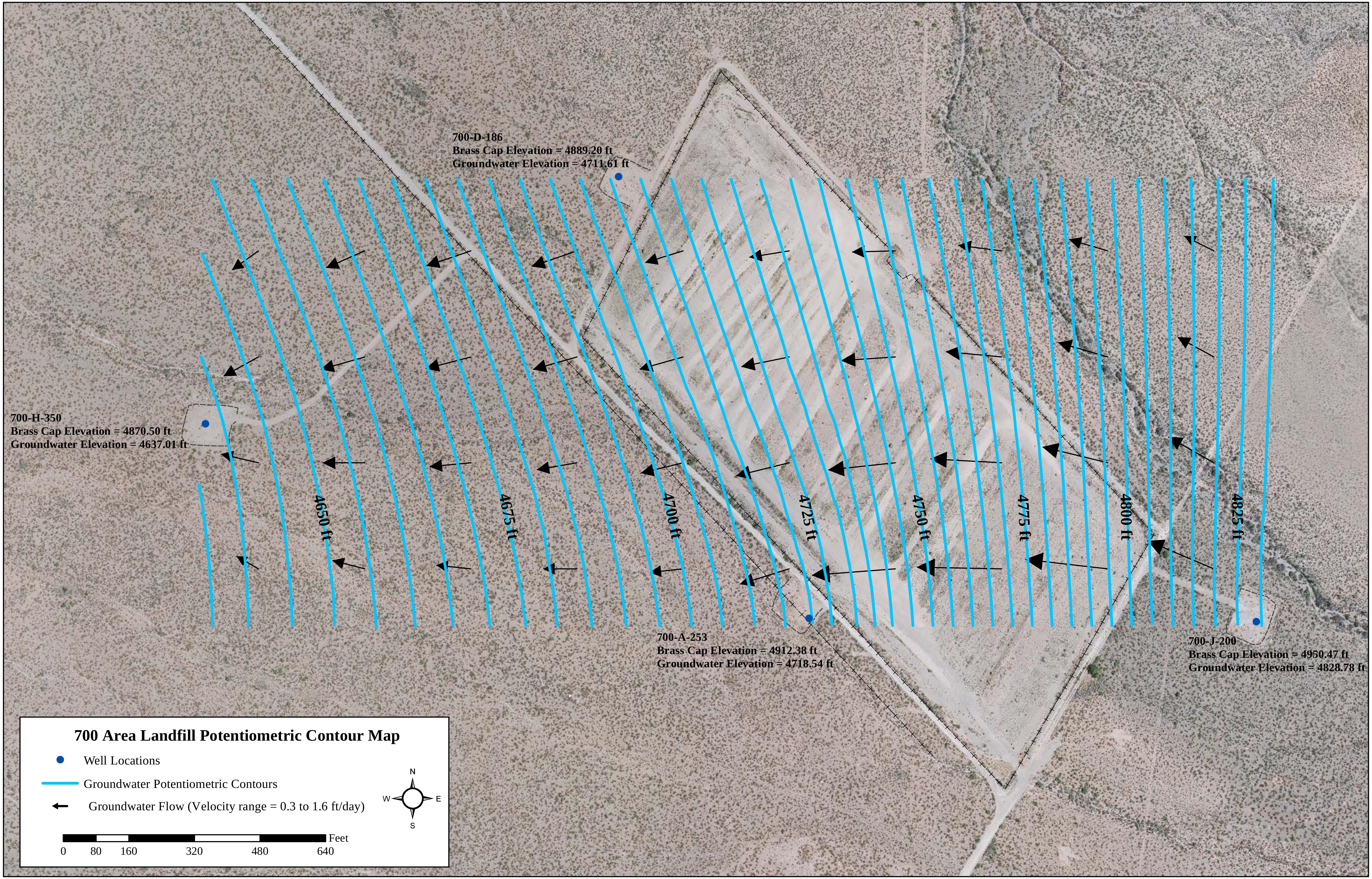
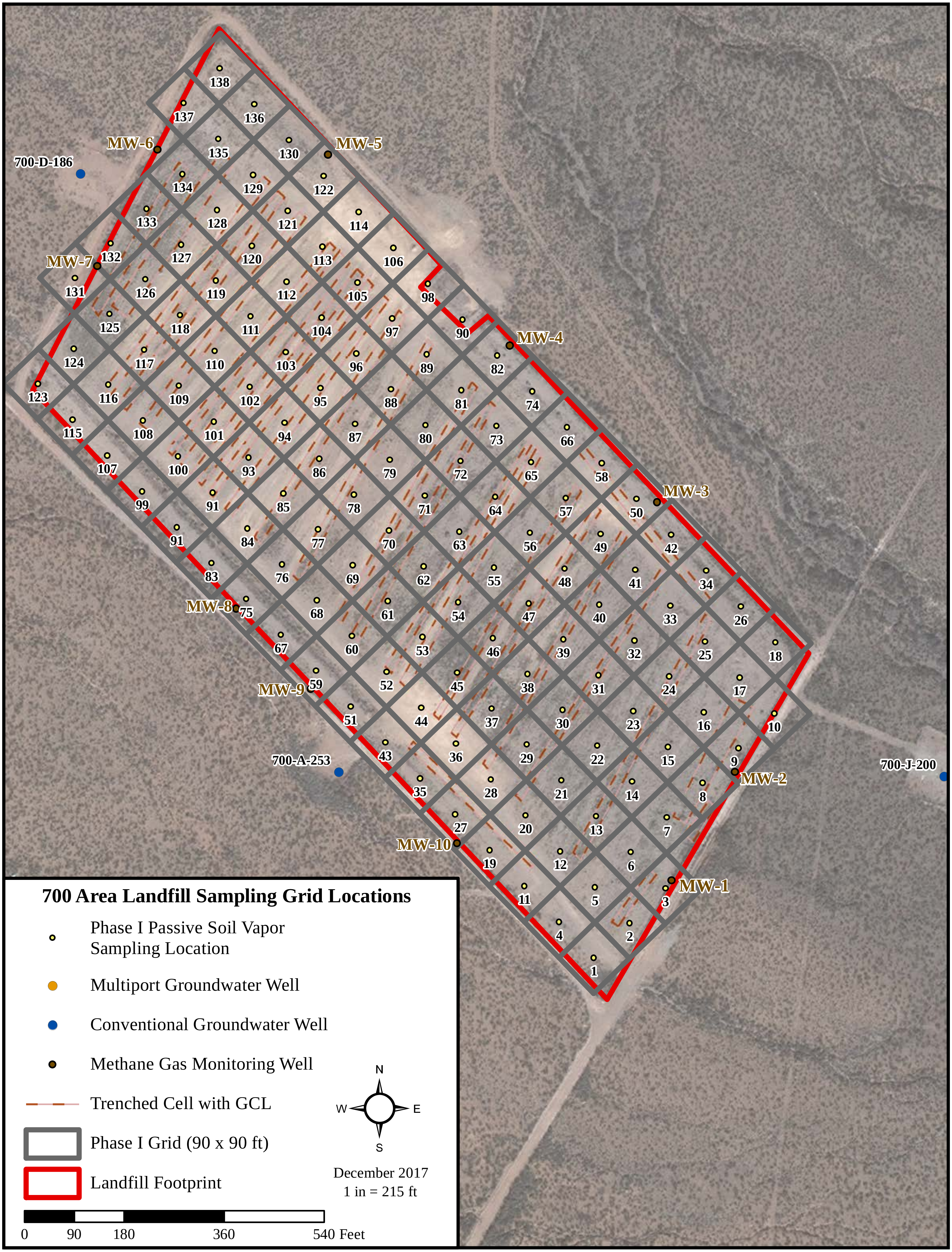

700-D-186
Brass Cap Elevation = 4889.20 ft
Groundwater Elevation = 4711.61 ft
700-H-350
Brass Cap Elevation = 4870.50 ft
Groundwater Elevation = 4637.01 ft
700-A-253
Brass Cap Elevation = 4912.38 ft
Groundwater Elevation = 4718.54 ft
700-J-200
Brass Cap Elevation = 4950.47 ft
Groundwater Elevation = 4828.78 ft
4650 ft
4675 ft
4700 ft
4725 ft
4750 ft
4775 ft
4800 ft
4825 ft
700 Area Landfill Potentiometric Contour Map
Well Locations
Groundwater Potentiometric Contours
Groundwater Flow (Velocity range = 0.3 to 1.6 ft/day)
N
W
E
S
Feet
0
80
160
320
480
640

Figure 4.1 **700 Area Landfill Base Survey Grid**

(SEE NEXT PAGE)


700 Area Landfill Sampling Grid Locations
Phase I Passive Soil Vapor Sampling Location
Multiport Groundwater Well
Conventional Groundwater Well
Methane Gas Monitoring Well
Trenched Cell with GCL
Phase I Grid (90 x 90 ft)
Landfill Footprint
0
90
180
360
540 Feet
N
W
E
S
December 2017
1 in = 215 ft
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
700-D-186
700-A-253
700-J-200

Tables

Table 2.1 List of Contaminants of Potential Concern for the 700 Area Landfill

Constituent	Sample Type
Asbestos	FIBROUS SILICATE
Chloride	ANION
Cyanide	CYANIDE
PCBs	CHLORINATED HYDROCARBON
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	DIOXINS/FURANS
Heptachlorodibenzo-p-dioxins (HpCDD), Total	DIOXINS/FURANS
Octachlorodibenzofuran (OCDF)	DIOXINS/FURANS
Octachlorodibenzo-p-dioxin (OCDD)	DIOXINS/FURANS
Hydrazine	HYDRAZINE
Monomethylhydrazine (MMH)	HYDRAZINE
Unsymmetrical Dimethylhydrazine (UDMH)	HYDRAZINE
Aluminum	METALS
Antimony	METALS
Arsenic	METALS
Barium	METALS
Beryllium	METALS
Boron	METALS
Cadmium	METALS
Calcium	METALS
Chromium (Total)	METALS
Chromium (VI)	METALS
Cobalt	METALS
Copper	METALS
Iron	METALS
Lead	METALS
Mercury	METALS
Molybdenum	METALS
Nickel	METALS
Potassium	METALS
Selenium	METALS
Silver	METALS
Strontium	METALS
Thallium	METALS
Tin	METALS
Uranium	METALS
Vanadium	METALS
Zinc	METALS
Bromacil	BROMACIL
N-Nitrodimethylamine	NITROSAMINES
N-Nitrosodimethylamine	NITROSAMINES
Nitrate	NITROGEN
Nitrite	NITROGEN
Perchlorate	PERCHLORATE
Bis(2-ethylhexyl) Phthalate	SVOA
Di-n-butyl Phthalate	SVOA
Diesel Range Organics	SVOA/TPH
1,1,1-Trichloroethane	VOA

Constituent	Sample Type
1,1,2-Trichloroethane	VOA
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	VOA
1,1-Dichloroethene	VOA
1,2-Dichloro-1,1,2-trifluoroethane (Freon 123a)	VOA
1,2-Dichloroethane	VOA
2,2-Dichloro-1,1,1-trifluoroethane (Freon 123)	VOA
2-Butanone (Methyl Ethyl Ketone)	VOA
2-Hexanone	VOA
2-Propanol	VOA
Acetone	VOA
Benzene	VOA
Bromodichloromethane	VOA
Bromoform	VOA
Chlorobenzene	VOA
Chloroform	VOA
Chloromethane	VOA
Dibromochloromethane	VOA
Dichlorofluoromethane (Freon 21)	VOA
Gasoline Range Organics	VOA/TPH
Methyl tert-Butyl Ether	VOA
Methylene Chloride	VOA
m-Xylene & p-Xylene	VOA
Oil Range Organics	VOA/TPH
Tetrachloroethene (PCE)	VOA
Toluene	VOA
trans-1,2-Dichloroethene	VOA
Trichloroethene (TCE)	VOA
Trichlorofluoromethane (Freon 11)	VOA

Table 3.1 700 Area Landfill and Vicinity Borehole and Well Completion Data

Borehole/Well and Type	Casing Elevation (ft amsl)	Depth to Bedrock (ft bgs)	Bedrock Type	Nov-2017 Depth to Groundwater (ft bgs)	Groundwater Elevation (ft amsl)	Screened Interval (ft bgs)	Borehole Total Depth (ft bgs)
300-D-153 Conventional	5112.82	75	Limestone	162.78	4950.04	153.10 – 173.80	194
700-A-253 Conventional	4912.38	149	Andesite	193.84	4718.54	253.00 – 263.40	287
700-B-510 Conventional	4809.57	285	Andesite	466.0	4343.57	510.00 – 530.84	550
700-D-186 Conventional	4889.20	180	Limestone	177.59	4711.61	186.00 – 196.30	205
700-E-458 Conventional	4722.01	285	Andesite	310.60	4411.41	458.10 – 478.90	515
700-F-455 Conventional	4767.67	305	Andesite	277.56	4490.10	455.0 – 475.03	526
700-G Abandoned Borehole	4779.19	260	Andesite	Dry	Dry	None	450
700-J-200 Conventional	4950.47	110	Hornfelsed Limestone	121.69	4828.78	199.64 – 219.68	240
700-H Westbay	4870.50	200	Andesite	264.77	4605.73	345.00 – 360.00 525.00 – 545.00 660.00 – 680.00	730
BW-6-355 Conventional	4818.71	238	Andesite	245.48	4573.23	355.00 – 375.53	401

National Aeronautics and Space Administration

SWMU 49, 700 Area Landfill Phase I Investigation Work Plan

Revised March~~December~~ 2019~~7~~

NM8800019434

NASA Johnson Space Center White Sands Test Facility

SWMU 49, 700 Area Landfill Phase I Investigation Work Plan

Revised ~~December 2017~~March 2019

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with 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.

____ ________________________

Timothy J. Davis — Date
Chief, NASA Environmental Office

National Aeronautics and Space Administration

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White Sands Test Facility
12600 NASA Road
Las Cruces, NM 88012
www.nasa.gov/centers/wstf

www.nasa.gov

Executive Summary

This investigation work plan (IWP) presents a planned Phase I field investigation at the National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF) 700 Area landfill, listed as Solid Waste Management Unit (SWMU) 49) in the New Mexico Environment Department (NMED) Hazardous Waste Permit (Permit; NMED, 2016). The 700 Area landfill was operational at WSTF between 1965 and 1997. A Notice of Intent (NOI) to close the 700 Area landfill was placed in the Operating Record on February 3, 1998, and NASA submitted the final closure certification to NMED on August 5, 1998 (NASA, 1998a). A post-Closure care (PCC) Plan for the 700 Area landfill was implemented on July 31, 1998, and is in effect for 30 years. The plan includes requirements for groundwater monitoring, soil vapor monitoring, PCC quarterly inspections and maintenance for landfill cover integrity, adequate drainage, fencing for the landfill boundary, and vegetative cover (NASA, 1999). NASA is currently reviewing potential options for an effective long-term solution for closure of the 700 Area landfill. The Permit (NMED, 2016) requires the development and submission of an IWP for the 700 Area landfill in conjunction with a historical information summary (HIS), to be submitted by December 29, 2017.

The proposed Phase I investigation will utilize non-invasive techniques that are designed to provide a detailed insight into the 700 Area landfill. The investigation will provide a conceptualization of the 700 Area landfill through a series of field surveys to evaluate: the distribution of volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH) in soil vapor (if present); the location and dimensions of waste disposal trenches; the location of metallic debris within the trench; and, additional information relative to subsurface geology with particular reference to the alluvial-bedrock interface. The investigation will provide supplementary information to support determination of the most effective strategy to mitigate potential future liability related to the landfill.

The Phase I investigation covers the area constituting the footprint of the 700 Area landfill, which is traversed by a standardized preliminary field survey grid constructed using 90-foot (ft) x 90-ft grid cells that will be utilized as the base grid for the shallow soil vapor and geophysical surveys. Individual survey lines will change in density depending on the type of survey performed. The detailed final grids will be developed in consultation with experienced subcontractors selected for each survey.

The Phase I investigation will focus on the shallow upper portion of the vadose zone that incorporates the 26 individual landfill trenches identified in the HIS (NASA, 2017e). Trenches were primarily excavated along the width of the landfill area in a northeast-southwest direction with reported dimensions of approximately 20 ft x 20 ft x 600 ft. In addition to the shallow vadose zone investigation, the deeper vadose zone in the vicinity of the alluvial-bedrock interface between 110 ft and 180 ft below ground surface (bgs) will be evaluated. The Phase I investigation survey methods will comprise a two-stage (Phase IA and IB) shallow soil vapor survey (SVS) and four geophysical surveys: an electromagnetic induction (EMI) survey; ground penetrating radar (GPR) survey; magnetic gradient survey; and, a passive seismic survey.

The Phase IA and IB SVS will be used to define the distribution of soil vapor VOCs and TPH in the shallow subsurface within the footprint of the 700 Area landfill. Phase IA will utilize a systematic grid approach based on 90-ft by 90-ft grid cells across the landfill footprint to identify preliminary targets of interest. In conjunction with the Phase IA survey, three geophysical surveys will specifically address the shallow subsurface: an EMI survey will be performed to establish spatial distribution of soil conditions within the landfill; a GPR survey will be performed to delineate the dimensions of landfill trenches; and, a magnetic gradient survey will be performed to locate and map the distribution of metallic objects. These surveys will utilize the baseline grid developed for the Phase IA SVS, with modifications made relative to line length and spacing (density). The final grids will be developed by geophysical subcontractors during the development of each field survey. A fourth geophysical survey will comprise a passive seismic survey that will be used to evaluate and improve conceptualization of the deeper vadose zone including the bedrock surface below the landfill. Following performance of the geophysical surveys, a supplemental Phase IB SVS survey will be performed that biases samples to specifically target the areas of greatest interest relative to potential soil vapor contamination within the landfill cells.

The Phase I investigation will be performed coincidentally with continuation of the ongoing PCC monitoring programs. The optimum strategy for 700 Area landfill closure will be determined based on the results of the Phase I investigative activities. If required, the scope of a supplemental Phase II investigation will be determined after completion of the Phase I investigation report (IR) and NMED's subsequent review and approval of the IR. The start date and schedule for the 700 Area landfill fieldwork is dependent on NMED approval of 700 Area landfill IWP and HIS. The proposed schedule requires that NASA submit the 700 Area landfill IR to NMED 360 days following approval of the 700 Area landfill HIS and IWP.

Table of Contents

List of Figures and Tables

List of Acronyms

°	Degrees
2-D	Two-dimensional
3-D	Three-dimensional
A-50	Aerozine-50
ASTM	American Society for Testing and Materials
ATV	All-Terrain Vehicle
BEHP	Bis(2-ethylhexyl) phthalate
bgs	Below Ground Surface
CME	Corrective Measures Evaluation
CoC	Chain-of-Custody
COPC	Constituents of Potential Concern
cu yd	Cubic Yard
EDD	Electronic Data Deliverable
EMI	Electromagnetic Induction
EPA	Environmental Protection Agency
ft	Feet/foot
GCL	Geosynthetic Clay Liner
GMP	Groundwater Monitoring Plan
GPR	Ground Penetrating Radar
GPS	Global Positioning System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HHF	Hardscrabble Hill Fault
HIS	Historical Information Summary
HSM	Health and Safety Manager
IDW	Investigation-Derived Waste
in.	Inch(es)
IPA	Isopropyl Alcohol
IR	Investigation Report
IWP	Investigation Work Plan
J	Estimated
JDMB	Jornada del Muerto Basin
MEK	Methyl ethyl ketone
mi	Mile(s)
mm	Millimeter
MMH	Monomethylhydrazine
N2O4	Nitrogen Tetroxide
NASA	National Aeronautics and Space Administration
NDMA	N-nitrosodimethylamine
NMED	New Mexico Environment Department
NOI	Notice of Intent
ODU	Open Detonation Unit
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyls
PCC	Post-Closure Care
PCE	Tetrachloroethene
PDF	Portable Document Files
PID	Photoionization Detector
PPE	Personal Protective Equipment

PSS	Passive Seismic Survey
QA/QC	Quality Assurance/Quality Control
R	Rejected
RCRA	Resource Conservation and Recovery Act
SAM	San Andreas Mountains
SCEM	Site Conceptual Exposure Model
SHP	Safety and Health Plan
SVOC	Semi-volatile Organic Compounds
SVS	Soil Vapor Survey
SWB	Solid Waste Bureau
SWMU	Solid Waste Management Unit
TBD	To Be Determined
TCE	Trichloroethene
TDS	Total Dissolved Solids
TPH	Total Petroleum Hydrocarbons
UDMH	Unsymmetrical Dimethylhydrazine
VOC	Volatile Organic Compounds
WSTF	White Sands Test Facility

1.0 Introduction

This investigation work plan (IWP) describes the approach for a planned investigation of the 700 Area landfill at the National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF; Figure 1.1). The 700 Area landfill is identified as Solid Waste Management Unit (SWMU) 49 in the New Mexico Environment Department (NMED) Hazardous Waste Permit (Permit; NMED, 2016). The WSTF 700 Area is located within the remote northeast part of WSTF (Figure 1.2). The 700 Area landfill has been described as a "modified landfill" (NASA, 1978), a sanitary landfill, and a "Class B landfill," which was "a sanitary landfill serving a population of less than 3,000" (NASA, 1991). The landfill was established to dispose of industrial and commercial non-hazardous waste.

The 700 Area landfill is located in Section 26, Township 20 South, Range 3 East and is a 24-acre trapezoid-shaped piece of land, with the long axis oriented northwest-southeast that was designed to contain solid waste for disposal within excavated cells or trenches. Access to the 700 Area is provided by gravel roads (Road P and Cereus Drive) from Apollo Boulevard, the main paved access road through WSTF (Figure 1.3). The 700 Area landfill was operational at WSTF between 1965 and 1997. Design and operational details for the landfill are provide in the Historical Information Summary (HIS; NASA, 2017e).

1.1 Objectives and Scope

The Phase I investigation is expected to improve conceptualization of the 700 Area landfill through the performance of a series of field surveys designed to identify the distribution of volatile organic compounds (VOCs) and total petroleum hydrocarbons (TPH), location and dimensions of landfill trenches, distribution of metallic objects, and additional information relative to the nature of the alluvial-bedrock interface in the subsurface. The investigation will provide supplemental information that is required to effectively address the primary objective of removing or mitigating potential future liability related to the landfill. The primary requirements for mitigating future liability are to: minimize exposure to site workers, the public, and wildlife; and, limit migration of contaminants to groundwater such that regulatory limits are not exceeded.

Final disposition of the landfill will be determined following the completion and evaluation of this Phase I field investigation. In the interim, NASA will continue with ongoing Post-Closure Care (PCC) activities until a decision is made based on consideration of the additional investigation results.

1.2 Regulatory Requirements

NASA submitted a Notice of Intent (NOI) to close the 700 Area landfill on February 3, 1998. The final closure certification was submitted to NMED on August 5, 1998 (NASA, 1998c). The Closure and PCC Plan for the 700 Area landfill was implemented on July 31, 1998, and is in effect for 30 years. The plan includes requirements for groundwater monitoring, soil vapor monitoring, PCC quarterly inspections and maintenance for landfill cover integrity, adequate drainage, fencing for the landfill boundary, and vegetative cover (NASA, 1998a).

The WSTF Resource Conservation and Recovery Act (RCRA) Hazardous Waste Permit (NMED, 2016) requires the development and submission of an IWP that addresses the upcoming work to be performed at this location. Initially, the due date for submittal of the IWP for SMWU 49 was December 30, 2015 (NMED, 2009). On November 17, 2015, NASA submitted a *Class 1 Permit Modification Request* (NASA, 2015) to the NMED HWB requesting a new due date for submittal of the IWP and HIS of December 29, 2017. NMED approved the Permit Modification Request on December 16, 2015 (NMED, 2015).

1.3 Landfill Closure and Post-Closure Care Monitoring

As part of the closure process, all the historical 700 Area landfill covered cells were located by trenching in April 1996 (HIS; NASA 2017c). Ten soil samples were also collected in the landfill prior to April 15, 1996 to evaluate natural WSTF clay in preparation for closure. In May 1996, NASA decided to use a geosynthetic clay liner (GCL) instead of local WSTF clay to ensure the proper low hydraulic conductivity barrier required.

NASA submitted the Landfill Closure and PCC plan to NMED on July 5, 1996 (NASA, 1996). The closure plan provided landfill survey details: "The 26 cells were located and surveyed utilizing the following methods: survey data resurrection; trenching using a backhoe and ripper; site investigations of observed settling; aerial photographs; and interviewing WSTF employees familiar with early landfill operations." Figure 1.4 shows the identified cells within the landfill. "The area of cells requiring cover within the 24.32 acres is estimated to be 173,046 square feet (ft^2; 3.97 acres)." NMED Solid Waste Bureau (SWB) personnel provided NASA with Environmental Protection Agency (EPA) computer software that was used to demonstrate the performance of the landfill cover and liner that were included in the 700 Area landfill Closure Plan. The final cover consisted of the GCL positioned between two 2-inches (in.) layers of select fill (screened to 1/4 in. and less in diameter) above and below to prevent any large rocks from damaging its integrity. The select fill and approximately 10 in. of uncompacted screened local material (topsoil) was used to complete the cover (NASA, 1996).

The Landfill Closure and PCC plan was approved by NMED SWB on August 22, 1997 (NMED, 1997a). From the solid waste annual report submitted to NMED; "NASA continued to transfer the majority of WSTF- generated solid waste off site by utilizing an independent contractor…" (NASA, 1998a). By November 1997, NMED personnel indicated in a landfill inspection that the landfill was no longer receiving any solid waste, that NASA was in the process of bidding package preparation for actual closure, and that waste was being picked up by Silva Sanitation (NMED, 1997b). An NOI to close the 700 Area landfill was placed in the Operating Record on February 3, 1998, and NASA submitted the final closure certification to NMED on August 5, 1998 (NASA, 1998b). Closure activities were conducted by a subcontractor and included:

- Shaping, grading, and compacting the landfill cells and area;
- Constructing berms and a drainage channel;
- Installing the GCL over each cell area on Figure 1.4 positioned between two 2-in. layers of selected fill;
- Installing 10 in. of topsoil;
- Completing final grading;
- Fencing the landfill; and
- Reseeding the landfill area.

The PCC Plan for the 700 Area landfill was implemented on July 31, 1998, and is in effect for 30 years. NMED officially approved the implementation of the PCC plan on August 14, 1998 (NMED, 1998). At this time, NMED personnel conducted a landfill closure inspection and observed no violations (NMED, 1998). The plan includes requirements for groundwater monitoring, soil vapor monitoring, PCC quarterly inspections and maintenance for landfill cover integrity, adequate drainage, fencing for the landfill boundary, and vegetative cover.

Since landfill closure, WSTF has performed quarterly inspections, semi-annual groundwater monitoring, and annual methane gas monitoring as part of the regularly scheduled PCC of the 700 Area landfill. Landfill inspections have identified occasional issues with the closure cap, resulting in the need to perform closure cap maintenance such as vegetation removal or repair of the closure cap. NASA provides the details of landfill closure cap repairs to the NMED SWB following each cap repair. The most recent report was submitted on June 1, 2017 (NASA, 2017c) and deemed in compliance by the SWB on July 7, 2017 (NMED, 2017). The results of groundwater detection monitoring are provided in semi-annual reports to the SWB, most recently on December 20, 2017 (NASA, 2017d). The results of annual methane monitoring are provided to the SWB in each Solid Waste Management Annual Report. NASA submitted the most recent annual report, for calendar year 2016, to the SWB on February 13, 2017 (NASA, 2017a).

2.0 Background

2.1 Operational History

The WSTF 700 Area landfill began operation between 1963 and 1965; the last waste was received on October 27, 1997 (HIS; NASA 2017c). NASA registered the 700 Area landfill with the New Mexico Environmental Improvement Division on October 19, 1978. The specific wastes and their quantities disposed in the landfill are not well documented, although evidence of the nature of the waste is available in spill reports and employee interviews for the deposition of hazardous substances.

Prior to the 1985 establishment of a full-time Environmental Department at WSTF, the only wastes shipped off site for disposal were vehicle batteries (1963 to present) and polychlorinated biphenyls (PCBs; 1980 to present). Any wastes generated at WSTF prior to 1985, including hazardous wastes, were disposed of on site. In general, liquid wastes were managed in surface impoundments and solid wastes were disposed of in the 700 Area landfill. Older cells installed prior to 1985 on the southeastern half of the 700 Area landfill are more likely to have been associated with the disposal of hazardous wastes (HIS; NASA 2017c).

2.2 Operations and Potential Wastes

The operations performed at the 700 Area landfill between 1963 - 1997 can be summarized as follows:

- For the years 1963 – 1985 there were no requirements for landfill waste management documentation, therefore uncertainty exists regarding the type and amount of “hazardous” waste disposed.
- For the years 1985 – 1997 landfill waste management documentation was required and “hazardous” waste disposal was mitigated.
- The exact total volume of waste at the landfill is unknown. The total volume of waste within the landfill has been estimated as 78,000 cubic yards (cu. yd.) within the HIS (NASA, 2017e), based on an estimate of 3,000 cu. yd. per cell and 26 total cells that were surveyed. This volume is approximated as the cells are not all uniform in size, and the survey may not have identified all cells.
- Office and construction waste comprised the majority of the waste.

Based upon information gathered for the HIS (NASA, 2017e), the following non-hazardous wastes are, or potentially could be, present at the landfill:

- Non-hazardous laboratory waste.

- Office waste.
- Scrap wood.
- Yard waste.
- Cafeteria waste.
- Animal carcasses.
- Drilling mud, additives, and cuttings

Based upon information gathered for the HIS (NASA, 2017e), the following hazardous wastes or hazardous constituents are, or potentially could be, present at the landfill (likely disposed of prior to 1985)

- Ash (in situ from trash burned in cells).
- Explosives residue.
- Infectious waste (sharps, blood, etc.).
- Chemical or petroleum contaminated soils (lead, benzene, arsenic, cadmium, chromium, solvents).
- Contaminated debris (such as soft goods, hardware, and clean-up materials) contaminated with fuels (unsymmetrical dimethylhydrazine [UDMH], Aerozine-50 [A-50], monomethylhydrazine [MMH], and hydrazine), and oxidizer (nitrogen tetroxide [N2O4]), also unused or off-spec containers of the above.
- All 200 Area laboratory chemicals (e.g., Trichlorofluoromethane [Freon 11], 1,1,2-Trichloro-1,2,2-trifluoroethane [Freon 113], trichloroethene [TCE], tetrachloroethene [PCE], other solvents, isopropyl alcohol [IPA], other alcohols, acetone, methyl ethyl ketone [MEK], phosphorus, etc.).
- Hydrocarbons (e.g., diesel, gasoline, hydraulic fluid, lubricating oils, motor oils, etc.).
- Teflon grease.
- Mercury (from lamps and soft goods from spill cleanup).
- Small amounts of metals (stainless steel, carbon steel, titanium, aluminum, iron, mercury, copper, tin, gold, silver, chromium).
- Fluorescent lights (lead, cadmium, mercury) and ballasts (containing PCBs).
- Asbestos containing construction debris and insulation.
- Paints and primers (chromium, lead, barium, benzene, MEK, ignitable wastes).
- Epoxies, resins, oils, adhesives, plastics, caulking, floor finish (solvents; possibly containing PCBs).
- Batteries (corrosive, lead, cadmium).
- Photographic papers/negatives (silver [silver bromide]), etching plates (copper, metals).
- Automotive wastes (tires, brake parts, filters, antifreeze, and used oil).
- Aerosol cans (barium, benzene, MEK, TCE, PCE, ignitable, corrosive, reactive wastes).
- Broken or inoperable equipment/meters (metals, possibly asbestos and PCBs).
- Pipes/plumbing (metals).

2.3 Previous Monitoring Results

Details of previous groundwater and methane monitoring data for the 700 Area landfill is provided in ~~in~~ the HIS (NASA, 2017e). In October 1994, NASA submitted a landfill groundwater monitoring system plan that was subsequently approved by NMED. On July 28, 1997, NASA provided analytical data, compliance status, and statistical analyses for constituents detected above background levels or assessment monitoring levels (AMLs) for the 700 Area landfill. Constituents listed were Freon 113, fluoride, total dissolved solids (TDS), sulfate, and Bis(2-ethylhexyl) phthalate (BEHP). NASA reported that Freon 113 concentrations were statistically above background levels in well 700-A-253; however, Freon 113 was not a listed hazardous constituent. BEHP was reported as the only hazardous constituent statistically above the AML in well 700-A-253.

Following a request by NMED to initiate an assessment monitoring program, NASA submitted a 700 Area Solid Waste Landfill Monitoring Well Installation and Groundwater Characterization Work Plan on January 19, 1999 (NASA, 1999). The groundwater sampling plan included sampling wells 700-A-253, 700-D-186, 700-B-510, 700-E-458, 700-F-455, BW-6-355, newly proposed 700 Area wells 700-H, and 700-J-200, and upgradient well 300-D-153. NASA concurrently conducted a BEHP investigation of other groundwater monitoring wells at WSTF and of fluids used in drilling groundwater wells. Evaluations of monitoring well data indicated that the BEHP detections had poor correlation to other contaminant plume profiles observed at WSTF. NASA installed dedicated sampling equipment in the 700 Area groundwater monitoring wells at WSTF, and BEHP concentrations dropped. BEHP and other phthalates were also detected in drilling fluids commonly used for well installation at the time.

In March 2000, NASA requested to return to detection monitoring at the 700 Area landfill from assessment monitoring (NASA, 2000), which was approved by NMED (NMED, 2000). Freon 113 continues to be detected at low levels within groundwater monitoring well 700-A-253 and at higher levels in 700-D-186; however, this constituent does not require assessment monitoring since Freon 113 is not listed as a hazardous constituent in the NMAC regulations. In February 2011, cadmium was detected at 0.0031 mg/L and confirmed at 0.003 mg/L in May 2011 above the AML of 0.0025 mg/L. At NMED's request, NASA provided a cadmium time-concentration graph to determine if cadmium concentrations were increasing over time. Cadmium concentrations have fluctuated from not detected to above the AML since 2011. Other constituents such as sulfate and TDS are detected above AMLs in 700 Area groundwater monitoring wells. NASA has provided information to the SWB that allowed for the determination that these constituents are from a source other than the landfill.

NMED personnel determined that NASA should begin methane monitoring during a 700 Area landfill closure consultation in February 1995. In preparation for landfill closure, ten methane monitoring wells were installed around the landfill perimeter (Figure 1.4). Each monitoring well consists of a 7-ft long, 1.25-in. diameter well point with 30 in. of #60 mesh screen set into a 6-ft deep, 4-in. diameter augured hole with a sand pack and bentonite seal.

Methane monitoring of the permanent landfill methane gas wells (MW-1 through MW-10) was conducted quarterly from 1996 to 1999. All results from these methane gas sampling events were non-detect (<5.0 ppm methane). On January 21, 1998, there was one detection of methane gas in well MW-5 of 7.6 ppm. In April 1998, all wells were measured at 0% LEL except MW-5, which could not be located following placement of the closure cap. Well MW-5 was apparently destroyed during cover and closure activities. WSTF facilities personnel repaired the well by removing the dirt from the pipe, installing an additional joint of pipe for well stick-up, filling the annulus to surface with bentonite. The concentration of methane was then measured at 0%. NMED also approved changing the methane monitoring frequency from quarterly to annually. Between October 1999 and December 2016 methane has not been detected at the 10 landfill methane monitoring wells. Methane monitoring results are provided to the SWB in the annual report (NASA, 2017a)

2.4 Preliminary Site Conceptual Exposure Model

A preliminary site conceptual exposure model (SCEM) was developed to provide an understanding of the potential for exposure to hazardous contaminants at the sites based on the source of contamination, the release mechanism, and the exposure pathway(s) as these relate to residential, industrial and construction exposure scenarios. Figure 2.1 summarizes and presents the SCEM in diagram form. Incomplete exposure pathways are denoted by dashed lines to potential receptors, and complete exposure pathways are denoted by solid lines.

2.4.1 Contamination Sources

The potential contamination sources ~~under investigation in the IWP~~ are hazardous materials that may have been disposed of in the 700 Area landfill (Section 2.2). Table 2.1 provides a comprehensive list of preliminary contaminants of potential concern (COPC) that may have been disposed of in the 700 Area landfill based on the operations and potential wastes identified in Section 2.2, and the lists of COPC generated for other test areas at WSTF (primarily the 200, 300, and 400 Areas). This represents the list of contaminants that may be contained within the 700 Area landfill closure cells; however, the list of constituents under investigation for the Phase I IWP are limited to VOCs and TPH for the shallow soil vapor survey (Sections 4.0 and 5.0). During this Phase I investigation, the area covered by the landfill footprint (Figure- 1.4) will be investigated using a variety of survey methods.

2.4.2 Release Mechanisms

Contamination can potentially be released from the landfill through the individual trenches that were used as a shallow repository for the waste materials. Waste materials may have been transported deeper into the vadose zone, and possibly groundwater, through leaching promoted by precipitation and infiltration.

2.4.3 Exposure Pathways

Four potential landfill exposure pathways are listed: 1) ingestion of groundwater; 2) incidental ingestion of soil or waste materials; 3) inhalation of volatile contaminants or particulate emissions (dust); and 4) dermal contact with soil or waste materials. There are no current or future residential land use scenarios anticipated in the vicinity of the 700 Area landfill. WSTF is a controlled test site located on the U.S. Army White Sands Missile Range and there are no encroaching residential areas. Therefore, there are no complete exposure pathways identified for the residential exposure scenario in this SCEM (Pathways 1, 2, 3, and 4).

The groundwater underlying much of WSTF is known to be contaminated and its future use and potential risk to receptors are part of an ongoing site-wide evaluation and corrective actions. The only water supply wells for the site are located several miles to the west and down hydraulic gradient from the 700 Area landfill. The supply wells are monitored regularly for the presence of any site-source contaminants. A risk assessment of the groundwater itself will not be conducted as part of this Phase 1 investigation. Ingestion of groundwater (Pathway 1) is not considered a completed exposure pathway for the residential, industrial, or construction worker exposure scenarios.

The landfill materials remain intact in the shallow subsurface in the 700 Area. Since the materials exist underground, and have been covered with a Closure cap the exposure pathways of potentially contaminated soil or waste materials (ingestion, inhalation, dermal) for the industrial exposure scenario is not considered complete (Pathways 2, 3, and 4).

Environmental Department field technicians (Construction Workers) will be performing a passive soil vapor survey during this investigation, which includes the installation of shallow soil vapor probes to depths of 2 to 3 ft below ground surface (bgs). A potential exposure pathway exists for that population to ingest, inhale, or come into dermal contact with potentially contaminated soil (Pathways 2, 3, and 4). This potential exposure will be mitigated by the use of personal protective equipment (PPE) during the shallow soil boring and sampling activities.

2.4.4 Potential Receptors

The Phase I investigative activities will include a limited shallow subsurface investigation that will provide complete release and exposure mechanisms to field scientists and technicians (construction workers). NASA will utilize procedures detailed in Section 5.8 to mitigate construction worker exposure.

3.0 Site Conditions

3.1 700 Area Landfill Closure Description

The 700 Area landfill is an approximately 24-acre (reported as 24.32 acres in the Closure Plan [NASA, 1996]) trapezoid-shaped piece of land, with the long axis oriented northwest-southeast, designed to contain solid waste for disposal within excavated cells or trenches, and has a trench depth between 14 ft and 20 ft (Figure 1.4). The design capacity of the landfill is estimated at between 55,044 cu yd to 72,000 cu yd with a ratio of waste to cover material of 8.5 to 1. The total volume of the 700 Area landfill has been estimated as 78,000 cu yd, based on an average estimate of 3,000 cu yd per cell and 26 total cells that were surveyed and covered during closure (HIS; NASA 2017c). The average waste volume estimate takes into account the variability in trench dimensions and estimates from the landfill operators that 20 percent of the cell volume consists of natural soil, at least two feet of which is final cover.

The Open Detonation Unit (ODU) was a ramped open trench used for waste explosives treatment and disposal operations, It was located adjacent to the northeast side of the 700 Area Landfill Closure (Figure 1.4). The dimensions of the unit were 46 ft by 9 ft by up to 6 ft deep. The unit began operation in 1987 and was under interim status until the unit was permitted in 1993. The most recent waste disposal activity at the RCRA-permitted ODU was performed on March 23, 1999. In late 1999, NASA decided to permanently close the unit. Closure activities originally began on August 20, 2002. NMED approved the clean closure of this unit on August 12, 2005 (NMED, 2005). Disposal of excavated soil from the original ODU closure occurred on January 19, 2006. Final ODU backfill activities began on March 2, 2006 and were completed on March 3, 2006. NMED regulatory personnel inspected the closure on March 7, 2006 (NASA, 2006).

3.2 Surface Geology

The surface geology at the 700 Area landfill consists of Quaternary piedmont slope facies of the Camp Rice Formation. The Camp Rice represents part of the widespread upper Santa Fe Group alluvium (Seager, 1981) derived from the adjacent San Andres Mountains (SAM) to the east. The piedmont slope deposits comprise coalescent alluvial fans that originated from Bear Canyon, a major east-west-trending transverse canyon in the southern SAM located 1 mile (mi) east southeast of the 700 Area landfill.

Santa Fe Group alluvial deposits comprise variably sized gravel clasts within a sand, silt and clay sized matrix. The alluvium is consolidated to unconsolidated, poorly sorted and locally contains discontinuous cemented caliche horizons a few inches in thickness. The most proximal outcropping lithologic units are located approximately 1 mi to the east southeast in the Bear Canyon area and comprise Pennsylvanian to Permian age limestone, sandstone, siltstone and shale.

3.3 Subsurface Geology

3.3.1 Stratigraphy

Unconformably overlying older Santa Fe Group alluvium in the vadose zone is the Quaternary alluvium of the Camp Rice Formation and younger piedmont slope alluvium. These younger alluvial units are syntectonic with a period of younger Basin and Range faulting. Several subsurface faults in the vicinity of the landfill have been inferred from seismic and well log data (Reynolds, 1988; Maciejewski, 1996; NASA, 1996).

Bedrock lithology in the vicinity of the 700 Area landfill comprise lower units of Permian Hueco Limestone and Tertiary (Eocene or Oligocene) Orejon Andesite (Seager, 1981) that consists of purple or green ash-flow tuffs and lava flows. The Permian Hueco Limestone and Tertiary Orejon Andesite bedrock are juxtaposed across inferred fault contacts. The bedrock surface below the 700 Area landfill forms an eroded and relatively flat bedrock pediment surface, based on existing borehole lithological and geophysical data. The bedrock surface decreases in elevation and increases in depth bgs from east to west across the landfill from 110 ft (well 700-J-200) to 180 ft (well 700-D-186).

3.3.2 Structure

Two styles of geologic deformation are present in the vicinity of the 700 Area landfill. The oldest and less prevalent deformation consists of west to northwest-trending folding and faulting associated with the Late Cretaceous to Early Tertiary Laramide Orogeny. This compressional deformation style is present east of the 700 Area landfill, exposed along Bear Canyon, and defined by Seager (1981) as the Bear Peak Fold and Thrust Zone. Thrust faults of the Bear Peak Fold and Thrust zone are interpreted to extend northwestward along strike in the subsurface and pass north of the northern boundary of the landfill. The second and more recent deformational style consists of extensional northwest-trending Late Tertiary Basin and Range normal faulting. The local expression of this structural style is the Rio Grande Rift. Basin and Range normal faulting began in the Rio Grande Rift between 26 and 32 million years ago (Seager, 1981).

Based on available borehole information, deformation near the landfill appears to be limited to Basin and Range normal faulting. Two inferred normal faults that strike northwest are located in the vicinity of the landfill with displacements of approximately 50 ft that downfault a small block of Tertiary Orejon andesite bedrock into Paleozoic limestone bedrock (Hueco Formation) at depth below the 700 Area landfill. Paleozoic limestones are located on the northeast and southwest sides of the fault block (intercepted by wells 700-J-200 and 700-D-186, respectively). Adjacent and to the west of the landfill, a third normal fault (potentially the extension of the Hardscrabble Hill Fault [HHF]) significantly drops the Paleozoic limestone to depth below the base of well 700-H installed in andesite by at least 530 ft as indicated by the thickness of andesite intercepted. The lack of surface expressions of normal faulting in the vicinity of the landfill suggests that the inferred subsurface normal faults near the landfill are related to an early period of extensional basin-range faulting, with beveling of the surface before deposition of the alluvium.

3.3.3 Geological Interpretation

Line of cross-section A-A' is presented in plan view in Figure 3.1, and extends southeast to northwest between WSTF upgradient well 300-D-153 (located 6,000 ft southeast of the landfill) and well 700-B-510 (located 3,500 ft west of the 700 Area landfill). Figure 3.2 presents the geological cross-section along line A-A'. Individual borehole and well completion characteristics of the wells in the vicinity of the 700 Area landfill are provided in Table 3.1. The surface elevation for the wells listed in Table 3.1 decreases from east to west moving down topographic gradient from the SAM into the southern Jornada del Muerto Basin. The elevation of bedrock also decreases from east to west in the direction of dip of the pediment slope. The bedrock surface appears to be relatively smooth and beveled through erosion, evidenced by existing boreholes installed in the area that do not suggest significant offset of the bedrock surface.

Between wells 300-D-153 in the 300 Area and 700-J-200 east of the 700 Area landfill, bedrock comprises micritic limestones of the lower member of the Permian Hueco Formation that predominantly strike N5°E to N45°E and dip 28° to 42° to the northwest based on surface outcrops in the 300 Area. These bedding plane attitudes may continue below the landfill unless the area is affected by the Laramide faulting documented in the Bear Canyon area by Seager (1981). Well 700-J-200, located approximately 500 ft east of the landfill, intercepts strongly hornfelsed (metamorphosed) limestone bedrock within the upper 60 ft, which becomes argillaceous and unaltered at depth.

Well 700-A-253, located adjacent to the landfill on the south side, intercepts 60 ft of Tertiary Orejon Andesite bedrock that overlies micritic limestone of the Hueco Formation. The microcrystalline texture of this andesite suggests a chilled margin to a volcanic flow or intrusive body, and this unit is inferred to be responsible for the metamorphism of hornfelsed limestone at well 700-J-200. Further northwest of the landfill along A-A', micritic limestone bedrock of the Hueco Formation is again intercepted at well 700-D-186 located adjacent and west of the landfill. The reoccurrence of limestone bedrock is inferred to be related to a faulted and uplifted horst block. The 700-D-186 limestone is reported to be well fractured from lithologic descriptions.

Westbay®[1] multiport well 700-H, located approximately 1,000 ft downgradient (west) of the landfill, was installed within a borehole drilled to 730 ft bgs. Andesite bedrock was intercepted at 200 ft bgs and continued to the total depth of drilling, a thickness of 530 ft. A significant fault contact is therefore inferred between wells 700-D-186 and 700-H west of the landfill that juxtaposes the Hueco Limestone and the Orejon Andesite. As a result of the significant displacement evidenced by the absence of limestone bedrock at well 700-H, the fault may represent a northern continuation or splay of the HHF, a north to northwest-trending regional fault with up to a few thousand feet of inferred displacement. The HHF is exposed at surface on Hardscrabble Hill approximately 4 mi south of the landfill. The structure is not observed on shallow seismic cross-sections due to the erosion and beveling of the bedrock pediment surface subsequent to faulting.

3.3.4 Hydrogeology

The aquifer in the vicinity of the 700 Area landfill is hosted within the Paleozoic limestone and Tertiary andesite bedrock, typically at depths up to 30 ft below the bedrock surface. There is little to no primary porosity in the bedrock; therefore, any porosity and groundwater flow is within secondary bedding solution channels and fractures within the limestone, and secondary fractures within the andesite induced through structural episodes. Monitoring wells in the vicinity of the 700 Area landfill (700-J-200, 700-A-

[1] Westbay is a registered trademark of Nova Metrix Ground Monitoring (Canada) Ltd.

253, 700-D-186, 700-H, and 700-B-510; Table 3.1) are screened below the static potentiometric surface in order to maximize groundwater flow from fractured zones. The groundwater monitoring system near the landfill consists of one upgradient well (700-J-200), two landfill PCC point-of-compliance wells located at the landfill boundary (700-A-253 and 700-D-186), and two downgradient wells (700-H and 700-B-510). The wells are conventional single screen wells and are located in the uppermost aquifer with the exception of 700-H, which consists of three Westbay sampling ports designed for vertical characterization along a deeper aquifer profile. The details of these well construction designs are discussed in the site-wide Groundwater Monitoring Plan (GMP; NASA, 2017b).

The screened intervals within the 700 Area groundwater monitoring wells were placed at the uppermost intervals where lithologic and geophysical log information identified the presence of secondary porosity fracture zones capable of generating sufficient water for collection of groundwater samples. Monitoring wells screened at the potentiometric surface do not always yield sufficient amounts of groundwater for samples, and may become dry during low recharge periods. The position of these zones with respect to the static potentiometric surface in the vicinity of the landfill is variable (Table 3.1).

Groundwater flow in the vicinity of the 700 Area landfill is from east to west based on the latest (November 2017) groundwater depth measurements (Figure 3.3). The relatively steep groundwater gradient in the area is approximately 0.1 ft/ft, promoted by the significant decline in surface topography and the bedrock pediment along the western SAM pediment slope (NASA, 2017b). Groundwater flow in this area is calculated to have a velocity of 0.3 to 1.6 ft per day. The volume is however restricted based on low hydraulic conductivities within the aquifer determined from slug testing at monitoring wells 700-H and 700-B-510, and observations from the dry borehole installed at the 700-G location.

4.0 Scope of Activities

Field activities planned for this Phase 1 investigation focus on: evaluating the distribution of VOCs and TPH (if present) in shallow soil vapor below the landfill cap; refining the location and orientation of individual trenches within the landfill; acquiring additional information relative to the metallic objects and their distribution within the landfill trenches; and, improving the conceptualization of the bedrock surface below the landfill. The Phase I investigation is expected to achieve these objectives utilizing the following techniques:

- Shallow soil vapor survey (SVS): to evaluate the distribution of soil vapor VOCs and TPH that may be emanating from landfill contents;
- Electromagnetic induction (EMI) survey: to establish spatial distribution of soil conditions, primarily the disturbed areas below the landfill Closure cap;
- Ground penetrating radar (GPR) survey: to further delineate the locations and dimensions of individual landfill trenches and to identify the location of metallic objects;
- Magnetic gradient survey: to locate and map the distribution of metallic objects of significant size; and,
- Passive seismic survey: to improve conceptualization of the alluvial-bedrock interface below the landfill, including displacement of the bedrock that may represent faulting.

The Phase I investigation will employ a preliminary standardized survey grid that utilizes 90 ft x 90 ft cells (Figure 4.1). Each survey method will utilize this grid as a starting point in developing the line densities for the final grid that will be based on the method requirements and primary objectives of the survey. In order to meet the technical requirements of each survey method and to provide the best quality data from each survey, specific survey grids will be established in consultation with the subcontractor selected during the competitive procurement process.

The Phase I investigation is not expected remove long-term environmental liability created by the continued presence of potential hazardous wastes or hazardous constituents in the landfill; however, it will provide essential information pertaining to evaluation of the scenarios for final landfill disposition. Improvement of the waste characterization through the Phase I investigation will support the landfill evaluation process and streamline decisions to improve the cost effectiveness of future investigation or potential corrective actions at the landfill.

4.1 Problem Statement

The problem statement is summarized in the Permit (NMED, 2016; Section VII.H.1.b), which states that the IWP "…shall include schedules for implementation and completion of specific actions necessary to determine the nature and extent of contamination and the potential migration pathways of contaminant releases to the air, soil, surface water, and ground water." The Phase I investigation initiates this process and serves to enhance the information available to support future actions at the 700 Area landfill.

4.2 Decision Statement and Alternative Actions

The primary decision is whether additional corrective actions are warranted at the 700 Area landfill due to the presence of a residual contamination source(s). Alternative actions for the decisions include:

- Consider a "Corrective Action Complete" status determination.
- If a "Corrective Action Complete" status determination cannot be made using the information obtained during the investigation, determine if further investigation of the unit is required.
- Perform a corrective measures evaluation (CME) for the site(s) to identify remedial options for mitigation of source(s) of continuing contamination (if required).

4.3 Decision Inputs

~~Contaminants of potential concern (~~COPC~~)~~ concentrations measured in the vadose zone soil and local groundwater are the primary inputs to the decision. Wastes or hazardous constituents potentially present at the landfill that were likely disposed of prior to 1985 (Section 2.2) were identified using two primary information sources:

- Detailed information pertinent to the establishment and operational history of the 700 Area landfill documented in the HIS (NASA, 2017e) through a variety of historical documents and reports, personnel interviews, and personnel questionnaires.
- Analytical data sets for samples collected during previous investigations at WSTF test areas in that generated materials potentially disposed of in the 700 Area landfill, including soil, soil vapor, and groundwater samples.

~~Information generated during this investigation will support further decision-making should additional investigation or corrective action be deemed necessary.~~The qualitative data collected for the 700 Area Landfill Phase I investigation will be used to support development of a 700 Area Landfill Phase II Work Plan. The Phase II Work Plan will address future management of the 700 Area landfill closure and the strategy for the collection of quantitative subsurface contamination data.

4.4 Study Boundaries

The horizontal boundaries of the study represent the known footprint of the 700 Area landfill as determined by photography, historical research, and field surveys of the site (Figure 1.4). This investigation specifically addresses the area contained within the footprint of the 700 Area landfill, and immediately adjacent areas as necessary.

The vertical boundaries of the study primarily represent the shallow vadose zone that incorporates the 26 known landfill trench locations. Most of the trenches were dug along the width of the landfill area (NE-SW) with maximum planned dimensions of 20 ft x 20 ft x 600 ft. Several trenches are positioned in the long dimension, along the outside edges of the landfill but within the footprint. The average depth of the cells has been reported to be 14 ft (HIS; NASA 2017c). The overall depth for the investigation will be refined and potentially increased using the results of passive seismic survey. Using an extension of the grid lines on the standard grid (Figure 4.1), the passive seismic survey will be used to expand the investigation to a depth that incorporates the alluvial-bedrock interface at between 110 ft and 180 ft bgs.

5.0 Investigative Methods

5.1 Survey Grid

The survey grid provided in Figure 4.1 will be used to guide data collection efforts during the Phase 1 investigation. Global positioning system (GPS) coordinates will be recorded for the intercepts along each grid line and the shallow SVS sampling locations using Trimble satellite tracking system equipment to an accuracy of approximately 8 millimeters (mm; 0.3 in.) horizontally and 15 mm (0.59 in.) vertically. To simplify coverage of the 700 Area landfill, the principal (long) axis of the SVS grid was oriented northwest-southeast, parallel to the principal axis of the landfill (Figure 4.1). SVS grid traverses were oriented perpendicular to the principal axis in a northeast-southwest direction. Each grid point will be staked and flagged in the field in preparation for shallow boring installation. This survey grid will be used as the basic grid for the shallow SVS and the geophysical surveys, however grid coverage or line density will be modified as necessary to accommodate the technical and data quality requirements of each survey. Specific survey grids will be established in consultation with the subcontractor selected during the competitive procurement process.

5.2 Shallow Soil Vapor Survey

Shallow SVS sampling will be performed using soil vapor sample modules installed in shallow soil borings in two separate phases designed so that results from the first phase (Phase IA) can be used to help define the second phase (Phase IB). In the event that selected soil properties (e.g. porosity and moisture) are required by the soil vapor analytical laboratory as part of the analytical process, selected soil samples will also be collected from the soil placed on top of the GCL at each cell and from undisturbed soil outside the footprint of the cells.

Soil vapor modules are adsorbent modules comprised of adsorbents contained or secured in a porous housing. The Phase IA SVS will screen for VOCs and TPH that may indicate the presence of residual contaminant mass in the landfill. The Phase IB SVS is expected to utilize a sampling bias that focuses on the results of the Phase IA SVS and geophysical surveys to enhance coverage of potential areas of interest. Elevated soil vapor contaminant mass could directly indicate residual contamination within the landfill.

The Phase IA SVS will utilize a standard grid configuration with 90 ft x 90 ft cells with overall dimensions of approximately 700 ft along the short axis (northeast-southwest) by 1,550 ft along the long axis (northwest-southeast; Figure 4.1), traversing the entire landfill footprint and incorporating all 26 trenches previously identified in the HIS (NASA, 2017e). Individual sampling nodes will be centered on each of the grid cells. The grid generally comprises eight cells in width (short axis) by 17 cells (long axis) in length, which will be labeled as sampling points 1 through 138 (Figure 4.1). Phase IB will incorporate supplemental SVS sampling points that will be established following the evaluation of the Phase IA sampling results, and performance of the EMI, GPR and magnetic gradient surveys. It is expected that evaluation of the results of these surveys will support the development of specific target areas for potential VOC anomalies (identified by the Phase IA SVS) within individual trench locations (refined through the EMI, GPR, and magnetic gradient surveys).

The anticipated shallow SVS soil vapor module samples to be collected are summarized below:

- 138 samples – Phase IA systematic grid.
- 13 samples – Phase IA existing monitoring well locations, including three conventional groundwater monitoring wells (700-A-253, 700-D-186, and 700-J-200) and ten existing shallow methane monitoring wells (MW-1 through MW-10 [with MW-5 damaged and unavailable]).
- TBD – Phase II biased sampling points based on the results of the Phase I SVS, GPR survey, and magnetic gradient survey.
- TBD – Field quality control samples (to be collected with both Phase IA and IB sample sets). Duplicate samples will be analyzed at a rate of 10% for samples collected in the field. For field duplicates, a second set of adsorbents housed in the soil vapor module will be analyzed. Trip blanks will be collected at a rate of 5% to document potential exposures that are not part of the signal of interest (e.g., impact during sampler shipment, installation or retrieval, and storage). Trip blanks are identical to the modules installed in the field, and will remain unopened during all phases of the project.

As part of the initial Phase IA investigation, conventional monitoring wells 700-A-253, 700-D-186, and 700-J-200 screened across the uppermost contaminated groundwater table will be equipped with soil vapor sampling modules as a control to compare shallow SVS results to a sampling environment where known groundwater contaminant concentrations contribute to soil vapor through off-gassing (Figure 4.1; Table 3.1). The ten shallow methane monitoring wells will also be evaluated using modules. Sample modules will be suspended inside the upper 2 ft of monitoring well casing and the well subsequently sealed with the well cap or other impervious material. Contamination in these wells is verified through periodic sampling as part of the WSTF groundwater monitoring program. The monitoring well results will be utilized for comparative purposes as they provide a direct conduit to the groundwater table. Analytical results for the sample modules installed within monitoring wells will not be included within the shallow soil vapor survey dataset planned for use in developing soil vapor contours.

The soil vapor sample module laboratory will analyze samples utilizing EPA Method 8260 or equivalent for VOCs and TPH. For passive, sorbent-based sampler such as a universal passive sampler, a semi-quantitative result can be developed by calculating the concentration per volume if the soil porosity, soil moisture content, and exposure time for the soil vapor sample modules is known. The soil vapor sample module analytical laboratory default unit of measurement is mass (grams of contaminant). Results will be presented on isoconcentration maps utilizing the mass in micrograms (µg), typically with a detection limit of 0.02 µg.

5.2.1 SVS Method and Materials

The use of sample modules for soil vapor sampling and screening surveys have been the subject of an EPA environmental technology verification report (Billets, 1998). The EPA indicated that the technology can provide useful, cost effective data for environmental problem solving. Sample modules are passive soil vapor samplers that collect a broad range of VOCs and semi-volatile organic compounds (SVOCs).

Sample module analyses include the suite of chlorinated solvents and chlorofluorocarbons that may be present within the 700 Area landfill. Each sample module contains two passive collection units called sorbers. Each sorber contains an equal amount of sorbent materials (polymeric and carbonaceous resins). These granular adsorbent materials are used because of their affinity for a broad range of VOCs and ~~semi-volatile organic compounds (~~SVOCs~~)~~. The sorbers are constructed of inert, hydrophobic, microporous expanded polytetrafluoroethane that allows vapors to move freely across the membrane and onto the sorbent material. The microporous structure also protects the granular adsorbents from physical contact with water and soil particulates. Sample modules are typically installed to a depth of between 2 to 3 ft bgs. Samplers are manually inserted into each boring using a stainless steel push rod. The samplers will be retrieved by hand using an attached string or cord, and analyzed using EPA Method 8260 by the soil vapor sample module analytical laboratory.

The passive soil vapor collection technique can be more effective in identifying lower soil vapor contaminant concentrations due to the increased exposure time as compared to a one-time sampling strategy where a discreet volume of soil vapor is collected (for example SUMMA canister grab samples). Native soils in the 700 Area consist of silty to sandy alluvial gravels with porosities typically between 30 to 40%. Individual landfill cells and fill materials will also have significant porosities. Although 12 in. of topsoil was used to cover the GCL liner, SVS sample modules will be installed to depths below the liner and will not be impacted by this low porosity barrier.

Because of the considerable amount of time that has passed since the landfill last received solid waste, soil vapor concentrations in the vadose zone are anticipated to be low relative to concentrations that would characterize a continuing source or a single and more recent point source. The passive soil vapor collection technique will employ an extended exposure time of 14 days (pending confirmation and approval by the SVS analytical laboratory).

5.2.2 Shallow SVS Boring Installation

Shallow SVS boring locations in the field will be predominantly on top of the 700 Area landfill closure and will be accessed on foot. Shallow SVS soil borings will be installed using an electric or battery-powered hand-held rotary hammer drill. Each boring will be drilled in two stages as described below.

Soils near the ground surface at many sample locations are characterized by relatively loose and unconsolidated material. It is expected that borings will be prone to collapse in this setting, so a modified ¾-in. diameter by 16-in. carbide hammer bit (approximate) fitted with a drive collar will be used to advance a ¾-in. inside-diameter by 15-in. length section of stainless steel conduit pipe into the ground with approximately 4 in. of conduit stickup. Prior to cutting individual sections, e~~E~~ach length of conduit pipe will be decontaminated ~~prior to installation~~ using detergent wash and potable rinse water. Equipment blank samples~~ing~~ will be collected from ~~of the conduit pipe will be performed at a frequency of~~ 10 percent of the Phase IA and IB SVS ~~sampling program~~conduit pipes. The equipment blank samples will be analyzed for VOCs and gasoline-range, diesel-range, and oil-range organics.

Each of the borings will be subsequently drilled to a total depth of approximately 32 in. using a 5/8-in. diameter by 36-in. carbide hammer bit (approximate). The depth of the boring will be confirmed using a measuring rod. The soil borings will be temporarily protected at surface by covering the conduit pipe with a plastic bag secured in place with electrical tape. The rotary hammer bit and measuring rod will be cleaned of any solid soil material and rinsed with de-ionized water between each boring installation.

Due to the accessible nature of the 700 Area landfill, significant adjustment of the SVS grid sample points is not anticipated. Modified locations will subsequently re-surveyed in the field, the locations imported to the SVS grid base map, and the deviation recorded in the field logbook.

5.2.3 Soil Vapor Module Deployment

Phase IA SVS grid node locations will be recorded with the serial number of the individual soil vapor module installed at each location using an installation and retrieval logbook. Dedicated chemical resistant gloves (latex or nitrile) will be worn by field personnel while installing and retrieving the modules. Each sampling location depth will be measured prior to soil vapor module installation. Any collapse incurred within the boring will be recorded during the module emplacement; however, all borings will remain open to a minimum depth of 20 in. bgs. If a boring collapses to a depth shallower than 20 in. bgs, a replacement boring will be installed adjacent to the collapsed boring using the methods previously described. Each module will be taken from a correspondingly numbered glass vial and inserted into the base of the boring using a ¼-in. diameter stainless steel rod. The module serial number, corresponding field ID, sample type, date and time, observations, sample environment, soil type, etc. will be recorded in the field logbook as each module is installed.

5.2.4 Soil Vapor Module Sampling and Recovery

Each soil vapor module will be suspended on a length of string inside the boring to facilitate retrieval. Each boring opening will then be sealed at the surface with a cork that fits snugly into the conduit pipe at the sample location. The soil vapor modules will be installed within the borings for 14 days. After this residence time, the sampling modules will be retrieved and placed into the corresponding glass vial in which they were shipped from the laboratory. The time and date of soil vapor module retrieval will be recorded at each sample location. In order to keep the residence time constant, the soil vapor modules will be removed in the same order and at a similar rate as they were emplaced. Custody seals will be placed on each glass vial after they are sealed and containers will be managed in accordance with the established WSTF sample management process. The modules will then be shipped to the laboratory for chemical analysis.

When the Phase IA and Phase IB shallow SVS sampling is complete, the ¾-in steel conduits will be removed from the borings. Soil vapor borings installed directly in soil will be backfilled with a small volume of native landfill materials following retrieval of the sampling modules and the completion of sampling.

5.2.5 Sample Management and Interpretation

Sample management techniques specific to the soil vapor module laboratory will be utilized. Procedures presented in WSTF internal instructions for environmental sample management will be followed during sample management operations wherever possible. Phase IA and IB sample modules will be shipped to WSTF in single batches by the contracted soil vapor module laboratory. Individual sample modules are contained separately within 40 milliliter glass vials. Soil vapor module samplers can typically be used within three months of receipt.

Sample modules will be stored and transported at all times in accordance with specific requirements of the soil vapor analytical laboratory. Trip blanks will be retained with the other modules during storage and travel to and from the field. During the period of field exposure between installation and collection, trip blank modules will be stored in a secure container at the 700 Area landfill. Each sample module and glass vial container will be labeled with a unique serial number and sealed with a custody seal. Sample module shipments will be returned by overnight carrier for laboratory analysis. Samples will be managed using an internal WSTF chain-of-custody form and an external chain-of-custody form provided by the laboratory.

Following evaluation of sample results from the initial Phase IA SVS grid, GPR survey, and magnetic gradient survey, the Phase IB SVS sampling will be performed. Up to 150 additional supplemental SVS points are anticipated. The set of Phase IB SVS borings and modules will be biased at tighter spacing between the existing grid nodes to provide greater detail where the initial Phase IA SVS and geophysical survey results indicate anomalous concentrations within a more refined trench scenario. The Phase IB SVS sampling will be performed as soon as possible after Phase 1A SVS sampling, in order to maintain as much consistency as is feasible between the two data sets. This will provide duplicity in the data, and tie the surveys together. By holding variables such as exposure time, installation depth, and analytical procedures constant from one survey to the next, the results from the two surveys will be comparable. The results will be combined onto one set of maps providing a comprehensive view of the subsurface soil vapor distribution.

5.3 Electromagnetic Induction Survey

5.3.1 Procedures and Goals

Industry-standard EMI devices are based on the measurement of the change in mutual impedance between a pair of coils on or above the earth's surface. EMI instruments are comprised of two or more sets of coils that are electrically connected and separated by a fixed distance. The EMI equipment is portable and allows data to be collected as fast as the operator can walk. Subsurface conductivities are collected continuously as the operator surveys the site with the instrument. The survey that effectively defines the 700 Area landfill can be performed rapidly and effectively.

The principal value of the method is that it provides continuous, high resolution data at reasonable cost. The EMI will be connected to a data logger that simultaneously measures and records the terrain conductivity of the subsurface, and will detect metallic and non-metallic objects or features with conductivity varying from their surroundings. The EMI device will be utilized to simultaneously examine soil conditions and locate utilities, drums, and other buried metal debris, in addition to non-metallic burial features such as trenches from the contrast of conductivity between the disturbed earth and the undisturbed earth (similar to the GPR method discussed in Section 5.4).

The EMI survey grid will utilize the systematic base grid (Figure 4.1) as a starting point for field survey grid development. Utilizing both sets of grid lines will facilitate the development of three dimensional data. The spacing of grid lines will be considerably denser with a tighter spacing for the EMI survey in order to facilitate the identification of individual targets such as drums. Grid spacing will be established during the interaction with geophysical subcontractors during the procurement process.

5.3.2 Equipment

Industry-standard EMI equipment can be carried by hand or mounted to a trailer for towing, as ground contact is not required for operation. Vegetation and obstacles can be navigated around easily. The equipment includes a transmitter that generates a pulsed primary magnetic field, which induces eddy currents into nearby metal objects. The decay of these currents is measured by two receiver coils mounted on the coil assembly. The responses are recorded and displayed by an integrated computer based digital data logger. The EMI device will be connected to a GPS receiver so that accurate horizontal and vertical location information is recorded concurrently with the EMI log data.

The specific EMI equipment and method utilized for the survey will be selected in order to provide comprehensive coverage for the vertical extent of the landfill trenches. Based on the HIS, the vertical extent of the landfill is expected to be between 14 ft and 20 ft. The EMI equipment to be utilized for the investigation will be determined during the competitive procurement process for the geophysical contractor(s). In response to a recent NMED request (NMED, 2018) potential devices include, but are not limited to, the Geophex Ltd. GEM-2 and Geonics, Inc. EM-31 and EM-34.

T~~t~~he Geophex Ltd. GEM-2 electromagnetic instrument is a candidate for the EMI survey. The effective depth of exploration for the device is variable depending on ground conductivity, target volume, and ambient electromagnetic noise. The manufacturer estimates the GEM-2 is effective to a depth of 60 ft in resistive areas (consisting of sand, gravel, and asphalt), and 30 ft in conductive areas. For typical applications in low noise rural areas similar to the 700 Area landfill, the recommended depth is up to 30 ft, which is anticipated to provide sufficient vertical coverage.

The Geonics, Inc. EM-31 terrain conductivity meter provides an alternate option, but typically provides more limited depth profiling up to 20 ft. The EM-31 meter will map any subsurface feature associated with changes in ground conductivity and is effective in areas of high surface resistivity. Alternately, the Geonics, Inc. EM-34 meter is preferred for greater depth profiling between 30 and 180 ft. The performance of the specific device will be evaluated during the initial EMI survey and an alternate will be considered if necessary.

5.3.3 Data Processing and Interpretation

Survey data generated by EMI will be stored in a data logger in the field as the survey is run, and will be downloaded daily to a laptop computer or other permanent storage for processing. All data will be given a preliminary review in the field for quality assurance purposes. After collecting EMI survey data, the operator will plot the data using commercially available software to visualize subsurface anomalies, targets, and/or potential soil issues. The EMI survey cannot provide exact information on the target’s depth, shape, and orientation but the data is easy to view, process, and even immediately overlay on digitized maps. Subsequent geophysical methods described below (GPR and magnetic gradient surveys) can then target areas of interest to provide more detailed information on depths, size (dimensions/shapes), and orientation of targets in either two-dimensional (2-D) or three-dimensional (3-D) imaging.

5.4 Ground Penetrating Radar Survey

5.4.1 Procedures and Goals

The GPR method is a non-destructive, non-intrusive geophysical method that produces a continuous cross-sectional profile or record of subsurface metallic and non-metallic objects. Radar profiles generated by GPR methods are used for evaluating the location and depth of buried objects and to investigate the presence and continuity of natural subsurface conditions and features. The GPR survey at the landfill is intended to provide information regarding the locations and depths of landfill trenches, identification of changes in subsurface lithology, subsurface objects in landfill trenches, and to identify voids.

The GPR uses high-frequency-pulsed electromagnetic waves (from 10 to 3000 megahertz) to acquire subsurface information. Energy is propagated downward into the ground from a transmitting antenna and is reflected back to a receiving antenna from subsurface boundaries between media possessing different electromagnetic properties. The depth of penetration is determined primarily by the attenuation of the radar signal due to the conversion of electromagnetic energy to thermal energy through electrical conduction, dielectric relaxation, or magnetic relaxation losses. Conductivity is primarily governed by the water content of the material and the concentration of free ions in solution (salinity). Environments not conducive to using the radar method include high conductivity soils, sediments saturated with salt water or highly conductive fluids, and metal. The use of GPR methods at the landfill is warranted as subsurface soils exhibit low conductivities and moisture content, and the groundwater depth is 120 to 180 ft bgs.

The GPR survey areas/lines will be selected based on the results of the EMI survey. Areas of interest identified using EMI methods that require a more detailed definition of subsurface features will be selected for GPR survey. The GPR survey grid will utilize the systematic Phase IA shallow SVS and EMI survey base grid (Figure 4.1) as a starting point for field survey grid development.

5.4.2 Equipment

The GPR equipment utilized for the measurement of subsurface conditions normally consists of a transmitter and receiver antenna, a radar control unit, and suitable data storage and display devices. The radar control unit consists of a small micro-computer and standard operating system that controls the measurement process, stores the data, and serves as a user interface. The control unit synchronizes signals to the transmitting and receiving electronics in the antennas. The synchronizing signals control the transmitter and sampling receiver electronics located in the antenna(s) in order to generate a sampled waveform of the reflected radar pulses. These waveforms may be filtered and amplified and are transmitted along with timing signals to the display and recording devices.

5.4.3 Data Processing and Interpretation

The objective of GPR data presentation is to provide a display of the processed data that closely approximates an image of the subsurface, with the anomalies that are associated with the objects of interest located in their proper spatial positions. Individual GPR surveys will be tied to the Phase I survey base grid points to accurately locate identified subsurface objects. Data display is central to data interpretation, and is generally a function of the radar control and data logging unit. Producing a good display is an integral part of interpretation. There are three types of displays of surface data, including: 1) a one-dimensional trace, 2) a two dimensional cross section, and 3) a three dimensional display. A one-dimensional trace is of limited value until several traces are placed side-by-side to produce a two dimensional cross section, or placed in a three dimensional block view. The wiggle trace (or scan) is the building block of all displays. A single trace can be used to detect objects (and determine their depth) below a spot on the surface. By towing the antenna over the surface and recording traces at a fixed spacing, a record section of traces is obtained. The horizontal axis of the record section is surface position, and the vertical axis is round-trip travel time of the electromagnetic wave. A GPR record section is very similar to the display for an acoustic sonogram, or the display for a fish finder. Wiggle trace displays are a natural connection to other common displays used in engineering (e.g., an oscilloscope display), but it is often impractical to display the numerous traces that are measured along a GPR transect in wiggle-trace form. Therefore, scan displays have become the normal mode of two dimensional data presentation for GPR data. A scan display is obtained by simply assigning a color (or a variation of color intensity) to amplitude ranges on the trace.

A determination of the appropriate survey method (2-D or 3-D) will be established during the interaction with GPR subcontractors during the procurement process. The selected GPR subcontractor will provide copies of all images and interpretations of the survey upon completion. These documents will be archived in the project files, and select images and interpretations will be presented in the investigative report.

5.5 Magnetic Gradient Survey

5.5.1 Procedures and Goals

A magnetometer measures both the orientation and strength of a magnetic field. Magnetic gradient surveys measure small, local variations in the Earth's magnetic field by using instruments that temporarily polarize protons in a container holding proton-rich fluids by applying an electrical current. When the current is removed, the protons realign corresponding to the magnetic field of the earth at that location and a reading is taken. These localized variations in the magnetic field can be measured with accuracies to 0.002% (Mariita, 2007).

Gradiometers utilize two magnetometers stacked one above the other to measure the magnetic field gradient rather than the total field strength. This relative measurement allows for the removal of background noise. Gradiometers accentuate the signal from shallow ferromagnetic objects while ignoring deeper features. They have been successfully used to locate buried ferrous objects such as drums, tanks, unexploded ordnance, and utilities. The depth of detection depends on the magnetic signature of the target object, so a ton block of iron may be located at a depth of 30 ft, while smaller ferrous debris (drum) might be located at a depth of 10 ft or shallower.

Because of the operating range in the shallow environment, magnetic gradient surveying has been demonstrated to be an effective tool in delineating old landfill boundaries, cell locations, and the presence of buried metallic wastes. Within New Mexico, the City of Albuquerque has successfully utilized magnetic surveys, in conjunction with other investigative methods, to map out at least two historical landfills within the boundaries of the city, the Nazareth Landfill (HGI, 2017a) and Los Angeles Landfill (HGI, 2017b).

At the 700 Area landfill, magnetic surveying will be used in conjunction with EMI and GPR to non-invasively characterize the lateral extents and thicknesses of buried waste and the depth of cover material over the waste cells. Magnetic measurements are highly sensitive to ferrous metals, a common component of the debris buried in landfill trenches. Upon obtaining survey data, a high-resolution, plan view map of the distribution of ferrous metallic objects within the cells will be generated. In addition, the magnetic survey will be used in conjunction with the EMI and GPR surveys to delineate the cells, due to inherent differences in profile signatures between the excavated trenches and undisturbed native soils.

Due to the variability in the widths of the landfill trenches and anticipated variability in the sizes of ferrous objects within them, it is proposed that survey lines be run across the width of the landfill area throughout its entire length at a line spacing of approximately 8 ft. At this density, approximately 21 line mi of survey are expected to provide enough coverage that no cells or ferrous debris the size of a 55-gallon drum will be missed. The survey grid for the Phase IA SVS will be utilized to orient the magnetic gradient survey, with subsequent refinement of the grid to the tighter line spacings. The magnetic survey grid will utilize the systematic Phase IA shallow SVS, EMI, and GPR base grid (Figure 4.1) as a starting point for field survey grid development. The spacing of grid lines will be considerably denser with a tighter spacing for the magnetic survey. Grid spacing will be established during the interaction with geophysical subcontractors during the procurement process.

5.5.2 Equipment

The equipment proposed for the magnetic gradient survey is a Geometrics®[2] G-858 axial gradiometer cesium magnetometer, or equivalent, with two probes positioned vertically in series (approximately 3 ft apart) to measure the magnetic gradient. The magnetometer will be utilized concurrently with GPS to continuously record the locations of readings with progression along the survey lines. Data loggers will record readings during data acquisition. The equipment will either be carried by a technician along each survey line or towed on a non-magnetic cart behind an All-Terrain Vehicle (ATV). Magnetic readings will be taken at 1 to 5-second intervals as the equipment is moved along the survey lines. Quality assurance tests, such as visual inspection, functionality, static response, vibration, and dynamic response will be performed daily to ensure the equipment is in satisfactory working condition. Magnetic survey data will be stored in a data logger in the field as the survey is run, and will be downloaded daily to a laptop computer or other permanent storage for processing. All data will be subject to preliminary review in the field for quality assurance purposes.

5.5.3 Data Processing and Interpretation

Geometrics MagMap™, or equivalent software, will be used to process the data and to generate a plan map of the distribution of ferrous anomalies in the landfill cells. These maps will be compared to maps of anomalies garnered from EMI and GPR data to evaluate the potential distribution of wastes and debris in the 700 Area landfill.

5.6 Passive Seismic Survey

5.6.1 Procedure and Goals

A passive seismic survey (PSS) involves the detection of natural low frequency earth movements and will be used with the purpose of discerning geological lithology and structure in the subsurface of the 700 Area. Passive seismic (also known as ambient noise surface wave tomography) utilizes background noise to generate vertical profiles through the ground. Variations in impedance contrast are mapped to show lithological and structural features. The technique can be applied to any scenario where softer layers overlie harder substrates, which is the case at the 700 Area landfill where alluvium overlies bedrock. Depending on the nature of the ambient noise and the physical properties of the subsurface lithologies, passive seismic can be used to support subsurface interpretations from near surface down to a few thousand feet in depth.

Passive seismic focuses on low frequency signals (0 to 10 hertz). The primary target layer for the PSS at the 700 Area landfill will be the Paleozoic Hueco limestone and Oligocene Orejon andesite bedrock surface. Enhanced interpretation of this surface will assist with the development of the subsurface site conceptual model in this area, and support site wide geophysical survey efforts. Data listening will be

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[2] Geometrics is a registered trademark of Geometrics, Inc.

performed using multiple measurement points along linear transects that will be monitored for a period of several days.

Prior to running a complete survey, it is advisable to perform a “noise test,” whereby approximately 30 seismic sensor nodes are laid out in a tight 2-D array. The nodes will be left deployed in the field for one to three weeks, collected, and the data analyzed in order to assist with the final spacing of geophones. The complete PSS will consist of a series of single seismic sensor nodes arranged in linear transects. The linear transects will be arranged across the 700 Area landfill into an appropriate grid pattern to generate a 3-D surface of the target horizon (bedrock).

The spacing of seismic sensor nodes influences subsurface resolution, and will be based upon the anticipated depth to the primary reflector (bedrock) at between 110 to 180 ft bgs. The vertical resolution for the PSS data set is typically about half the distance of the horizontal node spacing. The typical spacing for individual geophones is typically in the order of several tens of ft to a few hundred feet in order to provide best resolution for the anticipated depth of bedrock. Nearby wells 700-A-253, 700-D-186, 700-H, and 700-J-200 will be used as independent bedrock depth controls. The passive seismic survey grid will utilize the systematic Phase IA shallow SVS, EMI, GPR, and magnetic base grid (Figure 4.1) as a starting point for field survey grid development. The spacing of grid lines will be less dense, considerably wider-spaced, and extend further beyond the footprint of the 700 Area landfill than the other survey lines due to the greater target depth for this survey.

5.6.2 Equipment

The seismic sensor nodes act as seismic geophones that will be spaced based on the design and recommendation of the geophysical subcontractor. Monitoring points will comprise seismic sensor nodes that are placed at the surface or can be buried up to a few inches below the ground to shield them from the wind. Sensor nodes typically have a charge life of 30 to 45 days, but it is anticipated they will only be left in the ground for a few days to a few weeks. Several hundred nodes may be required to adequately cover the landfill and adjacent areas.

5.6.3 Data Processing and Interpretation

The conclusions for the PSS will be based on the spectral analysis of the observed seismic waves. Data are usually acquired in multiple points simultaneously, using synchronized PSS lines. The data will subsequently be processed to develop a 3-D velocity map.

5.7 Site Access and Maintenance of Closure Cap

The boundaries of the 700 Area landfill are fenced and the surface sparsely to moderately vegetated with desert shrubs and grasses, some of which may impede easy progression of equipment along planned survey lines. In order to establish the survey lines and ensure adequate access for survey equipment, some vegetation may be mowed or mechanically removed. Locations identified for the surveys will be assessed to determine the appropriate surface preparation to allow for successful operation of the associated equipment while ensuring the landfill cap is protected.

In addition, the GCL covering the landfill cells may be impacted if any equipment heavier than an ATV is driven over vulnerable cells. The shallow SVS and geophysical surveys can be completed by operators hand-carrying or towing equipment with an ATV. If vehicles larger than ATVs are required, NASA will limit their use to portions of the closure cap under which GCL is not installed.

5.8 Safety and Health Procedures

Field activities will be conducted in accordance with requirements of 29 CFR 1910, Occupational Safety and Health Administration (OSHA) Standards for Hazardous Waste Operations and Emergency Response (HAZWOPER, 2017). The Contractor's Corporate-wide Safety and Health Plan (SHP) will be augmented with site-specific Job Hazard Analyses to address potential hazard foreseeable for the project; and, will be followed in accordance with applicable requirements of the standards. The augmented SHP will address safety and health issues pertaining to work activities, including known and reasonably anticipated hazards associated with project scope of work as well as contingencies for unexpected conditions. The requirements of the SHP will apply to prime and sub-tier contractors as well as personnel requesting access to controlled areas of the investigation site.

Project field personnel are required to be current in HAZWOPER training. In the event that new hazards are encountered that are not addressed by the SHP, the field team will stop work and contact the responsible health and safety personnel to develop additional guidance on means to eliminate or mitigate any new threats. As required by the Hazardous Waste Operations and Emergency Response (2017), the SHP, and project-specific addenda will address:

- A safety and health risk or hazard analysis for each site task and operation found in this IWP.
- Employee training assignments.
- PPE to be used by employees for each of the site tasks and operations being conducted.
- Medical surveillance and fitness for duty requirements (based on nature of the project scope and COPCs).
- Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used.
- Site control measures in accordance with the site control program.
- Decontamination procedures.
- An emergency response plan for safe and effective responses to emergencies, including the necessary PPE and other equipment.
- Pre-entry briefing. The SHP shall provide for pre-entry briefings to be held prior to initiating any site activity, and at such other times as necessary to ensure that employees are apprised of the SHP and that this plan is being followed.
- Inspections shall be conducted by responsible contractor personnel who are knowledgeable in occupational safety and health.

During the project, subcontractors must comply with OSHA and EPA standards applicable to this IWP and the SHP. Project subcontractor field personnel are required to be current in HAZWOPER training required 29 CFR 1910 (2017). Prior to the start of each day's field activities, a Safety Tailgate Meeting will be conducted to review the planned activities of the day, potential hazards, and PPE required. Daily field activities will involve a minimum of two personnel working together. In the event of any injuries requiring first aid in the field, the person injured will report to the WSTF Clinic prior to the end of the work day. Any injuries or situations more serious than what could be mitigated using basic first aid will be handled by informing WSTF Emergency Services.

5.9 Site Restoration and Grading

~~Final restoration and grading activities at the investigation site will commence after the completion of investigation field surveys, receipt of the final analytical results, submittal of the investigation report to NMED, and receipt of concurrence from NMED.~~ Any suspected disturbance or damage to the GCL incurred during the Phase I shallow SVS field activities will be subject to repair during backfill of the associated soil boring. Following retrieval of the sampling module, the boring will be backfilled with powdered sodium bentonite and hydrated. This is a commonly accepted practice for the repair of landfill GCL liners, and has been performed previously at the WSTF 600 Area Closure (NASA, 2011). Any minor site grading will be completed using hand tools to prevent the ponding of water at the site location.

Following ~~Any~~individual phases of the field investigation, all ~~significant~~ modifications or repairs to the landfill closure cap will be reported the NMED Solid Waste Bureau. Significant final restoration and grading activities at the 700 Area landfill will be performed following the completion of the last phase of fieldwork, receipt of the final analytical results, submittal of the investigation report to NMED, and receipt of concurrence from NMED.

6.0 Equipment Decontamination Procedures

It is anticipated that only solid waste will be generated during this investigation due to the shallow penetration of the SVS and non-invasive geophysical survey techniques. Any equipment that may penetrate the surface into a landfill cell will be decontaminated before and after use. General decontamination guidance available in ASTM International D 5088-15a (ASTM, 2015) will be followed for this project. Decontamination procedures will be performed by 40-hour HAZWOPER trained personnel wearing appropriate PPE under the supervision of the site supervisor or their designee.

6.1 Decontamination Area

An individual small-scale decontamination station will be constructed adjacent to the 700 Area landfill to support decontamination of the shallow SVS steel conduit pipe and rotary hammer drill bit that will be used for the shallow SVS. Contamination reduction or decontamination activities will be performed over a containment device that will retain waste generated during the decontamination process. It is anticipated that all waste will be managed as solid waste.

6.2 Decontamination Methods

Decontamination will be performed on the SVS steel conduit pipe and rotary hammer bit to minimize the potential for any cross-contamination between shallow SVS sample locations. Any residual soil on the SVS steel conduit pipe and rotary hammer drill bit will be removed using a wire brush adjacent to each borehole location. Shallow SVS sampling equipment will be decontaminated prior to exiting the 700 Area landfill area. Decontamination will involve hand washing the item with non-phosphate detergent, rinsing with WSTF potable water, and finally by rinsing with purified water. In the event field screening instruments are used to monitor the condition of the 700 Area landfill, dry decontamination followed by an alcohol free moist wipe will be used for moisture sensitive equipment such as a photoionization detector (PID).

7.0 Field Documentation Procedures

The WSTF Environmental Department field supervisor (geologist or engineer) will keep a record of daily Phase I investigation activities, a log of site personnel, safety briefings, wastes generated, etc. in a project specific logbook. Logbooks will have durable pages, bound and serial numbered. Entries will be made in ink with no erasures. Each day's record will be reviewed and approved by another individual involved in the project. Logbook entries will include, as applicable, information such as:

- Standard Daily Header – project name, logbook number, date, weather conditions, team members present and their affiliations (including subcontractors), sample location identification, day's task(s), daily safety meeting topics, PPE to be used, equipment in use, and any calibration information, if applicable.
- Daily activities (time and observations recorded) – site arrival and departure, visitors and the purpose of their visit, sampling information, soil type, soil conditions, decontamination (i.e., method, equipment cleaned), reference data sheets or maps, if applicable.
- Daily summary – action items, materials used, changes or deviations made from planned protocol, plan for next day.
- Signatures (field personnel and logbook reviewer).

In addition to the field logbook, shallow SVS sample locations will be recorded with the serial number of the individual soil vapor module installed at each location using an installation and retrieval log. This log includes the date, location, depth, sample type, identification number, sampler, and any circumstances, events, or decisions that could impact sample quality. Even though each case may be unique, the geologist's decision must be documented as to conditions that precipitated any decisions for the unsuitability of samples for analyses.

Evidential records for the entire project will be maintained in hard copy or electronic form and will consist of:

- Project IWP with any deviations redlined.
- Site-specific internal procedural documentation or plans.
- Project logbooks.
- Field data records (i.e., surveyed site location).
- Sample installation and retrieval logs.
- Correspondence with NMED.
- Final analytical data packages.
- Reports.
- Miscellaneous related records such as photos, maps, drawings, etc.

8.0 Investigation Derived Waste

Permit Attachment 20 (Section 20.2.13) requires that a description of IDW management be provided in an appendix to each work plan (NMED, 2016). Because a very limited amount of solid waste is expected to be generated during the Phase I investigation fieldwork, waste management procedures are presented in this section in lieu of a separate appendix.

All IDW generated as part of the investigation is anticipated to be characterized and managed as non-hazardous solid waste. This will include a limited volume of soil cuttings, or environmental media, that adheres to shallow SVS steel conduit pipe and the rotary hammer drill bits. The cuttings will consist of soils that were used to construct the clean landfill closure cap. These are characterized as non-hazardous and will be left in the immediate project area. Other IDW will include used disposable PPE (gloves), plastic sheeting, and rags, which are characterized as non-hazardous and will be disposed of as solid waste at a Subtitle D landfill. Waste water and soap solutions used for equipment decontamination are also characterized as non-hazardous and will be disposed of in the WSTF sanitary sewer system. The shallow SVS soil vapor module samplers will be returned to the laboratory for chemical analysis.

9.0 Data Management Tasks

Passive diffusion sampler serial numbers, grid locations, and trip blank serial numbers will be recorded in the field logbook. Analysis of the samplers will be performed in the laboratory by gas chromatography per US EPA Method 8260. Analyses of trip blanks are performed in addition to laboratory blanks (instrument, method, standards, etc.) to ensure quality assurance. Data validation will be supported by the laboratory surrogate recovery and trip blank analysis.

Processed data will be recorded in mass data tables, concentration values, and site isoconcentration maps utilizing the mass in µg showing compound distribution. The results of the Phase I investigation will be submitted to NMED in the Phase I Investigation Report. Following NMED approval of the Phase I Investigation Report, a separate work plan for Phase II investigation activities will be submitted to NMED for review and approval. ~~NMED will be consulted during the review and evaluation of Phase I data prior to commencement of Phase II field activities. Presentation and detailed discussion of the results of the Shallow Soil Vapor Survey will be included in the 700 Area IR.~~

Significant deviations from the number and locations of shallow SVS samples indicated in the IWP will be discussed with NMED for concurrence. Geophysical field survey events will be managed in accordance with the requirements established by the knowledgeable contractors. If a survey cannot be conducted as planned, the site supervisor will be notified. Any deviations from the IWP or procedures will be documented and noted in the Phase I Investigation Report for review by the NMED.

10.0 Current Monitoring and Sampling Programs

The primary current monitoring program applicable to Phase I investigation fieldwork at the 700 Area landfill is NASA's ongoing groundwater assessment program. NASA routinely collects groundwater samples from a comprehensive network of monitoring wells at WSTF, including those near the landfill, in accordance with the NMED-approved GMP (NASA, 2017b). Groundwater samples are collected for the analysis of VOCs, N-nitrosodimethylamine (NDMA), bromacil, and metals. Groundwater samples collected from monitoring wells near the landfill (wells 700-A-153, 700-D-186, 700-H, and 700-J-200) are also analyzed for the constituents in Subpart A of 20.9.9.20 NMAC in accordance with the landfill PCC Plan (NASA, 1997).

NASA also performs annual methane monitoring at ten shallow soil vapor monitoring wells near the perimeter of the landfill (Figure 1.4) in accordance with the PCC Plan (NASA, 1997). Each monitoring well consists of a 7-ft long, 1.25-in. diameter well point with 30 in. of #60 mesh screen set into a 6-ft deep, 4-in. diameter augured hole with a sand pack and bentonite seal. Between May 1996 and December 2016, methane has been detected a single time above the instrument detection limit of 5 parts per million. A concentration of 7.6 parts per million was reported at well MW-5 on January 21, 1998. This well was accidentally destroyed in 1998 during closure cover installation activities, although the remaining wells are operational.

11.0 Schedule

The anticipated schedule for the SWMU 49, 700 Area landfill Phase I investigation fieldwork and reporting is as follows:

- NMED approval of the SWMU 49, 700 Area landfill IWP and HIS (to be determined).
- Complete Phase I investigation procurements and commence fieldwork - 60 days following NMED approval.

- Complete fieldwork components in the following general order and receipt of SVS analytical laboratory and geophysical subcontractor survey data all with a timeframe of 180 days following the start of fieldwork:
    - Phase IA systematic SVS on a standardized grid.
    - EMI to examine soil conditions and locate objects found beneath the surface and provide direction for GPR and magnetometer.
    - GPR to support trench delineation in subsurface.
    - Magnetic gradient survey to define metallic objects.
    - Passive seismic to investigate and discern geological lithology and structure.
    - Phase IB SVS designed with the support of results of the preceding Phase I SVS, EMI, GPR, and magnetic gradient surveys.
- Data compilation, review, and development of draft 700 Area landfill Investigation Report including internal reviews: 120 days after completion of Phase I fieldwork components and receipt of laboratory and geophysical subcontractor survey data.
- NASA Submits the SWMU 49, 700 Area L~~l~~andfill Phase I Investigation Report to NMED: 360 days after approval of the 700 Area landfill HIS and IWP.

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Figures

Figure 1.1 WSTF Location Map

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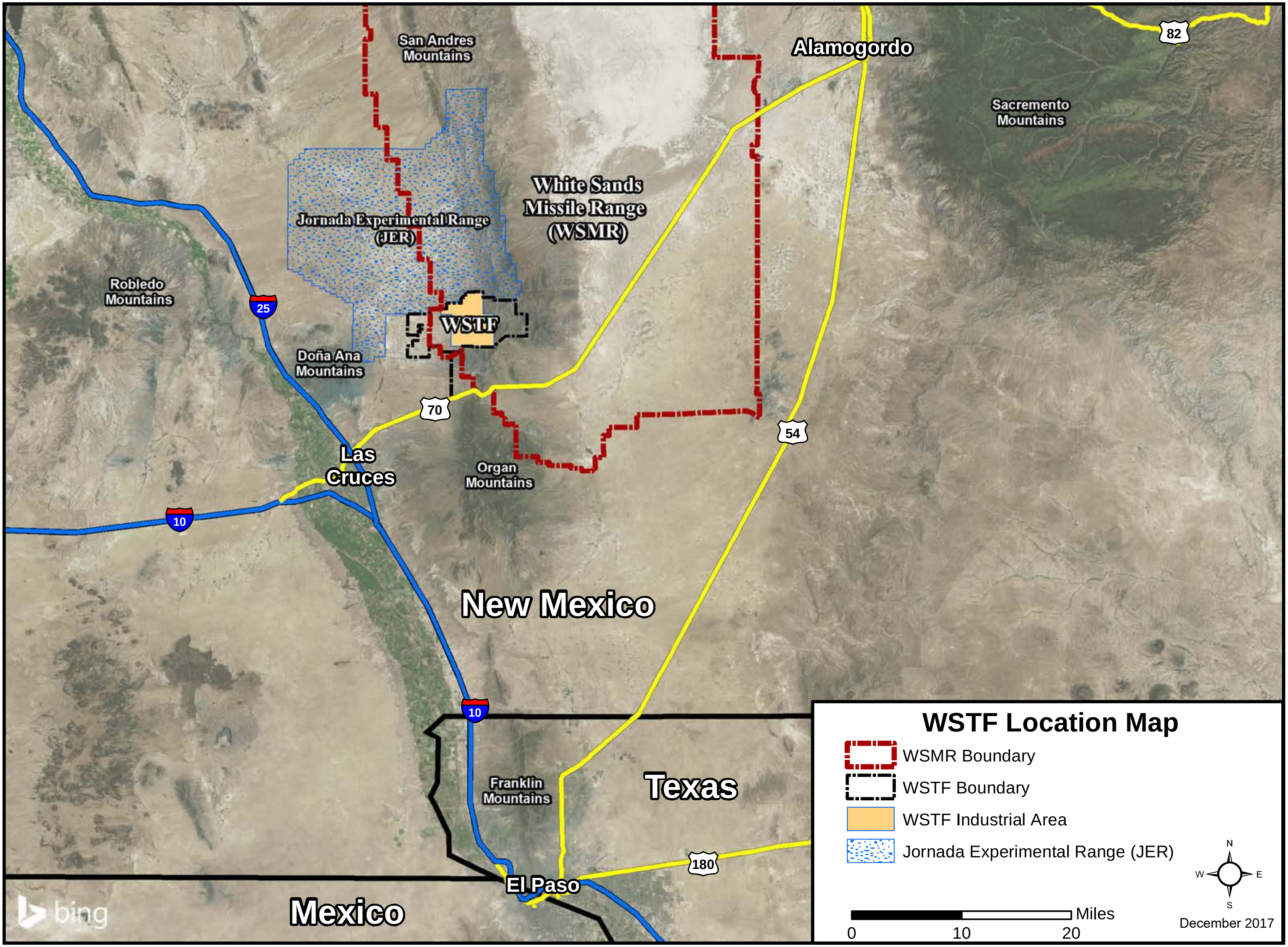

San Andres Mountains
Alamogordo
82
Sacremento Mountains
White Sands Missile Range (WSMR)
Jornada Experimental Range (JER)
Robledo Mountains
25
WSTF
Doña Ana Mountains
70
54
Las Cruces
Organ Mountains
10
New Mexico
10
Franklin Mountains
Texas
180
El Paso
Mexico
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
N
W
E
S
Miles
0
10
20
December 2017

(SEE NEXT PAGE)

STGT Area
700 Area
500 Area
(Fuel, Oxidizer Storage)
300 Area
400 Area
STGT Access Road
Apollo Boulevard
800
Area
200
Area
Well Road
600
Area
100 Area
WSTF Industrial Areas
700 Area Landfill
Feet
0
800
1,600
N
W
E
S
December 2017

Figure 1.3 **700 Area Landfill Location Map**

(SEE NEXT PAGE)

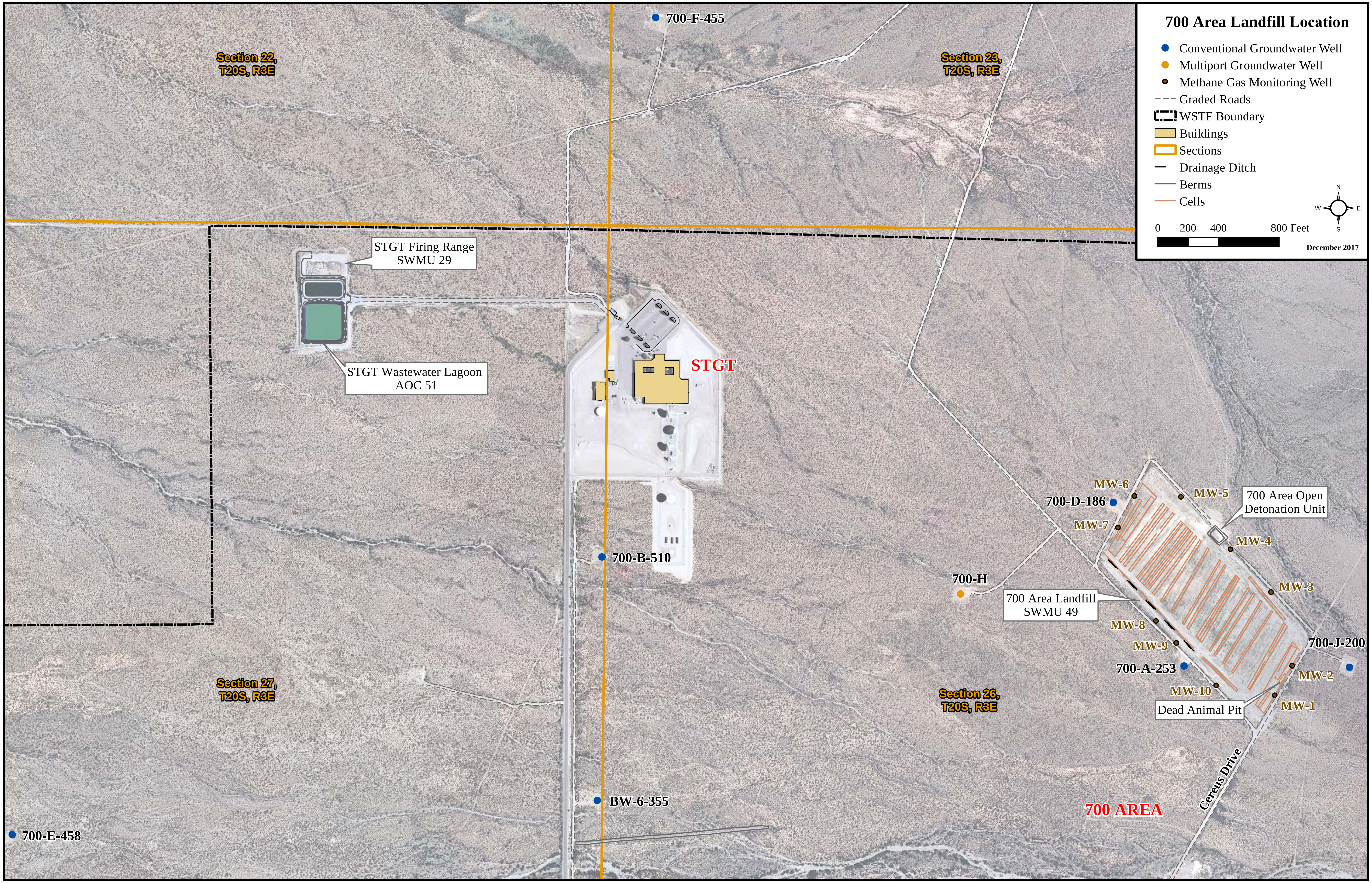
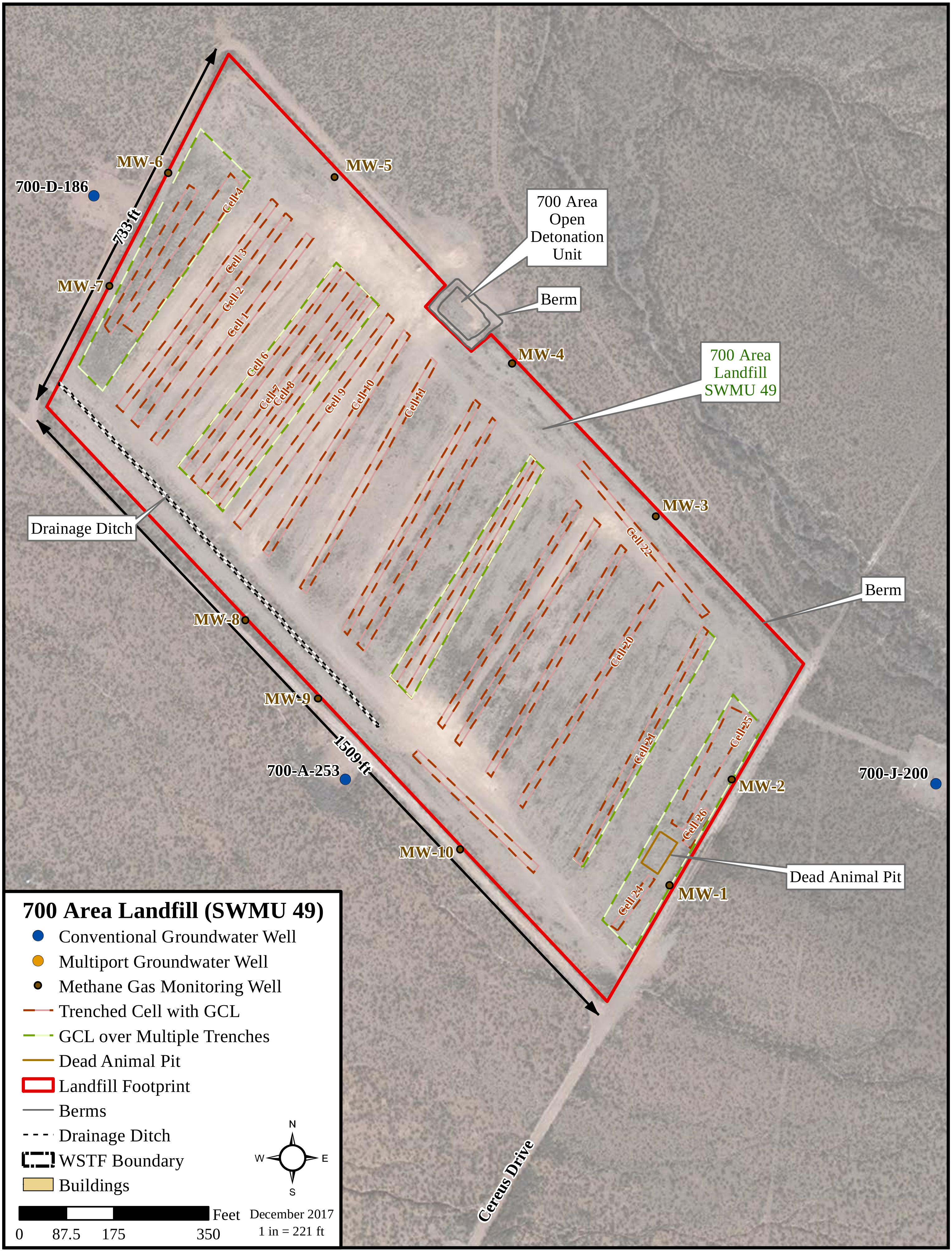

700 Area Landfill Location
Conventional Groundwater Well
Multiport Groundwater Well
Methane Gas Monitoring Well
Graded Roads
WSTF Boundary
Buildings
Sections
Drainage Ditch
Berms
Cells
0 200 400 800 Feet
December 2017
700-F-455
Section 22, T20S, R3E
Section 23, T20S, R3E
Section 27, T20S, R3E
Section 26, T20S, R3E
STGT Firing Range SWMU 29
STGT Wastewater Lagoon AOC 51
STGT
700-D-186
700-B-510
700-H
700 Area Landfill SWMU 49
700 Area Open Detonation Unit
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
700-J-200
700-A-253
Dead Animal Pit
BW-6-355
700-E-458
700 AREA
Cereus Drive

Figure 1.4 **700 Area Landfill Detail**

(SEE NEXT PAGE)



MW-6
MW-5
700-D-186
733 ft
Cell 4
Cell 3
Cell 2
Cell 1
MW-7
Cell 6
Cell 7
Cell 8
Cell 9
Cell 10
Cell 11
700 Area
Open
Detonation
Unit
Berm
MW-4
700 Area
Landfill
SWMU 49
MW-3
Cell 22
Drainage Ditch
Berm
MW-8
Cell 20
MW-9
Cell 21
Cell 25
1509 ft
700-A-253
MW-2
700-J-200
Cell 26
MW-10
Dead Animal Pit
MW-1
Cell 24
Cereus Drive
700 Area Landfill (SWMU 49)
Conventional Groundwater Well
Multiport Groundwater Well
Methane Gas Monitoring Well
Trenched Cell with GCL
GCL over Multiple Trenches
Dead Animal Pit
Landfill Footprint
Berms
Drainage Ditch
WSTF Boundary
Buildings
N
W
E
S
Feet
0
87.5
175
350
December 2017
1 in = 221 ft

Figure 2.1 **Site Conceptual Exposure Model**

(SEE NEXT PAGE)

Site Conceptual Exposure Model

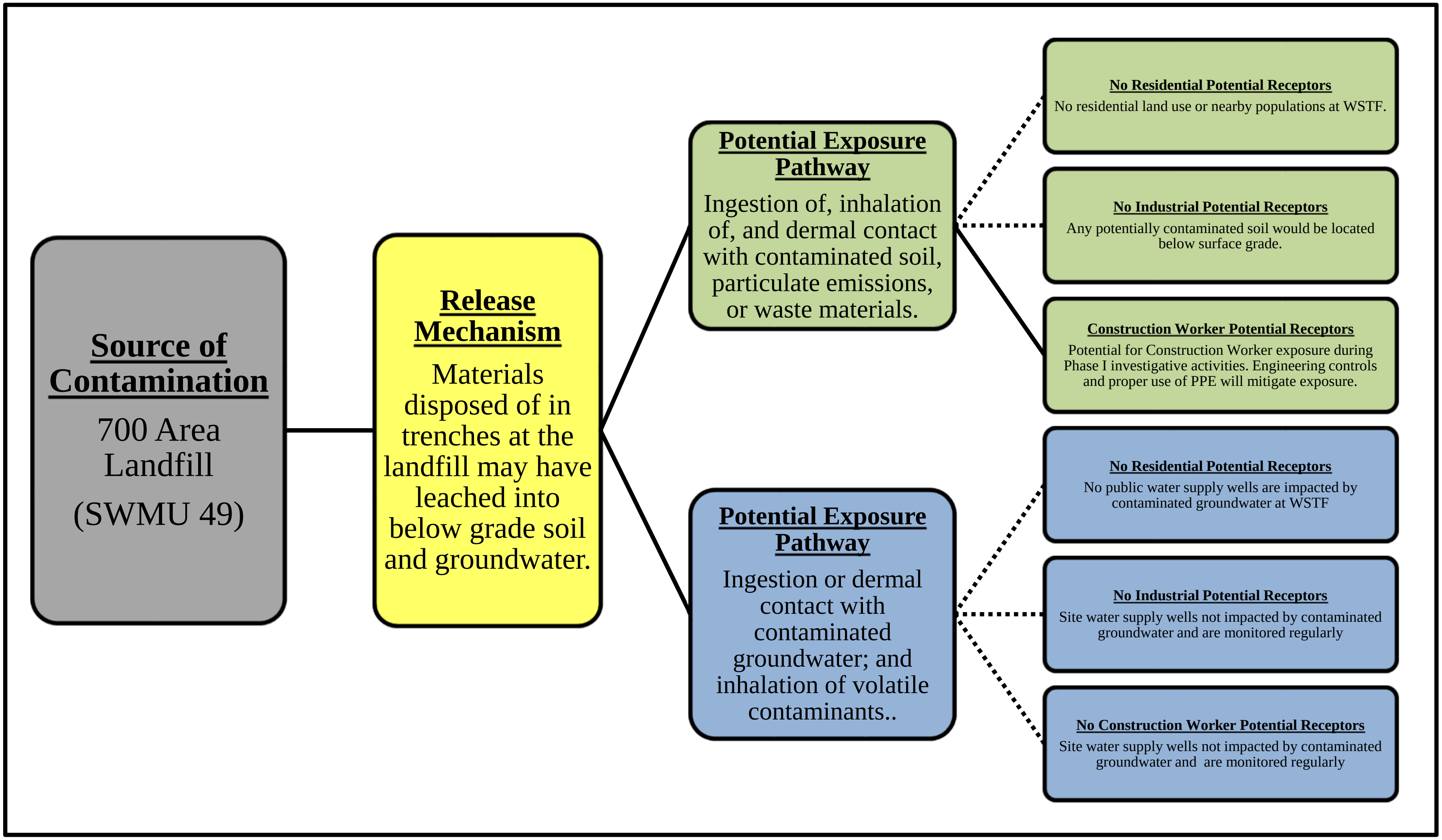


Figure 3.1 700 Area Cross Section Location Map

(SEE NEXT PAGE)

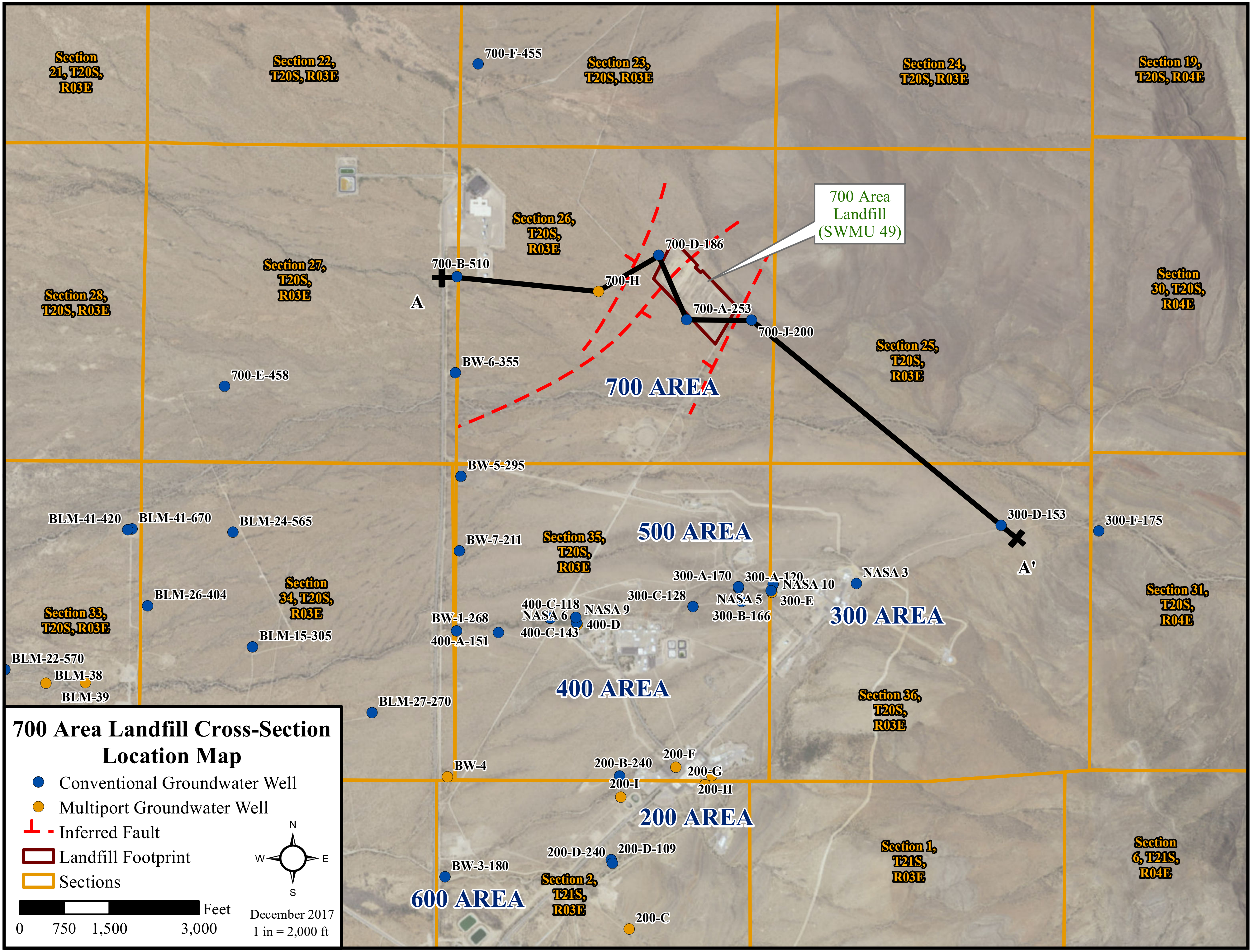
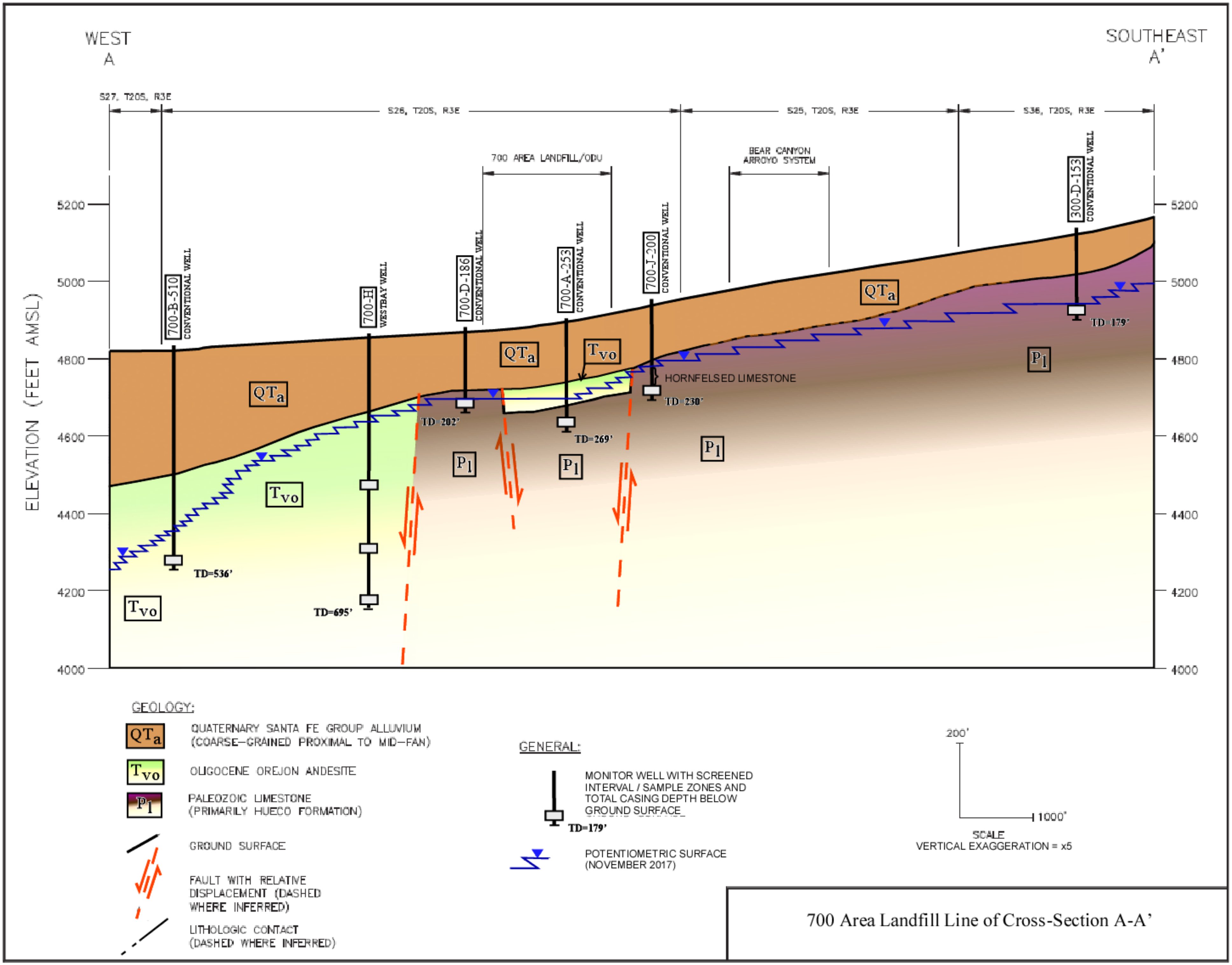

700 Area Landfill Cross-Section Location Map
Conventional Groundwater Well
Multiport Groundwater Well
Inferred Fault
Landfill Footprint
Sections
Feet
0 750 1,500 3,000
December 2017
1 in = 2,000 ft
N
W
E
S
700 Area Landfill (SWMU 49)
700 AREA
500 AREA
300 AREA
400 AREA
200 AREA
600 AREA
A
A'
Section 21, T20S, R03E
Section 22, T20S, R03E
Section 23, T20S, R03E
Section 24, T20S, R03E
Section 19, T20S, R04E
Section 26, T20S, R03E
Section 27, T20S, R03E
Section 28, T20S, R03E
Section 25, T20S, R03E
Section 30, T20S, R04E
Section 35, T20S, R03E
Section 34, T20S, R03E
Section 33, T20S, R03E
Section 31, T20S, R04E
Section 36, T20S, R03E
Section 1, T21S, R03E
Section 6, T21S, R04E
Section 2, T21S, R03E
700-F-455
700-B-510
700-D-186
700-H
700-A-253
700-J-200
700-E-458
BW-6-355
BW-5-295
BW-7-211
BW-1-268
BW-4
BW-3-180
BLM-41-420
BLM-41-670
BLM-24-565
BLM-26-404
BLM-15-305
BLM-22-570
BLM-38
BLM-39
BLM-27-270
300-D-153
300-F-175
300-A-170
300-A-120
NASA 10
NASA 3
NASA 5
300-E
300-C-128
300-B-166
400-C-118
NASA 6
NASA 9
400-D
400-C-143
400-A-151
200-B-240
200-F
200-G
200-I
200-H
200-D-240
200-D-109
200-C

Figure 3.2 **700 Area Landfill Line of Cross-Section A-A'**

(SEE NEXT PAGE)



700 Area Landfill Line of Cross-Section A-A’

Figure 3.3 **700 Area Landfill Potentiometric Contour Map**

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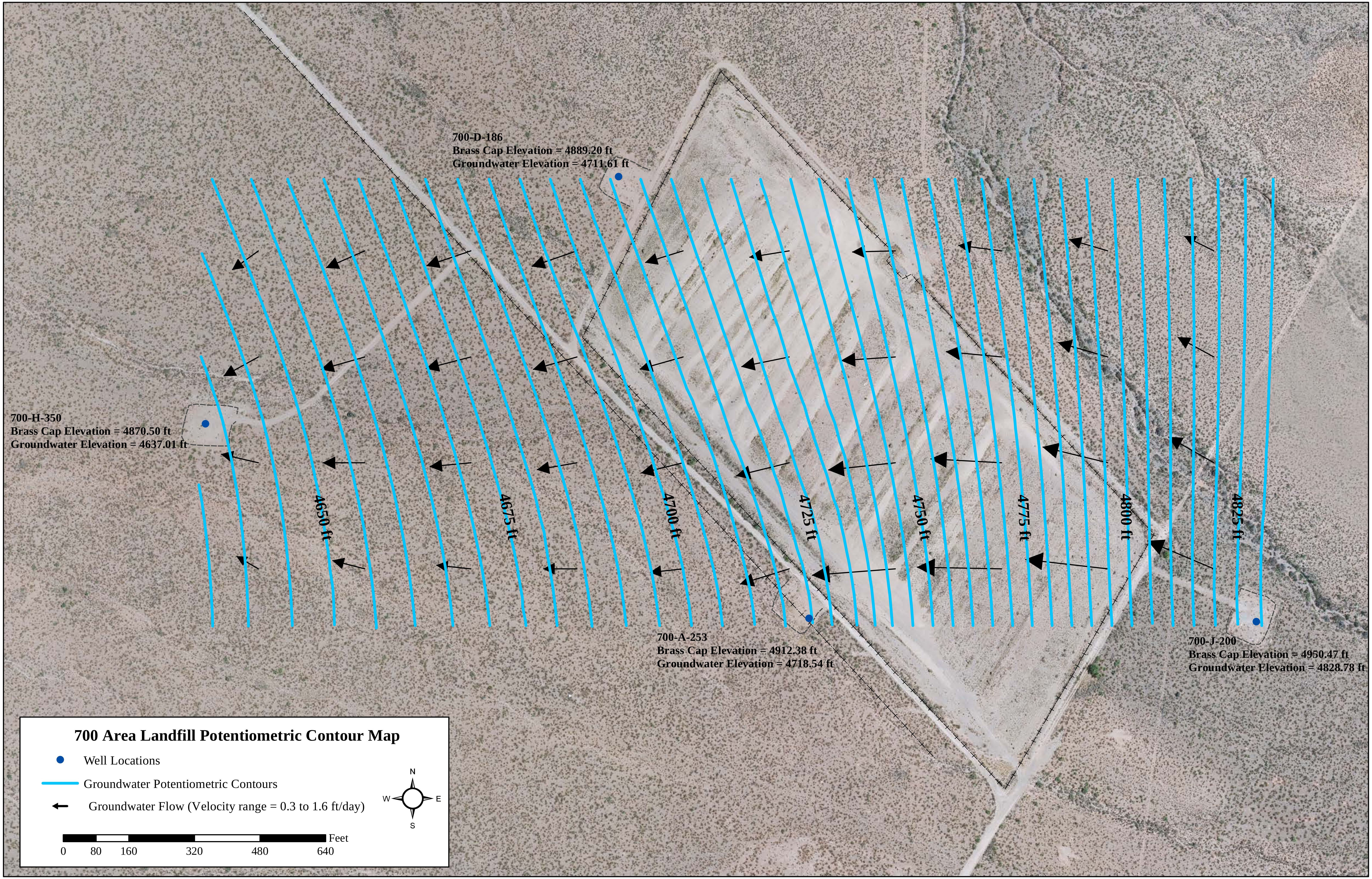
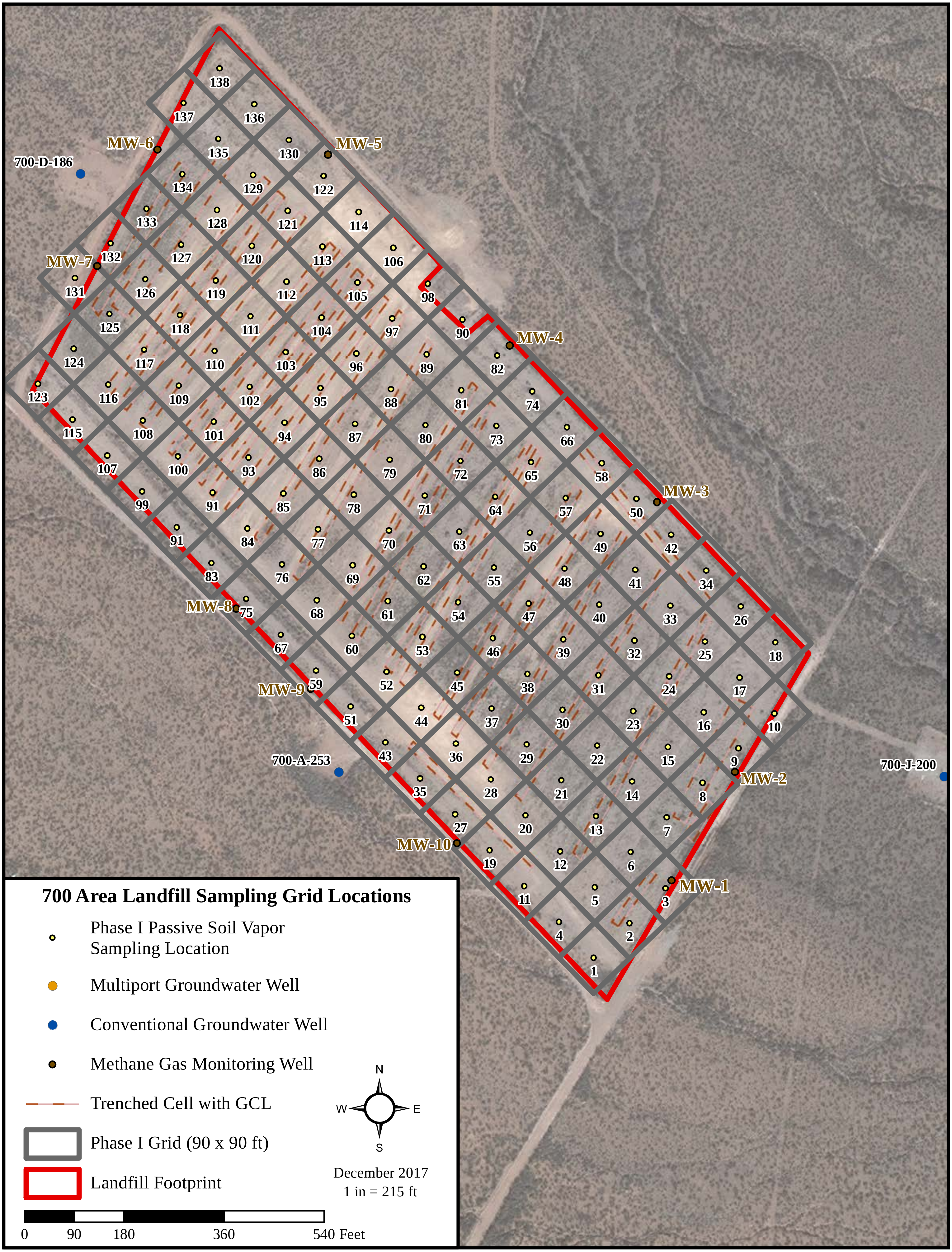

700-D-186
Brass Cap Elevation = 4889.20 ft
Groundwater Elevation = 4711.61 ft
700-H-350
Brass Cap Elevation = 4870.50 ft
Groundwater Elevation = 4637.01 ft
700-A-253
Brass Cap Elevation = 4912.38 ft
Groundwater Elevation = 4718.54 ft
700-J-200
Brass Cap Elevation = 4950.47 ft
Groundwater Elevation = 4828.78 ft
4650 ft
4675 ft
4700 ft
4725 ft
4750 ft
4775 ft
4800 ft
4825 ft
700 Area Landfill Potentiometric Contour Map
Well Locations
Groundwater Potentiometric Contours
Groundwater Flow (Velocity range = 0.3 to 1.6 ft/day)
N
W
E
S
Feet
0
80
160
320
480
640

(SEE NEXT PAGE)


700 Area Landfill Sampling Grid Locations
Phase I Passive Soil Vapor Sampling Location
Multiport Groundwater Well
Conventional Groundwater Well
Methane Gas Monitoring Well
Trenched Cell with GCL
Phase I Grid (90 x 90 ft)
Landfill Footprint
December 2017
1 in = 215 ft
0
90
180
360
540 Feet
N
W
E
S
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-7
MW-8
MW-9
MW-10
700-D-186
700-A-253
700-J-200

Tables

Table 2.1 List of Contaminants of Potential Concern for the 700 Area Landfill

Constituent	Sample Type
Asbestos	FIBROUS SILICATE
Chloride	ANION
Cyanide	CYANIDE
PCBs	CHLORINATED HYDROCARBON
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	DIOXINS/FURANS
Heptachlorodibenzo-p-dioxins (HpCDD), Total	DIOXINS/FURANS
Octachlorodibenzofuran (OCDF)	DIOXINS/FURANS
Octachlorodibenzo-p-dioxin (OCDD)	DIOXINS/FURANS
Hydrazine	HYDRAZINE
Monomethylhydrazine (MMH)	HYDRAZINE
Unsymmetrical Dimethylhydrazine (UDMH)	HYDRAZINE
Aluminum	METALS
Antimony	METALS
Arsenic	METALS
Barium	METALS
Beryllium	METALS
Boron	METALS
Cadmium	METALS
Calcium	METALS
Chromium (Total)	METALS
Chromium (VI)	METALS
Cobalt	METALS
Copper	METALS
Iron	METALS
Lead	METALS
Mercury	METALS
Molybdenum	METALS
Nickel	METALS
Potassium	METALS
Selenium	METALS
Silver	METALS
Strontium	METALS
Thallium	METALS
Tin	METALS
Uranium	METALS
Vanadium	METALS
Zinc	METALS
Bromacil	BROMACIL
N-Nitrodimethylamine	NITROSAMINES
N-Nitrosodimethylamine	NITROSAMINES
Nitrate	NITROGEN
Nitrite	NITROGEN
Perchlorate	PERCHLORATE
Bis(2-ethylhexyl) Phthalate	SVOA
Di-n-butyl Phthalate	SVOA
Diesel Range Organics	SVOA/TPH
1,1,1-Trichloroethane	VOA

Constituent	Sample Type
1,1,2-Trichloroethane	VOA
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	VOA
1,1-Dichloroethene	VOA
1,2-Dichloro-1,1,2-trifluoroethane (Freon 123a)	VOA
1,2-Dichloroethane	VOA
2,2-Dichloro-1,1,1-trifluoroethane (Freon 123)	VOA
2-Butanone (Methyl Ethyl Ketone)	VOA
2-Hexanone	VOA
2-Propanol	VOA
Acetone	VOA
Benzene	VOA
Bromodichloromethane	VOA
Bromoform	VOA
Chlorobenzene	VOA
Chloroform	VOA
Chloromethane	VOA
Dibromochloromethane	VOA
Dichlorofluoromethane (Freon 21)	VOA
Gasoline Range Organics	VOA/TPH
Methyl tert-Butyl Ether	VOA
Methylene Chloride	VOA
m-Xylene & p-Xylene	VOA
Oil Range Organics	VOA/TPH
Tetrachloroethene (PCE)	VOA
Toluene	VOA
trans-1,2-Dichloroethene	VOA
Trichloroethene (TCE)	VOA
Trichlorofluoromethane (Freon 11)	VOA

Table 3.1 700 Area Landfill and Vicinity Borehole and Well Completion Data

Borehole/Well and Type	Casing Elevation (ft amsl)	Depth to Bedrock (ft bgs)	Bedrock Type	Nov-2017 Depth to Groundwater (ft bgs)	Groundwater Elevation (ft amsl)	Screened Interval (ft bgs)	Borehole Total Depth (ft bgs)
300-D-153 Conventional	5112.82	75	Limestone	162.78	4950.04	153.10 – 173.80	194
700-A-253 Conventional	4912.38	149	Andesite	193.84	4718.54	253.00 – 263.40	287
700-B-510 Conventional	4809.57	285	Andesite	466.0	4343.57	510.00 – 530.84	550
700-D-186 Conventional	4889.20	180	Limestone	177.59	4711.61	186.00 – 196.30	205
700-E-458 Conventional	4722.01	285	Andesite	310.60	4411.41	458.10 – 478.90	515
700-F-455 Conventional	4767.67	305	Andesite	277.56	4490.10	455.0 – 475.03	526
700-G Abandoned Borehole	4779.19	260	Andesite	Dry	Dry	None	450
700-J-200 Conventional	4950.47	110	Hornfelsed Limestone	121.69	4828.78	199.64 – 219.68	240
700-H Westbay	4870.50	200	Andesite	264.77	4605.73	345.00 – 360.00 525.00 – 545.00 660.00 – 680.00	730
BW-6-355 Conventional	4818.71	238	Andesite	245.48	4573.23	355.00 – 375.53	401

National Aeronautics and Space Administration

SWMU 49, 700 Area Landfill Historical Information Summary

Revised March 2019

NM8800019434

Executive Summary

This report summarizes information regarding historical site operations, hazardous chemical use, and hazardous waste management practices at the NASA White Sands Test Facility (WSTF) solid waste landfill, located within the 700 Area. This summary will facilitate identification of any potential releases of hazardous substances or hazardous waste to the environment and is designed to support the development of the 700 Area Landfill Phase I Investigation Work Plan (IWP; NASA, 2017g). Attachment 16 of the WSTF Hazardous Waste Permit requires that this IWP be submitted to the New Mexico Environment Department (NMED) on or before December 29, 2017 (Permit; NMED, 2016b).

Operations and waste management practices at WSTF were not well documented prior to 1985, when a full-time Environmental Department was established at WSTF to implement waste management practices (including off-site shipment/disposal of hazardous wastes) and ensure regulatory compliance. Prior to 1985, the only WSTF wastes shipped off site for disposal were vehicle batteries (1963-present) and polychlorinated biphenyls (PCBs; 1980-present). Any wastes generated at WSTF prior to 1985, including hazardous wastes, were disposed on site. In general, liquid wastes were managed in surface impoundments and solid wastes were disposed in the 700 Area landfill. Documentation regarding 700 Area landfill waste management is incomplete. NASA has researched existing historical records and conducted interviews of both retired and active long-term site employees to determine the nature and timing of any releases or potential releases to the environment.

The SWMU number as listed in the Permit for the 700 Area landfill is SWMU 49, and the WSTF 700 Area landfill began operation between 1963 and 1965. The last waste was received on October 27, 1997. The total volume of waste within the landfill has been estimated as 78,000 cubic yards (cu. yd.), based on an estimate of 3,000 cu. yd. per cell and 26 total cells that were surveyed. This estimate may not be accurate; however, because the cells are not all uniform in size, and the survey may not have identified all cells.

The majority of wastes disposed in the 700 Area landfill included office and non-hazardous laboratory wastes with lesser amounts of construction and demolition debris, wood, yard waste, cafeteria waste, and animal carcasses, placed in a separate trench. Known wastes disposed in the 700 Area landfill that would be prohibited under current regulations include:

- Special wastes such as:
    - Infectious waste (sharps, blood, etc.) from the on-site dispensary.
    - Chemical or petroleum contaminated soils (lead, benzene, arsenic, cadmium, chromium, solvents).
- Hazardous wastes disposed in the 700 Area landfill included:
    - Contaminated debris (such as soft goods, hardware, and clean-up materials) contaminated with:
        - Fuels (unsymmetrical dimethylhydrazine [UDMH], Aerozine-50 [A-50]. monomethylhydrazine [MMH], and hydrazine).
        - Oxidizer (nitrogen tetroxide [N_2O_4]).
        - All 200 Area laboratory chemicals (e.g., trichlorofluoromethane [Freon 11], 1,1,2-trichloro-1,2,2-trifluoroethane [Freon 113], trichloroethene [TCE], tetrachloroethene [PCE], other solvents, isopropyl alcohol [IPA], other alcohols, acetone, methyl ethyl ketone [MEK], phosphorus, etc.).
        - Hydrocarbons (e.g., diesel, gasoline, hydraulic fluid, lubricating oils, motor oils, etc.).
        - Krytox lubricant (Appendix C contains material safety data sheets [MSDS]),

        - Teflon grease. and
        - Mercury (cloth used to clean broken thermometers or spills prior to initiation of shipping wastes off-site for disposal).
    - Small amounts of metals (stainless steel, carbon steel, titanium, aluminum, iron, mercury, copper, tin, gold, silver, chromium).
    - Fluorescent lights (lead, cadmium, mercury).
    - Fluorescent light ballasts (containing PCBs).
    - Mercury lamps (mercury).
    - Construction debris, insulation (asbestos).
    - Oil-based paints and primers (chromium, lead, ignitable).
    - Epoxies, resins, oils, adhesives, plastics, caulking, floor finish (solvents; possibly containing PCBs).
    - Copy paper, tapes, caulking.
    - Batteries (corrosive, lead, cadmium).
    - Photographic papers/negatives (silver [silver bromide]).
    - Etching plates (copper, metals).
    - Automotive wastes (tires, brake parts, filters, antifreeze, used oil).
    - Aerosol cans (barium, benzene, MEK, TCE, PCE, ignitable, corrosive, reactive wastes).
    - Broken or inoperable equipment/meters (metals, possibly asbestos and PCBs).
    - Pipes/plumbing (metals).
    - Spent charcoal (fluorine, reactive wastes).
    - Possibly wastewater (sewage) lagoon sludge.
- Liquids (estimated to be 10s to 100s of gallons [gal] annually from mid-1960s to 1985).
    - Unused or off-specification substances within containers or free liquids (lead, mercury, solvents, paints).
    - Freons (Freon 11 and Freon 113 in 55-gal drums and free liquids).
    - Other solvents (TCE, MEK, etc.).
    - Paints (barium, benzene, MEK, ignitable wastes; possibly PCBs).
    - Epoxies.
    - Electrolytes from batteries (from mid-1960s-1968; corrosive, lead).

Fires or explosions were also historically conducted within the trenches at the 700 Area landfill. During three different testing programs at WSTF (one in the 1960s, one in the 1970s, and one in 1985), small propulsion engines were destroyed using explosives within active trenches at the landfill. These engines may have contained fuel and oxidizer, and the solid propellant motor contained full solid propellants/oxidizer when destroyed. If the composition of the propellant was aluminum/ammonium perchlorate, then residual perchlorate may be present.

Long-term WSTF employees recalled one fire resulting from the destruction of engines within the landfill. The fire involved the active cell and an adjacent covered cell. One employee witnessed one "spontaneous" fire of flammable rags in the mid-1970s, and weekly intentional fires were set to destroy sensitive documents and computer cards within active trenches/cells conducted from the mid-1960s to the mid-1980s.

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List of Acronyms

µg/L	Microgram per Liter
A-50	Aerozine-50
ADF-SW	Aerospace Data Facility-Southwest
AML	Assessment monitoring level
amsl	Above mean sea level
AOC	Area of concern
$BaSO_4$	Barite
BATES	Ballistic Test and Evaluation System
BEHP	Bis(2-ethylhexyl)phthalate or di(2-ethylhexyl phthalate)
bgs	Below ground surface
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
cu yd	Cubic yard(s)
DoD	Department of Defense
DP	Discharge Plan
DR	Discrepancy Record
EIB	Environment Improvement Board
EPA	Environmental Protection Agency
ETU	Evaporation Tank Unit
Freon 11	Trichlorofluoromethane
Freon 113	1,1,2-Trichloro-1,2,2-trifluoroethane
ft	Foot or feet
FY	Fiscal year
gal	Gallon(s)
GCL	Geosynthetic clay liner
GeCL	Geoscience Consultants, Ltd.
HAFB	Holloman Air Force Base
HIS	Historical Information Summary
HWB	Hazardous Waste Bureau
HWMU	Hazardous Waste Management Unit
in.	Inch(es)
IPA	Isopropyl alcohol
IWP	Investigation Work Plan
JER	Jornada Experimental Range
JSC	Johnson Space Center
K	Hydraulic conductivity
lbs	pounds
LEL	Lower explosive limit
MCL	Maximum Containment Level
MEK	Methyl ethyl ketone
mg/L	Milligrams per Liter
MMH	Monomethylhydrazine
MSDS	Material Safety Data Sheet(s)
n.t.	No title
N_2O_4	Nitrogen tetroxide or dinitrogen tetroxide
NASA	National Aeronautics and Space Administration

NiCad	Nickel Cadmium
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMEID	New Mexico Environmental Improvement Division
NMSLO	New Mexico State Land Office
NOI	Notice of intent
ODU	Open Detonation Unit
PCB	Polychlorinated biphenyl
PCC	Post-closure care
PCE	Tetrachloroethene
PVC	Polyvinyl chloride
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAM	San Andres Mountains
SCAPE	Self-contained atmospheric protection ensemble
STGT	Second TDRSS Ground Terminal
SWB	Solid Waste Bureau
SWMR(s)	Solid Waste Management Regulation(s)
SWMU(s)	Solid waste management unit(s)
TCE	Trichloroethene
TDRSS	Tracking and Data Relay Satellite System
TDS	Total dissolved solids
TPS	Test Preparation Sheet
UDMH	Unsymmetrical dimethylhydrazine
UST	Underground Storage Tank
WSMR	White Sands Missile Range
WSTF	White Sands Test Facility

1.0 Introduction

1.1 Purpose

The National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC) White Sands Test Facility (WSTF) Hazardous Waste Permit (Permit) issued by the New Mexico Environment Department (NMED) requires the preparation and submittal of a historical information summary (HIS) for each solid waste management unit (SWMU) or area of concern (AOC) to be investigated (NMED, 2016b, Section VII.H.1.c). The information gathered during preparation of each HIS will be used to aid the development of unit-specific investigation work plans (IWPs). The purpose of this HIS is to evaluate past site operations, hazardous chemical usage, and waste management practices to identify known or potential releases of hazardous waste or hazardous substances to the environment in or around WSTF SWMU 49, the 700 Area landfill. The SWMU 49 Phase I IWP (NASA, 2017g) will be submitted concurrently with this HIS.

1.2 Scope

Information compiled in this summary was obtained from review of historical documentation, including reports, correspondence, files, and photographs. Additional information was obtained from questionnaires from, or interviews with, current and former WSTF employees. NASA collected and reviewed the information in this HIS between April and December 2017.

The observations and interpretations presented in this document are strictly limited in time and scope to the information obtained during the review process. No subsurface exploratory drilling, sampling, or chemical analyses were performed during the course of this evaluation. However, previous methane gas and groundwater monitoring associated with the 700 Area landfill is discussed.

1.3 Limitations and Assumptions

WSTF historical operations and waste management practices were not well documented from the inception of the site in 1963 through the mid-1980s. For this HIS, NASA relied on a limited assortment of documents, correspondence, and the recollections of long-term WSTF employees to provide waste disposal practices for SWMU 49, the 700 Area landfill. The information is subject to the limitations of historical documentation, availability and accuracy of pertinent records, and the personal recollection of the individuals interviewed. In many cases, there is insufficient information available to provide independent verification that the information is accurate and complete.

2.0 Site Description

2.1 Location

WSTF is located in Doña Ana County, 18 miles northeast of Las Cruces, New Mexico and 65 miles north of El Paso, Texas. Figure 2.1 provides a WSTF location map. Access to the site is provided via a paved road (NASA Road) that intersects U.S. Highway 70, one mile west of Organ, New Mexico.

2.2 Land Ownership

WSTF administrative and testing facilities are located on White Sands Missile Range (WSMR), owned by the U.S. Department of the Defense, Department of the Army (DoD). NASA is the operator of the facility under an inter-agency agreement with the U.S. Army (DoD, 1982). NASA also maintains land-use agreements with the Bureau of Land Management (BLM; a right-of-way agreement; BLM, 1978), the

New Mexico State Land Office (NMSLO; a water exploration/development easement; NM, 1989), and the U.S. Department of Agriculture, Agricultural Research Service Jornada Experimental Range (JER; an easement deed; USDA, 2003) for the use of lands located to the west of the industrial facility. Figure 2.2 provides an ownership overview of lands used by NASA.

2.3 Land Use

SWMU 49 is located within the industrial area of WSTF (Figure 2.2). All of the WSTF industrial areas are strictly for industrial use. Security and firefighting personnel staff the facility 24-hours per day, seven days per week; however, there are no full-time residents at WSTF. WSTF is a restricted access area closed to the public, and access by visitors is provided only in accordance with NASA JSC policies.

2.4 General Physical Setting

WSTF is located on soil composed of coalescent alluvial fans that are locally dissected by arroyos. The facility is bordered on the east by the north-south trending San Andres Mountains (SAM) that ascend over 6,000 feet (ft) above mean sea level (amsl). The WSTF site is bordered on the west by a broad uniformly sloping alluvial pediment plain extending into the Jornada del Muerto Basin and to the Doña Ana Mountains. The major alluvial fan systems originate from Bear Canyon to the northeast and Loman Canyon to the southeast of WSTF. Foothills on the western pediment of the SAM at WSTF are typically 4,800 to 5,000 ft amsl, are moderately sloping (15 to 25%), and consist of thin layers of alluvium covering fractured limestone and volcanic bedrock. The numerous dissecting arroyos only flow during periods of heavy rainfall. Figure 2.3 provides a topographic map of WSTF and surrounding areas.

3.0 SWMU 49 Background

3.1 Location and Current Use of the 700 Area

The 700 Area is located in Section 26, Township 20 South, Range 3 East. Access to the 700 Area is provided by gravel roads (Road P and Cereus Drive) from Apollo Boulevard, the main paved access road through WSTF. Currently, southwest of the landfill and also within the 700 Area is a high-energy blast facility used for expending ordnance and propellant blast testing as needed (Figure 3.1).

3.2 Physical Setting at the Property

Sections 3.2, Surface Conditions and 3.3, Subsurface Conditions in the SWMU 49, 700 Area landfill IWP provide detailed descriptions of the physical setting at the landfill (NASA, 2017g).

3.3 Description of Structures

Attachment 22 of the Permit (NMED, 2016b) identifies SWMUs at WSTF. The 700 Area contains two SWMUs, a remote testing area titled the 700 Area High Energy Blast Facility (SWMU 18) and the WSTF 700 Area landfill (SWMU 49; Figure 3.1).

Buildings and structures in the 700 Area High Energy Blast Facility include a control center, three temporary buildings/shelters, and several steel pole remnants. There are no buildings located within the 700 landfill area, but structures include both conventional and multiport groundwater monitoring wells surrounding the landfill and methane gas monitoring wells within the boundaries of the 700 Area landfill (Figure 3.1).

3.4 Current Uses of Adjoining Properties

3.4.1 Open Detonation Unit

The Open Detonation Unit (ODU) was an unlined, ramped, open trench surrounded by protective 3-ft high soil berms to restrict surface water drainage into the unit. The ODU was used for waste explosives treatment and disposal operations and was located adjacent to the northeast side of the 700 Area Landfill (Figure 3.1). The dimensions of the ODU were 46 ft long by 9 ft wide by up to 6 ft deep. The unit began operation in 1987 as an open burning/open detonation unit and was under interim operational status until the unit was permitted as only an open detonation unit (no burning allowed) under HWMR-6, Part V, Subpart X in 1993 as part of the WSTF Hazardous Waste Operating Permit (NMED, 1993b). The last waste disposed at the RCRA-permitted ODU was on March 23, 1999. In late 1999, NASA decided to permanently close the unit. Closure activities originally began on August 20, 2002. NMED approved the clean closure of this unit on August 12, 2005 (NMED, 2005). Disposal of excavated soil from the original ODU closure occurred on January 19, 2006. Final ODU backfill activities began on March 2, 2006 and were completed on March 3, 2006. The unit was backfilled with soil from the WSTF borrow area near Well J. NMED regulatory personnel inspected the closure on March 7, 2006 (NASA, 2006b).

3.4.2 Second TDRSS

The Second Tracking and Data Relay Satellite System Ground Terminal (STGT) is located to the west of the 700 Area (Figure 3.2). The STGT facility is part of the Space Network data communication system comprised of satellites in geosynchronous orbit (referred to as the Tracking Data Relay Satellites) and ground terminals with high-gain microwave antennas that relay data between satellites. Services include telecommunications, tracking and clock calibration, testing, and analysis 24 hours per day, 365 days per year (NASA, 2017e).

Buildings consist of a main operations building, a power plant, a vehicle maintenance building, a security guard building, and various storage and support buildings. Structures include two 15,000-gallon (gal) capacity fuel underground storage tanks (USTs), a 300,000-gal capacity potable water tank, and large antennas for satellite communications.

There are two SWMUs located within the STGT Area, the STGT small arms firing range (SWMU 29) and the STGT fuel UST (SWMU 52; also listed in the Permit as AOC 52). The STGT wastewater lagoon is listed in the Permit as AOC 51. It is currently managed in accordance with discharge plan (DP)-584 and is in the investigation and closure process.

3.4.3 600 Area

The 600 Area is located adjacent to the 100 Area and extends approximately 4 miles to the west of the other industrial areas at WSTF (Figure 3.2). The 600 Area is currently used for support of the WSTF water supply system, the groundwater monitoring well network, and the groundwater remediation systems. Buildings and structures adjacent to the 100 Area include groundwater assessment support buildings containing generators, gas cylinders, tools, and equipment necessary for performing groundwater assessment activities. Buildings and structures located in the 600 Area west of the industrial areas include buildings for chlorination and transfer of WSTF site water, WSTF water supply production wells, piezometers, exploration wells, groundwater monitoring wells, groundwater extraction and injection wells and associated buildings, and two groundwater treatment facilities, where groundwater contaminated with n-nitrosodimethylamine and volatile organic compounds is treated with ultraviolet light and air-strippers. The treated groundwater is then reinjected into the uncontaminated aquifer.

The 600 Area contains five SWMUs, the terminus of the historical 200 Area hazardous waste transmission line (SWMU 10), the JP remote test areas (SWMU 14), the 600 Area burn pit (SWMU 15), the BLM or 600 Area off-site soil pile (SWMU 16), and the 600 Area overflow wastewater lagoons (SWMU 34, managed in accordance with DP-392 and currently in the investigation and closure process). One hazardous waste management unit (HWMU) is also located in the 600 Area, the former 600 Area surface impoundments that historically contained dilute hazardous waste resulting from 200 Area laboratory operations (NASA, 1996d). This HWMU was closed in 1989 as an interim landfill. An HWMU investigation was completed in March 2011 (NASA, 2011c), and NMED Hazardous Waste Bureau (HWB) approved the 600 Area Closure Investigation Report on June 9, 2011 (NMED, 2011a).

3.4.4 500 Area

The 500 Area contains two separate locations, one area is located south of the 300 Area and the other is located south of the 700 Area (Figure 3.2). The 500 cryogenic storage area is used for storing large quantities of gases used at WSTF, including nitrogen and oxygen. There are no SWMUs associated with this area.

The 500 fuel and oxidizer storage area was designed to store fuel and oxidizer for use at WSTF. Buildings and structures include small control buildings, shelters, piping, breathing air generation equipment, and the permitted Fuel Treatment Unit, where fuel wastes are diluted and stored until shipment off site for disposal. There is one SWMU located in the area, the 500 Fuel Storage Area (SWMU 47), identified by NASA in March 2000 (NASA, 2000b). A preliminary investigation consisting of three soil sampling events was completed in July and December 2000 and May 2001. The results of this investigation were summarized in the 500 Fuel Storage Area HIS (NASA, 2011d).

3.4.5 400 Area

Both the WSTF 300 and 400 Areas are part of the WSTF propulsion test office. Both areas were designed and constructed to test various propulsion systems, including those necessary to accommodate cold flow and hot firing static testing (NASA, 1994f). Combined current capabilities include development, qualification, and acceptance testing, custom modifications, testing existing systems, developing new systems, certification requirements, propellant and aerospace fluids handling and expertise, decommissioning and decontamination of systems for repurposing and/or recycling, and developing, testing, or evaluating new technologies, standards, services, protocols, and best practices (NASA, 2017c).

The 400 Area is located south of the 700 Area (Figure 3.2). Test facilities and support buildings in this area include two altitude dual-position (vertical and horizontal) firing test stands, one ambient dual-position (vertical and horizontal) firing test stand, and two altitude horizontal-firing test stands (one capable of firing solid propellant engines), a test control building, and several preparation buildings. The altitude simulation test stands use either boilers to operate vacuum pumps or three alcohol/liquid oxygen combustion rocket engines to operate a water steam generator to create a vacuum that simulates high altitude conditions. Test support systems include pressurization, storage, and handling of large amounts of alcohol, liquid oxygen, nitrogen, oxidizer, hypergolic propellants, diesel generators, and a pretreatment boiler water system.

SWMUs located within the 400 Area include the 400 Area oxidizer burner (SWMU 12), the 400 Area historical aspirator discharge pipe (SWMU 13), the 400 Area main septic tank (SWMU 27, managed in accordance with DP-392), and the 400 Area four-cell, boiler water discharge (salt) pond (SWMU 48, managed in accordance with DP-1170). The three septic tanks historically used in the 400 Area were removed in January 2015, February 2016, and April 2016 accordance with NMED Liquid Waste Program regulations and the approved (with modifications; NMED, 2013c) septic tanks IWP, which included the septic tanks removal plan (NASA, 2013b).

The 400 Area also contains one HWMU. This HWMU consisted of two concrete-lined surface impoundments and three reinforced concrete treatment tanks that historically contained dilute hydrazine-type propellants (MMH, hydrazine, UDMH, A-50), oxidizer, and referee propellants (1,1,2-Trichloro-1,2,2-trifluoroethane [Freon®[1] 113] and Trichlorofluoromethane [Freon 11]). This HWMU was approved as an interim landfill by NMEID in 1989 (NMEID, 1989), and the 400 Area Closure IWP (NASA, 2011d) was approved by NMED HWB in November 2011 (NMED, 2011c). The 400 Area HWMU is currently being investigated.

3.4.6 300 Area

The 300 Area is located to the southeast of the 700 Area (Figure 3.2). Test facilities and support buildings in the 300 Area include one ambient, dual-position (vertical and horizontal) firing test stand, one altitude simulation, dual-position (vertical and horizontal) firing test stand, one altitude simulation, horizontal-firing test stand, one ambient, horizontal-firing test stand, two below grade structures for instrumentation and control signal conditioning equipment, a test control center, a remote command building, and shelters for equipment storage. Test support systems include fuel and oxidizer storage, pressurizing, and handling.

SWMUs located within the 300 Area include the 300 Area oxidizer burner (SWMU 11), three septic tanks (the 300 Area main septic tank [SWMU 24], the Building 320 septic tank [SWMU 25], and the Building 364 septic tank [SWMU 26], all three were managed in accordance with DP-392), and the 302 condensing water discharge pond (SWMU 33, managed in accordance with DP-697). The three septic tanks historically used in the 300 Area have been removed in May 2015, February 2016, and April 2016 in accordance with NMED Liquid Waste Program regulations and the approved (with modifications; NMED, 2013c) septic tanks IWP, which included the WSTF septic tanks removal plan (NASA, 2013b).

There is one HWMU located within the 300 Area. This HWMU consisted of two concrete-lined surface impoundments and three reinforced concrete treatment tanks that historically contained dilute hydrazine-type propellants (Monomethylhydrazine [MMH], hydrazine, unsymmetrical dimethylhydrazine [UDMH], Aerozine-50 [A-50]), and oxidizer. This HWMU was approved as an interim landfill in 1989 by NMEID (NMEID, 1989). An investigation of the HWMU was completed in October 2011. NASA submitted the Closure Investigation Report on August 30, 2011 (NASA, 2011e), and NMED HWB approved the 300 Investigation Closure Report on October 13, 2011 (NMED, 2011b).

3.4.7 200 Area

The 200 Area is located to the south of the 400 Area (Figure 3.2). Personnel in the 200 Area conduct materials and component testing in hazardous environments, including materials properties determination, materials compatibility and toxicity analyses, detonation studies, flight article outgassing characterization, systems analysis, orbital debris impact simulation testing, and propellant characterization. Area personnel contain expertise in composite material structures (testing, nondestructive evaluation, and analysis) and oxygen systems, including compatibility in air and space crafts and for industrial and medical applications. Personnel and facilities in the 200 Area also provide support for the Propulsion Test

[1] Freon is a registered trademark of The Chemours Company CF, LLC.

Department at WSTF, including preparing test articles, performing analytical services, and fabrication and cleaning of aerospace program articles. (NASA, 2017d).

The 200 Area laboratory and test preparation complex consists of offices, storage space, preparation rooms, clean rooms, shops, test facilities, various laboratories (including photography, fuel, oxidizer, chemistry, metallurgy, molecular desorption, analytical, gas and spectroscopy, x-ray, vacuum, and calibration laboratories), and support areas for testing activities. The laboratory and test preparation complex also contains systems for the storage and handling of many types of propellants, corrosive chemicals, flammable solvents, and compressed gasses.

SWMUs located within the 200 Area include the clean room discharge pipe (SWMU 4), the self-contained atmospheric protection ensemble (SCAPE) room discharge pipe (SWMU 5), the Building 203 discharge pipe (SWMU 6), the South Highbay discharge pipe (SWMU 7), the 200 Area sewage lagoons (SWMU 8), the 200 Area main burn pit (SWMU 9), the beginning of the historical hazardous waste transmission lines (SWMU 10), two septic tanks located adjacent to Building 272 (SWMU 23), and the 200 Area small arms firing range (SWMU 30). The SWMU 23 septic tanks were removed in December 2015 in accordance with NMED Liquid Waste Program regulations and the approved (with modifications; NMED, 2013c) septic tanks IWP, which included the WSTF septic tanks removal plan (NASA, 2013b). SWMU 9 was investigated in June 2015, and NMED HWB approved the IR with modifications in May 2016 (NMED, 2016). SWMU 10 was investigated in May through August 2016. NASA submitted the SWMU 10 IR to NMED HWB in December 2017 (NASA, 2017f). Accelerated corrective measures activities for SWMU 30 commenced in September 2015 and are still in progress currently.

The 200 Area contained three HWMUs (the clean-closed Evaporation Tank Unit [ETU]) and two separate closed HWMU sites that historically contained four hazardous waste USTs. The ETU treated aqueous wastes by evaporation in two open-top lined tanks in accordance with the Permit (NMED, 2016b). On January 17, 2012, NASA submitted the ETU Closure Plan to NMED HWB and was approved for implementation on June 19, 2012. NASA conducted a soil investigation of the soil beneath the hazardous waste drain line and ETU tanks, and NASA submitted the ETU Closure Certification Report to NMED on August 1, 2013 (NASA, 2013c). On September 5, 2014, NASA received NMED HWB approval for the ETU Certification Report (NMED, 2014).

The two closed HWMUs were the west and east closures. The west closure consisted of two steel USTs for storing hazardous wastes derived from the clean room. The east closure consisted of two USTs, one steel and one concrete, for storing hazardous wastes derived from the 200 Area laboratories complex (other than the clean room). All of the USTs were excavated and removed, and the areas were closed as interim landfills in 1986, with NMEID approval received in 1989 (NMEID, 1989). A vadose zone investigation was conducted in the 200 Area in two phases. Phase I included geophysical and shallow soil vapor surveys in 2012. NMED HWB approved the phase I status report with modifications October 22, 2013 (NMED, 2013b). Phase II included drilling 18 soil borings and installing 15 soil vapor wells and 2 soil vapor, groundwater wells. NMED HWB approved the 200 Area Phase II IR on November 30, 2015 (NMED, 2015a). The 200 Area is currently undergoing a vapor intrusion investigation.

3.4.8 800 Area

The 800 Area is located adjacent to the 200 Area to the northeast (Figure 3.2). This area performs tests for ignition and combustion characteristics on a variety of materials in various liquid and gaseous atmospheres for aerospace, aircraft, medical, and industrial applications. Compatibility assessments and post-fire failure analyses are performed to identify potential problems and fire causes to recommend design criteria and avoid future real-world fires. The 800 Area contains a control building, 30 reinforced concrete test cells (18 Hazardous Fluids Test Area cells and 12 High Pressure Test Area cells), various test support structures, and test support systems for the pressurization, storage, and handling of cryogenic materials and oxygen. SWMUs located within the 800 Area include an oxidizer burner (SWMU 20) and a below grade storage tank (SWMU 19) for temporary storage of diluted and residual testing fuels. The SWMU 19 below grade storage tank area was investigated in November and December 2015, with an additional soil boring installed in October 2017 (NASA, in press).

3.4.9 100 Area

The 100 Area is located southwest of the 200 Area (Figure 3.2). Buildings and structures within the 100 Area include office facilities for administrative, management, and engineering activities, an emergency center (Fire Department and Clinic), security facilities, heavy equipment maintenance and related facilities, vehicle maintenance facilities, construction facilities, warehouse facilities, trade/fabrication shops, storage buildings, waste accumulation areas, a fuel station, a cafeteria, a fitness center, and an auditorium (NASA, 1994f). The warehouse and support buildings house all materials, supplies, and substances entering WSTF. Distribution of goods/substances to the appropriate industrial area is accomplished following receiving procedures at the warehouse.

SWMUs located within the 100 Area include the 100 Area burn pit (SWMU 1), the 100 container storage area (SWMU 3), two septic tanks (SWMUs 21 and 22), an abandoned small arms firing range located near groundwater monitoring well WB-2 (SWMU 31), and the WSTF active firing range (SWMU 53). SWMUs 1 and 3 were investigated in June 2015, and NMED HWB approved the IR with modifications in May 2016 (NMED, 2016). The SWMU 21 and SWMU 22 septic tanks were removed in July 2017 and November 2016, respectively, in accordance with NMED Liquid Waste Program regulations and the approved (with modifications; NMED, 2013c) septic tanks IWP, which included the WSTF septic tanks removal plan (NASA, 2013b). The SWMU 22 site is currently being investigated. Accelerated corrective measures activities were instigated for SWMU 31 in September 2015 and are still in progress currently.

3.4.10 TDRSS

TDRSS is located south of the 100 Area (Figure 3.2). The mission of TDRSS is to provide communications and data links between satellite users and spacecraft in earth orbit through the TDRSS fleet. The data is relayed from the orbiting tracking and data relay satellites to the TDRSS ground terminals for processing and transmitting to users (NASA, 2017e). Buildings and structures at the TDRSS facility consist of an operations building, a security guard building, a technical support building, the Extended TDRSS Ground Terminal, a wood building shop, hazardous chemical storage and flammable storage buildings, a remote generator building, various storage buildings, large antennae for satellite communications, and various fuel tanks and support systems. There is one SWMU located at the TDRSS facility, the TDRSS diesel release (SWMU 50).

3.4.11 ADF-SW

The Aerospace Data Facility-Southwest (ADF-SW) is located south of TDRSS (Figure 3.2). It is an Air Force facility that supports worldwide defense operations and the collection, analysis, reporting, and dissemination of intelligence information for multiple agencies. This area contains an operations building, a data storage building, a security guard building, a warehouse, a gymnasium, large-capacity water tanks, above-ground diesel storage tanks, emergency generators, and various support buildings and systems. There are no SWMUs managed by NASA located at the ADF-SW.

4.0 Historical Records Review

4.1 Record Sources

Reasonably ascertainable and practically reviewable records relevant to the history, operations, and environmental conditions of SWMU 49, the 700 Area landfill, were selected and reviewed dating back to 1964. The type and location of these records are as follows:

- NASA Environmental Records – Located on site in the WSTF Environmental Department and available in both paper and electronic forms. They include:
    - Reports (Resource Conservation and Recovery Act (RCRA) Facility Investigation [RFI] (NASA, 1996d), WSMR quarterly and annual reports, inspection reports, annual reports to regulatory agencies, site assessment, closure plan, groundwater monitoring reports).
    - Solid waste regulations (New Mexico Solid Waste Management Regulations [NM SWMRs], Code of Federal Regulations [CFR], New Mexico Administrative Code [NMAC], solid waste amendments).
    - Correspondence (NASA, contractor, NMED, Environmental Protection Agency [EPA]).
    - Internal WSTF documents (correspondence, analytical data, memoranda, reports, e-mail communications, records of communication, Environmental Committee meeting minutes, regulation reviews, internal inspections, field notes, waste minimization records, recycling records, landfill closure records, environmental resource documents).
    - Laboratory reports.
- WSTF Test Records – Located on site in the Quality Assurance Office available in electronic form including:
    - WSTF test preparation sheets (TPSs).
    - Discrepancy records (DRs).
- NASA Photographs – Located on site in the WSTF Photography Laboratory.
- NASA Engineering Drawings – Located on site in the WSTF Drafting Department.

4.2 Interviews and Questionnaires

In addition to the review of historical records, interviews with current long-term and retired WSTF personnel were also conducted. A summary of information obtained from interviews is provided in Appendix A.

5.0 Operational History

The following sections discuss the operational history for WSTF.

5.1 Pre-WSTF History

From the early 1800s to approximately 1935, the Organ Mountains and the SAM were mined for gold, silver, zinc, copper, and lead. There were several established mines located in the SAM and numerous prospect mines. The nearest established mine to WSTF was the Smith Mine located approximately 1 mile southeast of WSTF within the Loman Canyon area. The Smith Mine produced approximately $30,000 worth of silver ore during its operations. Deposits of galena (lead sulfide) and barite ($BaSO_4$) were also mined just north of the eastern mouth of Bear Canyon.

Lands now occupied by WSTF were historically open-range grazing lands. The ruins of a historic ranch house (Gardner Ranch) are located just east of the current 200 Area laboratory facilities, and Love Ranch is located approximately 1.6 miles east of the 700 Area. These properties were acquired by the federal government and became part of WSMR in 1952.

5.2 Inception of WSTF

NASA Headquarters announced selection of a testing site in south-central New Mexico on July 6, 1962. The site was chosen for the isolated location and topography, which minimized the inherent hazards of aerospace propulsion testing to the general population. From the date of the official announcement until January 1965, the site was known as the Propulsion Systems Development facility. From January to June 1965, the official designation was White Sands Operations. Then on June 16, 1965, the official name of the installation was changed to White Sands Test Facility (NASA, 1986a).

Site planning activities began in August 1962. Exploratory drilling to locate a water supply source began in December 1962, and drilling of water supply wells was completed in May 1963. Development of the site location began in May 1963 with construction of the access road (NASA Road) from U.S. Highway 70. The access road was completed in October 1963 (NASA, 1980b, 1986a). The first increment of the 300 Propulsion Test Area was completed, and the first permanent personnel began working at WSTF in January 1964 (Fire Department). By April 1964, full time employees were working in the Propulsion Department. The second increment of the 300 Propulsion Test Area was completed by June 1964, followed by the 200 Area Preparation Buildings (200 and 201 in December 1964 and 203 in March 1965) and the 400 Propulsion Test Area in November 1965. The 100 Area was constructed to be the project control area. Building 114 was constructed in 1963. Building 100 was completed in March 1964, followed by Building 101 in January 1965. The initial emergency center (Building 112), the security guard station (Building 116), the cafeteria (Building 111), the warehouse (Building 120), and maintenance shops (Buildings 113 and 121) were also constructed during 1964. Other support buildings were constructed as needed from 1965 through 1966. The 800 Area was completed between January 1974 and December 1979 (NASA, 1986a). The 200 Area Laboratory consolidation facility addition to Building 200 was constructed from 1989 to 1990, and the 250 and 270 testing areas were completed between 1987 and 1991 (NASA, 1994f).

TDRSS was constructed in 1977, with expansions built in 1982 and 1996. STGT was constructed in 1988 (NASA, 1994f) with additions in 1994 and upgrades in 1996. Currently, the ground terminals are undergoing a ground segment sustainment project to modernize the ground terminals while maintaining the space network (NASA, 2011b). According to a long-term employee, the Air Force facility, titled ADF-SW was constructed in 1983 and 1984, with expansions in 1991 and 2004 (Appendix A).

Locations for the specific areas of WSTF were chosen to minimize the potential impact and hazards in one area from affecting any other areas. Hazardous test and storage areas were located downwind from administration areas, the 300 and 400 propulsion areas were positioned so that they were not in line with respect to the prevailing wind direction, and the 200 Area was located far enough from the 300 and 400 propulsion areas for sufficient acoustic attenuation, blast pressure decay, and adequate reduction of fragment impingement hazards, but close enough for easy transport of test articles to and from the test areas (NASA, 1980b). The land use buffer zone surrounding WSTF was designed to ensure a safe distance for diffusion of vapors or other hazards to avoid impacts to off-site inhabitants, livestock, and agriculture.

6.0 700 Area Landfill (SWMU 49) History

This section outlines the history of solid waste regulation implementation at WSTF and the history of the 700 Area landfill (SWMU 49) design, operations, waste disposal, waste minimization, groundwater monitoring, methane monitoring, closure activities, and post-closure care (PCC). Figure 6.1 presents a map of the 700 Area landfill, and Figure 6.2 shows a photograph of the landfill while still in use in September 1993. There were no photographs located that show details of the 700 Area landfill prior to 1993.

6.1 700 Area Landfill (SWMU 49) Regulatory History

The current 20 NMAC 9.2 provides a history of New Mexico solid waste management regulations. "Pre-NMAC History: The material in this part was derived from that previously filed with the commission of public records – state records center." These regulations were NM Environment Improvement Board (EIB) 74-1, Solid Waste Management Regulations, filed 5/3/74, EIB/SWMR-2, Solid Waste Management Regulations, filed 4/14/89, EIB/SWMR-3, Solid Waste Management Regulations, filed 12/31/91, and EIB/SWMR-4, Solid Waste Management Regulations, filed 7/18/94. The EIB/SWMR-4 was renumbered into the first version of the 20 NMAC 9.1, Solid Waste Management Regulations, effective 11/30/95, and the 20 NMAC 9.1, Solid Waste Management Regulations were repealed 8/2/07, when the current 20 NMAC 9.2 regulations replaced them (20.9.2 NMAC).

20 NMAC 9.2 provided the definition of a landfill: "a solid waste facility that receives solid waste for disposal…" Solid waste is defined as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, construction, demolition and agricultural operations and from community activities…" (20.9.2 NMAC).

NM SWMRs of 1989 (EIB/SWMR-2) defined a sanitary landfill as "a facility employing an engineered method of disposing of solid wastes on land in a manner that minimizes environmental hazards and meets the design and operation requirements of these regulations" (EIB, 1989).

On October 19, 1978, NASA registered the 700 Area landfill with the New Mexico Environmental Improvement Division (NMEID). In this letter, NASA stated, "There is no record in our files of the system having previously been registered, and no record of an application having been submitted" (NASA, 1978), suggesting that this was the first regulatory action regarding the landfill taken by NASA. This began interim status operation of the 700 Area landfill.

In 1980, NASA completed an Environmental Resources Document that described the laws and regulations governing operations of the 700 Area landfill. "The generation, treatment, storage, and disposal of solid wastes at WSTF are subject to provisions of the Federal Water Pollution Control Act, the Solid Waste Disposal Act, the Resource Conservation and Recovery Act, and various other Federal laws and regulations administered by the EPA…State of New Mexico laws and regulations regarding solid wastes include the Solid Waste Management Regulations, the New Mexico Water Quality Act, and various Water Quality Control Commission Regulations" (NASA, 1980b).

Also in 1980, NASA filed a RCRA Part A Hazardous Waste Permit application with the NMEID (NASA, 1980a). The 700 Area landfill was originally included in the permit application. NASA applied to NMEID to remove the landfill from the Part A Hazardous Waste Permit application in October 1984. NASA stated that the 700 Area landfill had been erroneously included in the Hazardous Waste Application due to disposal of warfarin rat poison. NASA replied that "the landfill has never been used for the disposal of any hazardous wastes, including warfarin (EPA ID number P001), the rat poison chemical for which the landfill was originally listed" (NASA, 1984b). On October 19, 1984, NMEID approved the removal of the landfill from the Permit application and requested that NASA file an amended Part A form (NMEID, 1984). On November 30, 1984, NASA submitted a revised Part A permit application that did not include the 700 Area landfill (NASA, 1984c).

On November 9, 1984, the Hazardous and Solid Waste Amendments of RCRA were signed into law, and NMEID sent a letter to NASA in March 1985 regarding changes that may affect WSTF.

> "These Amendments add a considerable number of new requirements for the treatment, storage and disposal that EPA and the States permit under Subtitle C of the RCRA…If you are a generator and have an on-site facility after September 1, 1985, you must certify, at least annually, that you have reduced the volume and toxicity of the waste to the maximum degree economically practicable, and that the method you use to manage the waste minimizes the risk to the extent practicable… After May 8, 1985, you will not be able to dispose of bulk or non-containerized liquid hazardous waste or free liquids contained in hazardous waste (regardless of whether or not absorbents have been added) in your landfill. After November 8, 1985, you will not be able to dispose of non-hazardous liquid wastes in your landfill…until EPA authorizes your State to manage aspects of the program based upon the provisions in the Amendments, your RCRA permit will need to be jointly issued by the State and EPA to be fully effective" (NMEID, 1985a).

To comply with these and other regulations, NASA initiated a full-time Environmental Department and began a site-wide program of waste management and waste reduction. NASA listed the 700 Area landfill as a SWMU in a report provided to the EPA on June 14, 1985 (NASA, 1985a). Then, in March 1987, a variance from NM SWMRs, Sections 108.F.1 and 2, was requested regarding requirements for fence and cattle guard installation around the 700 Area landfill. The justification for the variance request was, "The NASA/White Sands Test Facility (WSTF) landfill is used only by the institutions located at this site. Access to the WSTF site is restricted and the location is entirely fenced and protected by cattle guards at roads. Because the Facility is protected from the entrance of cattle, a variance is requested to exclude the 700 Area landfill from the requirements of fencing and maintaining a gate or cattle guard at the landfill" (Lockheed, 1987). NMEID granted the variance for one year on April 1, 1987 (NMEID, 1987). The variance was requested and granted again for 1988 (NASA, 1988d; NMEID; 1988).

NASA requested a variance from the same requirements of the newly enacted NM SWMR-2 regulations in 1989 (NM SWMR-2, Section 301.E); however, a fence seems to have been installed at the landfill by 1989. "…the landfill itself is enclosed with a three-strand barbed wire fence. A variance is therefore requested from additional requirements for access control at the facility landfill," i.e., maintaining a gate or cattle guard at the landfill entrance. NASA also included two additional variance petitions: for the control of methane gas generation and inspection procedures (NASA, 1989g). The justification for methane gas control, NM SWMR-2, Section 301.C, was:

> "The NASA WSTF landfill is remotely located from all WSTF structures and is over 3 miles from any public or private structures. Construction and office trash, which is not expected to generate significant amounts of methane gas, account for the majority of material disposed in the WSTF landfill. Based upon the distances involved and the nature of disposed materials, a variance from the methane gas control requirement is requested."

For inspection procedures, NM SWMR-2, Section 301.N.1.c, 2.b, 2.c, and 2.d, the justification stated,

> "In order to insure proper operation, the NASA WSTF landfill is inspected on a weekly basis. Several other factors also facilitate control of waste disposal in the landfill. These include the

small size, operational limits, employee education, and utilization of only one vehicle for transportation of wastes. Based upon these factors, the following variances are requested:

- 301.N.1.c: An inspection area located away from the tipping area is not needed because of the small size of the operation and direct inspection of the tipping area during unloading operations.
- 301.N.2.b: A written record of the transportation company and driver transporting waste to the facility landfill is unnecessary as WSTF utilizes only one Government vehicle for this purpose.
- 301.N.2.c: NASA WSTF has only one vehicle for transport of waste which renders the requirement to maintain a written record of truck license and description unnecessary.
- 301.N.2.d: NASA WSTF does not receive waste from offsite which makes it unnecessary to maintain a written record of the waste source" (NASA, 1989g).

NMEID toured WSTF in response to the variance requests and determined that NASA did not need a variance for methane gas control "as the Division has determined the types and small quantities of waste landfilled are accepted as a demonstration that the waste will not generate methane which will migrate laterally from the landfill site so as to endanger structures, vegetation or occupants of adjacent properties" (NMEID, 1990). NMEID personnel also stated that a variance for maintaining a cattle guard at the landfill was not required due to the existing security measures at WSTF and the landfill. The inspection and record requirements variances were granted; however, NMEID required NASA to determine current landfill fill rates (NMEID, 1990). In response, NASA provided a description of the solid waste transport vehicle at WSTF (NASA, 1990b) and a way to track waste to the landfill. "The method which will be utilized will be to calculate the size of the trench and monitor the quantity of fill dirt and the amount of time it takes to fill it up. This will provide a quantity of waste per trench and when combined with the dates the trench is opened and closed, give the rate…This information will be maintained…for the current and future trenches, but will not be retroactive" (NASA, 1990c). Detailed records of wastes, quantities disposed, and amounts of fill dirt used were not located; however, general waste types and estimates of quantities disposed annually were provided to NMEID/NMED in annual reports beginning in 1990.

From an internal WSTF memorandum regarding new requirements of NM SWMR-2, "New Mexico has recently issued new regulations (effective May 15, 1989) for solid waste landfills restricting the disposal of infectious waste…(sharps, blood, etc.)…The new regulations will require that infectious waste either be treated to render it non-infectious or disposed of as 'special waste.' In order to dispose of 'special waste' in the WSTF landfill, operational and permitting modifications would be required. The increase in operating cost and permitting requirements do not make this a reasonable choice" (NASA, 1989d). Special wastes were no longer accepted to the WSTF landfill by May 1989.

The NM SWMRs of 1989 also required that landfills certify operations and obtain a permit for operation if requested. NASA submitted a certification letter to NMEID on August 8, 1989, "This letter will serve as certification, as required under section 201.B of the NM SWMR-2, that the WSTF landfill will continue to operate after May 15, 1989, on a temporary basis until a permit is issued" (NASA, 1989e). NMEID acknowledged the receipt of NASA's notice of intent (NOI) to continue operating on August 14, 1989. The letter also stated, "An application for a permit to operate a solid waste management facility may be requested at anytime [sic] from the Solid Waste Section. The application, however, will not need to be submitted to the Solid Waste Section until you are given notification to send in your application for review. The application must then be submitted within 90 days after receipt of the request for review" (NMEID, 1989). However, a solid waste operating permit was never applied for nor obtained from NMEID/NMED in the active life of the 700 Area landfill, since it was never requested of NASA.

A groundwater monitoring program began at the 700 Area landfill in late 1989, and the first solid waste facility annual report was submitted to NMEID in March 1990, summarizing landfill information from

May 15, 1989 (the effective date of the NM regulations) through December 31, 1989 (NASA, 1990d). Refer to Section 6.6 for details of the 700 Area landfill groundwater monitoring program.

Continuing compliance with newly enacted solid waste regulation requirements, by May 1991, 700 Area landfill operators were trained and present during operational hours of the landfill, according to an inspection conducted by NMED Solid Waste Bureau (SWB) personnel (NMED, 1991).

NASA received a notice of violation from a NMED SWB landfill inspection in late November 1991. "Notice of Violation items were § 106.A.1 and 2, recording the quantity of waste received on a diagram or map and § 301.B., litter (minor) in the landfill area." Better compaction was also suggested for the landfill. In response to these violations, corrective actions proposed included strictly controlling landfill access with locked gates and only two operation days a week, removing cardboard from the solid waste disposed at the 700 Area landfill, keeping a log of "pit" location and contents, and compacting waste after each load was delivered (NASA, 1991h); however, documentation suggests that cardboard was not recycled until October 1995 (see Section 6.6), and landfill waste logs were not initiated (NASA, 1991g).

The NM SWMRs were amended again (third revision) in December 1991 (effective date January 31, 1992). These regulations required that NASA submit a NOI to continue operation of the 700 Area landfill and also a preliminary site assessment summary within one year. NMED would then rank the landfills in New Mexico and request submittal of permit applications based on the landfill rankings. Variances in effect for landfills would be honored until their expiration dates. New groundwater remediation standards were added that were derived from the New Mexico Water Quality Control Commission Standards and the Safe Drinking Water Act standards (NASA, 1991e).

A regulatory review of NM SWMR-3 was performed by a WSTF Environmental employee. Any operational changes, such as disposal of special wastes or expansion of the landfill area, would require modification of the original registration. Special wastes were revised for these regulations to include:

> "solid waste…residue from a chemical spill of a chemical substance or a commercial product (including contaminated soils)…no person shall dispose of petroleum waste, certain sludges, sewage or septage at a facility, dispose of hazardous waste at a facility unless permitted for such; dispose of bulk liquids at a landfill…" (NASA, 1991f).

NASA altered landfill operations to comply, no longer accepting chemical or petroleum spill residues.

The regulations also increased documentation requirements. "All facilities must maintain daily records and submit annual reports. The annual report must summarize facility activities including waste types, quantities, remaining capacity, a narrative of the operator's progress in implementing the closure plan, and any monitoring results." Other requirements included:

- Keeping a schedule of cell filling and methods of compaction of solid waste.
- A description of ground water monitoring, vadose zone monitoring, liner, leachate collection, landfill gas monitoring and control.
- Confining solid waste to the smallest practical area.
- Preventing unauthorized access.
- Providing fire control measures.
- Providing contingency, closure, and PCC plans.

- Operators must also be certified every 3 years by passing training courses in landfill operation, design, geology/hydrology, engineering, and environmental issues.
- Any variances must be accompanied by proof of public notice (NASA, 1991f).

It was recommended that NASA:

> "…seek variances from any inappropriate requirement due to the site security, lack of public access, written disposal procedures, and the uniqueness and isolation of the facility. Currently WSTF maintains variances for load checking and record maintenance, methane gas monitoring, access control" (NASA, 1991f).

Other recommendations included submitting a NOI to continue operating, surveying the landfill to locate areas for future use, placing future cells close together, completing a preliminary site assessment, training and certifying a 700 Area landfill operator approved by NMED, disposing of no special wastes, and developing closure and PCC plans (NASA, 1991f). As part of the required preliminary site assessment, soil samples would need to be collected and analyzed. This soil sampling could be conducted in conjunction with excavating a new cell, estimated in mid-October 1992 (NASA, 1992d). On January 29, 1992, NASA submitted the NOI to continue operating the 700 Area landfill in interim status (NASA, 1992b).

In April 1993, NMED SWB prompted NASA:

> "This is to remind you that site assessments are required to be completed on all landfills which are currently being operated under interim status…The site assessments are required as a condition to maintaining interim operating status under the Solid Waste Management Regulations. The information will be used to rank landfills for calling in permit applications in the future" (NMED, 1993c).

NASA submitted the 700 Area landfill site assessment to NMED SWB on June 2, 1993 (NASA, 1993c). The site assessment summarized:

- The landfill field investigation (installing four groundwater monitoring wells; 700-A-253, 700-B-510, 700-D-186, and 300-D-153).
- The surface geology (Quaternary alluvial fan/piedmont slope alluvium).
- The subsurface geology (limestones of the Pennsylvanian Heuco and Permian Panther Seep Formations, the Eocene or Oligocene Orejon Andesite, and late Tertiary to Quaternary Camp Rice Formation and piedmont slope alluvium).
- Groundwater occurrence (within fractured bedrock flowing from east to west).
- Wind direction (predominantly from the south and east).
- The subsurface soils (no continuous clay beds; fine-grained soils were not encountered in borings; NASA, 1993c).

For the category "Proximity to Water Courses," the 700 Area landfill was reported as "Within 200 feet of a major arroyo/intermittent stream." Stormwater runon/runoff was accomplished naturally. "The channels of intermittent streams in the landfill area…directs stormwater run on away from the surface of the landfill. The landfill surface is topographically higher than adjacent stream channels" (NASA, 1993c).

In 1994, landfill compliance with proposed NM SWMR-4 (fourth revision) regulations was discussed in an internal memorandum.

> "WSTF's existing landfill is located within 200 feet of a watercourse. This provision will not apply to WSTF until the Secretary requests a permit application…a permit application will be called for within the next year…The operating record must include the type and amounts of solid wastes received, haulers of the waste, deviations from approved designs and plans, and document groundwater monitoring activities…Based on the review of these regulations, NASA will be required to initiate closure of the existing landfill within the next year" (NASA, 1994h). Refer to Section 6.8, Closure, for details.

On December 30, 1994, NMED received EPA approval of the NMED Solid Waste Program. NMED SWB now had primacy for solid waste regulations and implementation at the 700 Area landfill. "…compliance with the State regulations will ensure compliance with the federal criteria" (NMED, 1994b).

As described in the 2004 NASA response to an NMED HWB request for additional information during the WSTF Hazardous Waste Permit renewal process, the 700 Area landfill was included in Annual Unit Audit (AUA) list of SWMUs prior to closure. However, the landfill was removed from the AUA list of SWMUs when it was formally closed and PCC was initiated. At closure, the landfill was transferred to "Solid Waste Bureau authority…to ensure no problems with dual regulatory oversight. The unit was officially closed per NMED Solid Waste Bureau requirements and is currently managed under authority of an in-place Post-Closure Care Plan issued by the Solid Waste Bureau." The landfill was listed as a WSTF SWMU that did not require corrective action (NASA, 2004b). However, in the 2009 renewal of the Permit, the 700 Area landfill was included as SWMU 49, and an IWP was originally required to be submitted to NMED HWB for investigation of the 700 Area landfill by December 30, 2015 (NMED, 2009c). NASA submitted a Class I Permit Modification request on November 17, 2015 to the NMED HWB requesting a new due date for submittal of the IWP and HIS of December 29, 2017 (NASA, 2015b). Additional time was requested since there was still 12 years remaining under the original PCC monitoring period. At that time, NASA was still evaluating potential investigation options for SWMU 49 and wanted to focus on several other concurrent investigations at WSTF. NMED HWB approved the Permit Modification Request on December 16, 2016 (NMED, 2015b).

6.2 Inception

The 700 Area landfill (SWMU 49) began use between 1963 and 1965. WSTF documentation and employee statements provide contradictory information regarding the year of landfill inception. In an inventory list of disposal areas at WSTF in 1985, it was stated that the 700 Area landfill had been in operation since 1963. This 1963 operational date was also reported in 1986, in an EPA survey (NASA, 1986d), and from the landfill registration with NMEID in 1978, "The modified landfill at White Sands Test Facility has been in operation for approximately fifteen years" (NASA, 1978). Then, in an internal plan for landfill operation, generated in 1992, it was stated, "The existing WSTF landfill has been in continuous operation since 1964" (NASA, 1992d). One long term WSTF employee interviewed for the landfill site assessment stated that the landfill began use in late 1964, and early construction debris was transferred to an off-site landfill (NASA, 1993c). Finally, within the groundwater monitoring system plan, the landfill Closure Plan, and the Design Capacity Report, it was stated that the landfill began operation in 1965 (NASA, 1994g, 1996g, 1998j). One employee stated in 1993 that the 700 Area landfill opened in October 1965, and "the waste was being transferred to the first cell on the SW end when I started delivering site waste" (Appendix A).

6.3 Design

The 700 Area landfill (SWMU 49) is an approximately 24-acre (reported as 24.32 acres in the Closure Plan; NASA, 1996j) trapezoid-shaped piece of land, with the long axis oriented northwest-southeast that was designed to contain solid waste for disposal within excavated cells or trenches (Figure 6.1). Trench depth was reported as between 14 ft and 20 ft. In a 1981 application for landfill registration to NMEID, it was stated, "The trench is dug to a 20 ft. depth" (NASA, 1981). Later documents describe average trench depths of 14 ft (NASA, 1994b, 1994g, 1996j).

The original design capacity of the landfill was reported in a required EPA survey in December 1986 as 72,000 cubic yards (cu. yd.) with a ratio of waste to cover material of 8.5 to 1 (NASA, 1986d); however, in August 1998, the design capacity of the 700 Area landfill was reported to be 60,000 m^3 (or 55,044 cu. yd.; NASA, 1998j). Both of these values were estimated.

The 700 Area landfill has been described as a "modified landfill" (NASA, 1978), a sanitary landfill, (NASA, 1990i), and a "Class B landfill", which was "a sanitary landfill serving a population of less than 3,000" (NASA, 1991f). Refer to Section 6.1, 700 Area landfill (SWMU 49) Regulatory History, for a definition of a sanitary landfill. A definition for a modified landfill, as used in the 1978 landfill registration, was not located in solid waste regulations; however, a long-term WSTF employee stated that the term "modified" was likely referring to the different wastes disposed at WSTF compared to most landfills. WSTF only disposed of wastes generated at WSTF, never commercial or residential wastes from off-site sources (Appendix A). A definition of "modified" was provided by EPA as "an increase in the permitted design capacity caused by an increase in the horizontal or vertical dimensions of the landfill" (EPA, 1999). However, this definition was referring to gas monitoring regulations, not specifically to the landfill types.

6.4 Operations

In the early 1960s, when use of the 700 Area landfill (SWMU 49) began, generators of solid waste included major WSTF industrial areas (100, 200, 300, and 400 Areas). There were no other tenants using the WSTF site at that time. Then, as stated in Section 5.2, TDRSS was built in 1977, ADF-SW was initially completed in 1984, and STGT was constructed in 1988; therefore, these facilities eventually became solid waste generators (NASA, 1994f).

The terms "trench" and "cell" are used interchangeably in WSTF documentation to describe the disposal area at the 700 Area landfill (SWMU 49). A synopsis of the 700 Area landfill operations was provided in the Landfill Groundwater Monitoring System Plan submitted to NMED SWB in October 1994. "NASA operates a 24-acre landfill on land owned by the Department of Army, White Sands Missile Range (WSMR). Wastes are transferred to the landfill by WSTF site contractor personnel using a 30-cubic yard garbage truck" (NASA, 1994g). Wastes were deposited to the current active trench/cell from the edge (Figure 6.3). Driving into the trenches was only permitted when compacting loads or when retrieving unacceptable items if a crane could not retrieve them from the trench top (Appendix A). From the 1978 landfill registration to NMEID, "Dempster dumpster storage containers are located at all occupied buildings on WSTF, into which all waste is placed. These containers are checked frequently and are transported to the modified landfill as required" (NASA, 1978). The term Dempster dumpster was derived from the Dempster company, that in 1935 developed portable storage (trash) containers and a device for lifting and transporting these containers. The containers and front loading truck became known as Dempster dumpsters (Voytko, 2006). In 1978, when the 700 Area landfill was first registered with the NMEID, WSTF was using 26 Dempster dumpster containers and an "International Harvester Truck with Integral Dempster Dumpster Handling Mechanism" (NASA, 1978).

The shortest transport distance from waste generation point to the landfill was reported in a 1981 landfill registration application as 1.5 miles, and the farthest was reported as 3.4 miles. Regarding landfill site security, it was stated, "The site Fire Department makes a check of the landfill every 90 minutes," and regarding runoff: "The landfill is on higher ground and water is diverted by natural and manmade channels" (NASA, 1981).

This 1981 registration application also provided additional details regarding WSTF solid waste management. "All office waste is contained in plastic bags…The disposal trenches are dug, using the bulldozer, as they are needed. Upon completion they are approximately 600 ft. long x 20 ft. wide x 20 ft. deep. The trench is covered as required in Section 108.F and the solid waste is compacted to conserve space" (NASA, 1981). Wastes were covered in trenches/cells using the previously excavated cell material (soil; NASA, 1994b; Appendix A). In 1981, compaction of wastes was completed using an "Allis-Chalmers HD-21 bulldozer" and a "Lorrain front-end loader" to drive over the loads (NASA, 1981; Appendix A).

There was not a strict procedure for new trench placement at the 700 Area landfill. In general, older trenches were excavated at the southeast side of the landfill, oriented in line with the short axis of the landfill and close to the landfill entrance; however, there are two trenches that were excavated in line with the long axis of the landfill and perpendicular to all other trenches (Figure 6.1). Also, as space became limited in the 1990s, the areas between older trenches were used for new trenches. This is discussed in more detail below.

In November 1991, diminishing capacity of the landfill was first mentioned in WSTF documentation. "Material deposited at the landfill has more than doubled over the past year. Due to the large number of additional buildings sitewide, landfill usage has increased to a point which demands stricter control for proper maintenance (NASA, 1991h). "…the current WSTF landfill operator has projected expansion of the landfill will be necessary within 5 years…based on the present rate of cell closures and staff increase at STGT." It was recommended that NASA "survey the current landfill and establish the area that can be used for future cells…[and] place future cells close together…The current fenced area is estimated at approximately 24.5 acres;" however, the original certificates of registration in 1978 and 1981 stated the size of the landfill was 29 acres. It was stated that this additional five acres could be used with no landfill modification (NASA, 1991f); however, this extra land was never used as part of the 700 Area landfill due to the required closure of the landfill discussed in Section 6.8, Closure. Figure 6.4 shows the 700 Area landfill with the unused five acres to the north.

To continue utilizing the present landfill, the capacity needed to be increased. As a means to do this, increased compaction could be employed. It was recommended that NASA purchase a bulldozer and compactor,…survey, mark, and use areas between existing trenches, and research and implement waste reduction (NASA, 1991f, 1992d). Refer to Section 6.1, 700 Area landfill (SWMU 49) Regulatory History, for further details. Figure 6.5 shows a photograph of the landfill in 1995. Notice that the current open cell was located in the approximate middle of the 700 Area landfill, between older, previously filled and covered cells and not adjacent to the cell that was open in 1993 (Figure 6.3). Even though it was recommended that NASA use the additional five acres to the north of the landfill to supply additional capacity, this area was not utilized in the life of the 700 Area landfill. Refer to Section 6.8, Closure, for details.

In September 1992, NMED SWB commented in a landfill inspection that NASA had purchased a new bulldozer (a 40,870-pound [lb] Caterpillar D8L bulldozer) and compactor (a 39,800-lb Caterpillar 816 landfill compactor; NMED, 1992; NASA 1994b, 1995b). Figure 6.3 shows a close-up view of the 700 Area landfill, open trench, and heavy equipment used during landfill operations. NMED SWB personnel also commented that NASA was "getting ready to dig a new pit" (NMED, 1992). In the September 10, 1993 landfill weekly inspection log entry, the comments read, "old pit covered and filled. Start new" (NASA, 1993a). This cell was filled by August 15, 1994, as reported, "old cell partially closed," and the next week (August 22), "new cell totally open/old cell covered" (NASA, 1994a). Landfill procedures required that dates cells were opened and closed at the landfill be recorded on a landfill drawing; however, this was not consistently done. A list of known landfill cell open and close dates are provided as notes on Figure 6.4. Refer to Section 6.1, 700 Area landfill (SWMU 49) Regulatory History, for further details.

To comply with stricter access control requirements within the revised NM SWMR-4, NASA installed a new gate and keyed lock (NMED, 1994; NASA, 1994a) and further restricted access to the 700 Area landfill, "Starting 12 December, 1994 the landfill will be closed to all personnel unless a landfill operator is present. All personnel or organizations wishing to use the landfill will be required to call…an operator…" (NASA, 1994i).

NASA began the closure process by contracting an off-site company to provide solid waste disposal service to WSTF in October 1995. There were 40 Dempster dumpsters in use at WSTF, TDRSS, STGT, and ADF-SW at the time (NASA, 1994g). After October 1995, only construction/demolition wastes and dead animals could be disposed at the 700 Area landfill. As reported in the solid waste annual report, between October and December, 1995, 1 ton of construction/demolition debris was disposed at the 700 Area landfill; dead animal wastes were not recorded (NASA, 1996b).

The landfill Closure Plan provided a summary of historical landfill drainage and cell cover: "Throughout the landfill's active life, cells were covered with a minimum of two feet of native soil prior to excavation of new trenches." Both WSTF and the landfill were fenced, and the landfill was not accessible to the public or unauthorized site personnel. Operations at the landfill were limited to the working hours from 7 am to 3:30 pm Monday through Friday. The landfill entry was controlled by key issuance. "The site's natural grade, 2.5 percent, accommodates drainage with no impacts upon the surrounding area" (NASA, 1996j). "Historically stock piles were redistributed in areas showing settling and the landfill operator estimates that 20 percent of the cell volume consists of natural soil, at least two feet of which is final cover…" (NASA, 1996j).

"No liner or other modifications were made to the trench bottoms prior to waste disposition. The trench bottoms serve as the lower-most layer of the unit. An investigation of 700 Area soils determined that the conductivity of the material composing the undisturbed lower surface is 3.7 x 10^{-6} cm/s" (NASA, 1996j).

6.4.1 Landfill (SWMU 49) Documentation

From the inception of the 700 Area landfill (SWMU 49) until 1985 (when the WSTF full-time Environmental Department was established), there were no landfill documentation requirements; therefore, there were no records regarding oversight, waste disposal, operations, or procedures for the 700 Area landfill. One long-term employee estimated documentation generation began in the early 1990s (Appendix A).

The first document discussing the need for landfill records was Environmental Advisory Committee meeting minutes for October 16, 1986. It was stated that control procedures needed to be developed for the landfill and past trenches needed to be mapped (NASA, 1986c). This statement emphasizes that WSTF did not have written procedures and that the locations of past/filled trenches had not been documented. By March 1987, a written landfill operation procedure was completed for WSTF (NASA, 1987b); however, this document could not be located. In May 1987, WSTF personnel began conducting weekly visual inspections of the landfill and generating inspection logs. Categories on the inspection logs included date, time, unpermitted items (items not allowed for disposal in the landfill), burning (evidence of burning), blowing refuse (loose trash blown out of the trench), berm condition, refuse coverage, and animal coverage for the dead animal pit (NASA, 1987c).

As required by solid waste regulations, NASA began submitting annual solid waste summary reports to NMEID in 1990 (NASA, 1990d). Documents regarding exact waste amounts and types were not generated, so wastes were estimated. During the process of requesting several variances from NM SWMR, it was determined that NASA needed to develop and maintain better landfill records.

> "During the inspection of the facility on January 30, 1990, the inspector discovered, while NASA maintains records of the number of truckloads of solid waste entering the facility, NASA does not translate this information into quantity or volume of solid waste deposited. The records need to reflect the current fill rates at the facility" (NMEID, 1990).

NASA responded with a proposed tracking method (NASA, 1990c). (Refer to Section 6.1, WSTF Landfill (SWMU 49) Regulatory History, for details.) However, when the NM SWMR-4 regulations were proposed in November 1994, NASA WSTF personnel stated, "NASA is required to maintain an operating record during a facility's active life (operations, monitoring, closure, and PCC activities). The operating record must include the type and amounts of solid wastes received, haulers of the waste, deviations from approved designs and plans, and document groundwater monitoring activities. An operating record is not maintained at this time…" (NASA, 1994h).

In December 1994, NASA proposed more restricted access to the 700 Area landfill. "These operational changes will allow the…section to provide a certified landfill operator who will inspect and log the quantity and type of all waste material going into the landfill (NASA, 1994i)"; however, no waste logs could be located. The 700 Area landfill also did not have a contingency plan in 1994 for coping with potentially exceeding groundwater, surface water, air quality, gas, or other applicable requirements (NASA, 1994c).

Even though many historical landfill records provided sporadic operational data, including regulatory reviews, surveys, and DRs for unpermitted items observed in the landfill, the only systematic operational records for the 700 Area landfill located were the weekly inspection logs and annual reports.

6.4.2 Dead Animal Pit

The dead animal pit was a small active cell within the 700 Area landfill (SWMU 49) with approximate dimensions of 20 ft long by 14 ft wide, and approximately 10 ft deep. The pit was located "directly inside the landfill entrance and to the right as you came into the gate, right by the fence" (Appendix A). As surveyed during closure activities, this pit was approximately 330 ft northeast of the WSTF gate. As the name suggests, the dead animal pit was used for disposal of any animal carcasses found at WSTF. This pit was used for the entire life of the 700 Area landfill from the early 1960s to October 1997. Following landfill closure, any dead animals found at WSTF were disposed by the Doña Ana Animal Control (for domestic animals) or the NM Department of Game and Fish, (for wildlife; Appendix A). Figure 6.1 shows a map of the 700 Area landfill showing the location of the dead animal pit, and Figure 6.6 shows an aerial view of the dead animal pit in September 1993.

Although records of animals added to the dead animal pit were not generated at WSTF, a total amount was estimated for the WSTF Closure Plan in 1996: "The dead animal pit, located near the gate on the southeast end of the landfill has received an average of one animal per year" (NASA, 1996j). Also, from a weekly inspection log in 1997, 11 dead oryx were discovered at WSTF and added to the dead animal pit between late February and early April 1997 (NASA, 1997a). Other dead animals known to have been disposed in the dead animal pit at the 700 Area landfill (SWMU 49) include cows, birds of prey, other birds, cats, dogs, coyotes, and snakes (Appendix A).

6.4.3 Wind-Blown Debris

Stacking of refuse within the active cell at the 700 Area landfill (SWMW 49) was required to be low enough to prevent wind blowing of trash or debris out of the trench; however, solid waste debris within the landfill (outside the active trench) was common in the windy spring and summer seasons at WSTF, based on weekly landfill inspection logs. In May and June 1987, wind-blown debris was listed as minimal and “light” (NASA, 1987c). No wind-blown waste was documented for 1988 in the weekly inspections, but in February 1989, personnel wrote that the refuse was “stacking too high blowing waste across [the] desert” (NASA, 1988a). Wind-blown solid waste was reported in weekly inspections three times between April and early May 1991 (NASA, 1991c). No wind-blown debris was documented in 1992, but in 1993, trash blown from the trenches was listed on the weekly inspection log ten times, mostly within the spring and summer months (NASA, 1993a). For 1994, wind-blown debris was present at the landfill May and June. This waste was removed prior to June 27, as documented in the weekly inspection logs. Wind-blown debris was listed in July and August, September 26, and October 24, 1994. The landfill area was cleaned up and all wind-blown waste removed in late October 1994 (NASA, 1994a). For 1995, wind-blown debris was again listed, once each in January, March, April, and June (NASA 1995a). Finally, wind-blown solid waste was listed only once in 1996, on January 22, and was removed by February 5, 1996 (NASA, 1996a).

6.5 Waste Estimates and Disposal Rates

Cell usage and waste disposal rates were not historically tracked at the 700 Area landfill (SWMU 49). When required for regulatory reporting, waste volumes were estimated based on cell size, disposal truck capacity, and disposal frequency. Reported waste estimates differed over time.

An estimate of historical solid waste generated at WSTF was performed in response to requirements from 40 CFR 245.100 (g) in 1976. NASA estimated 0.3 tons per day of solid waste was generated based on the formula provided in the regulations of 1.55 lbs per person per day with a total of 383 employees working at WSTF at the time (NASA, 1976). In 1977, an EPA required cost analysis was performed for paper recycling at WSTF. It was estimated that “high-grade paper” waste amounted to 4.1 tons per month at WSTF (NASA, 1977). Then, in 1980, reported estimates were 120 cu. yd. per month of “office and other organic waste, including paper” and 20 cu. yd. per month of “miscellaneous wastes from on-site construction and maintenance activities” (NASA, 1980b).

In a 1986 EPA survey, it was estimated that the average annual quantity of waste was 2,000 cu. yd., generated by 1,100 employees. At that time, it was reported that 11 trenches/cells had been previously filled and covered, and one cell was active or open at the time. Waste disposal fill rates for each cell were estimated to be 2 years, with an average waste height of 22 ft, placed in the cell in a single lift, (waste layer) with 2.5 ft of sand/gravel cover material at the top (NASA 1986c).

This estimate was increased to 2,400 cu. yd. in 1989, when NASA provided a certification of operations to NMEID following adoption of new Solid Waste Management Regulations (NASA, 1989e). The first solid waste facility annual report estimated 1,000 cu. yd. disposed between May 15, 1989 and December 31, 1989. Then, in March 1990, a summary of previous waste estimate methods was provided in an internal WSTF memorandum:

> “Facilities estimates that the garbage truck makes two runs a week. The truck can hold 30 cubic yards of uncompacted solid waste. This translates into 60 cubic yards a week or 3,120 cubic yards a year. Previous estimates…were based on the number of trips made by the truck and the fact that the truck is not normally filled to capacity. The annual report gave 1,000 cubic yards over a 6 month period and the NOI gave 2,400 cubic yards per year. It has been estimated that

> two trenches a year are being cut at the landfill. The size of the last trench was 8' x 10' x 450' which would hold about 2,000 cubic yards a year. A surface survey of the number of old trenches, estimate of trench size, and distance between trenches, provided a historical estimate of 16 trenches. Assuming that the size of trenches has remained constant a total of 35,000 cubic yards of solid waste have been buried in the WSTF landfill over the past 27 years. Use of the trench size provides a more accurate estimate and will be used for future estimates" (NASA, 1990e).

Current waste estimates provided in a solid waste questionnaire in November 1990 were 80 cu. yd. per week, generated by 1,200 employees (NASA, 1990i), and the total amount of estimated uncompacted solid waste disposed for 1990 was reported as 3,120 cu. yd., (for 1,100 employees; NASA, 1991a). By May 1991, the waste disposed at WSTF was estimated to be approximately 15 cu. yd. per week (NMED, 1991), based on estimates provided to NMED during inspections; however, the 1991 solid waste annual report to NMED SWB listed the annual waste received as 2,976 cu. yd., generated by 1,192 employees (NASA, 1992c). This is much greater than the estimated weekly rate of 15 cu. yd., which would yield 780 cu. yd. of solid waste annually. The 1991 annual waste was further categorized as yard/landscaping wastes, estimated at 1 cu. yd. monthly, construction/demolition wastes, estimated at 22 cu. yd. monthly, and industrial wastes (office, shop, and non-hazardous laboratory wastes) estimated at 225 cu. yd. monthly (NASA, 1992c).

Within NMED SWB inspection lists, the disposal rates were reported as 15 cu. yd. per week until January 1993, causing this discrepancy in WSTF landfill solid waste disposal amounts. When the estimate was revised to 237 cu. yd. per month (NMED, 1993a) in January 1993, this represented a closer estimate to the waste estimates in the annual report. In the solid waste facility annual report, it was stated that 1,235 employees disposed an estimated 2,844 cu. yd. of solid waste for 1992 (NASA, 1993b), which is consistent with the monthly reported estimate of 237 cu. yd. Like the 1991 annual report, wastes were again further categorized as yard/landscaping (1 cu. yd.), construction/demolition (22 cu. yd.), and industrial office, shop, and non-hazardous laboratory wastes (215 cu. yd.; NASA, 1993b).

From July 1993 to June 1996, the waste estimate provided during NMED SWB inspections was 240 cu. yd. per month (NMED, 1993d, 1996). The annual report for 1993 listed 3,036 cu. yd. as the estimated annual waste received at the landfill, (for 1,346 employees; NASA, 1993b), and the annual report for 1994 estimated 468 tons of waste received at the 700 Area landfill from 1,235 employees (NASA, 1995b). Annual waste estimates for 1995 were 283 tons, generated by 1,160 employees (NASA, 1996b).

As discussed in Section 6.4, Operations, NASA began using an off-site solid waste disposal company in October 1995, so only 1 ton of waste was reported as disposed in late 1995 (NMED, 1996). In the 700 Area landfill Closure Plan, NASA stated that a total of 78,000 cu. yd. of solid waste had been deposited in the landfill over the 31 years of use within 26 total individual cells/trenches. The estimate was based on 26 trenches and 3,000 cu. yd. of solid waste within each trench (NASA, 1996j), which may not be accurate due to inaccurate trench number estimates and variations in cell sizes (Figure 6.1).

6.6 Groundwater Monitoring

The quarterly report to WSMR for the first quarter of fiscal year (FY) 1990 (October-December 1989) listed the completion of drilling, well installation, and development of two groundwater monitoring wells adjacent to the 700 Area landfill (SWMU 49): 700-A-253, located approximately 80 ft to the south of the central portion of the landfill, and 700-D-186, located approximately 95 ft to the west of the northern portion of the landfill (NASA, 1990a; Figure 6.1; Figure 6.7). Well completion diagrams are provided in Appendix B. Initial sampling for halogenated volatile organics, aromatic volatile organics, priority pollutant volatile organics, n-nitrosodimethylamine, metals, general inorganics, and dissolved metals was completed in January 1990. Detections consisted of 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113), barium, calcium, magnesium, and sodium in both wells (NASA, 1990d). Table 6.1 provides a summary of Freon 113 results in 700 Area wells 700-A-253, 700-D-186, 700-J-200, and 700-H.

In the second quarter of FY 1990 (January-March 1990), groundwater monitoring well 700-E-458 was drilled and completed (Appendix B). This well is located approximately 7,700 ft (1.5 mi) west southwest of the landfill (NASA, 1990f; Figure 6.7). In the third quarter of FY 1990 (April-June), development was completed and well 700-E-458 was sampled. "…results of analyses indicate no hazardous waste contamination" (NASA, 1990g). Groundwater monitoring well 700-B-510, located approximately 3,250 ft (0.6 mi) west of the western corner of the 700 Area landfill was drilled, completed, and developed in the fourth quarter of FY 1990 (July-September; NASA, 1990h; Figure 6.7).

Finally, during the second quarter of FY 1991 (January-March 1991), monitoring well 700-F-455, located approximately 4,400 ft (0.8 mi) northwest of the north corner of the 700 Area landfill, was completed (Appendix B) and sampled. The purpose of this well installation was to bound the WSTF groundwater plume to the north (NASA, 1991b). No groundwater contamination was detected in this well (NASA, 1991d).

In October 1994, NASA submitted a landfill groundwater monitoring system plan as required by the NM SWMRs-4. This plan outlined monitoring frequencies, assessment monitoring levels (AMLs), plans for AML exceedences, descriptions of well sampling equipment, descriptions of well sampling procedures, and required documentation (NASA, 1994g). NMED SWB approved the plan on November 3, 1995 (NMED, 1995).

During landfill compliance groundwater monitoring in 1996 and early 1997, di(2-ethylhexyl)phthalate (also known as bis(2-ethylhexyl)phthalate or BEHP) was detected for the first time. Table 6.2 provides a summary of BEHP detections in landfill groundwater monitoring wells. Detections were above the established AML of 3 µg/L (NASA, 1997f). On July 28, 1997, NASA provided a letter to NMED SWB with analytical data, compliance status, and statistical analyses for constituents detected above background levels or above AMLs. Constituents listed were Freon 113, fluoride, TDS, sulfate, and BEHP. NASA reported that Freon 113 concentrations were statistically above background levels in well 700-A-253; however, Freon 113 was not a listed hazardous constituent in the NM SWMRs-4. Fluoride concentrations were statistically above the AML in well 700-D-186; however, the average concentration of 0.76 mg/L was below the AML of 0.8 mg/L. TDS and sulfate concentrations were both above the AML in 700-D-186; however, these two constituents are non-hazardous. BEHP was reported as the only hazardous constituent statistically above the AML (well 700-A-253; NASA, 1997f).

On August 14, 1998, NMED SWB responded to NASA's analytical data submittal and stated,

> "Due to the assessment monitoring level (AML) exceedance of di-(2-ethylhexyl)phthalate in wells 700-A-253 and 700-D-186, NASA must initiate an assessment monitoring program in accordance with §806 within 90 days of receipt of this letter. [An intrawell statistical comparison between the respective background concentration and each successive sampling result must be conducted for other constituents to determine an AML exceedance such as fluoride, TDS, and sulfate]…NASA must also:
>
> a. characterize the nature and extent of the release by installing additional monitoring wells as necessary (NASA will be required to submit a plan with the well or probe locations and a time line for conducting this characterization);
> b. install at least one additional monitoring well at the facility boundary in the direction of the contaminant migration and a minimum of four independent samples from this well will need

> to be collected and analyzed to establish background concentrations for all detected constituents from sampling of the other wells…" (NMED, 1998).

Regarding Freon 113 detections, NMED SWB stated, "At this time, NASA has adequately addressed the issue of freon-113 detection," meaning that NASA would not need to conduct assessment monitoring for Freon 113.

NASA submitted a 700 Area Solid Waste Landfill Monitoring Well Installation and Groundwater Characterization Work Plan on January 19, 1999. This plan proposed installing one downgradient multiport groundwater monitoring well, one upgradient conventional groundwater monitoring well, and two supplemental conventional monitoring wells "to adequately characterize the 700 Area groundwater," and specifically to identify potential plume boundaries of BEHP. The multiport well was proposed to provide a vertical contaminant profile. The proposed groundwater sampling schedule included sampling 700-A-253, 700-D-186, 700-B-510, 700-E-458, 700-F-455, BW-6-355, the proposed new 700 Area wells, and the upgradient well 300-D-153, used at that time as the background well for the 700 Area landfill (NASA, 1999a). Well 700-J-200 was proposed approximately 340 ft to the east (upgradient) of the landfill, and well 700-H was proposed approximately 1,100 ft west of the landfill. NMED SWB approved the work plan in March 1999 (NASA, 2000a).

NASA also concurrently conducted a BEHP investigation of other RCRA groundwater monitoring wells at WSTF and of fluids and materials used in drilling groundwater wells. The 700 Area monitoring well installation work plan stated that BEHP was pervasive in PVC, solvents, defoaming agents, plastics, rubber materials, resins, industrial oils, film, wire and cable. NASA stated that possible sources of BEHP contamination at WSTF included the 700 Area landfill, well installation activities, or laboratory cross-contamination. "Preliminary evaluations (of RFI monitoring well data) indicate that the BEHP detections have a poor correlation to other contaminant plume profiles observed at WSTF…data thus far suggest that the BEHP detections in the RFI wells may not be representative of groundwater contamination" (NASA, 1999a). With continued sampling and data evaluation, WSTF "…personnel observed a definite correlation between phthalate detections and the use of non-dedicated well purging equipment. It was noted that nearly all phthalate detections were obtained from wells that had been purged with non-dedicated equipment" (NASA, 2000c). The non-dedicated well purging equipment used was a Bennett pump, which was suspended in the well by a tubing bundle bound together by a wrapped layer of plastic adhesive tape. Testing of Bennett pump sampling procedures and components indicated that the adhesives used on the tape contained sufficient quantities of phthalate based compounds to adversely affect the quality of groundwater samples. Phthalates were volatilized by steam cleaning equipment during decontamination and deposited on the pump and tubing, then subsequently transferred to the groundwater during well purging operations. NASA installed dedicated sampling equipment in the 700 Area groundwater monitoring wells at WSTF, and the BEHP concentrations dropped (not detected for most sampling events; NASA, 2000c).

From the WSMR quarterly report for the third quarter of FY 1999 (April-June 1999), it was reported that the conventional upgradient well 700-J-200 (NASA, 1999c) and Westbay®[2] multiport monitoring well 700-H were completed in August 1999 (Appendix B). Well 700-H contains three monitoring zones with measurement ports located at 350 ft, 535 ft, and 670 ft below ground surface (bgs). The other supplemental wells proposed were not completed. 700-G did not contain groundwater and was plugged and abandoned in 1999 after drilling. Proposed well 700-I was not drilled due to the suspected lack of groundwater. In March 2000, NASA submitted an explanation letter and requested to return to detection

[2] Westbay is a registered trademark of Nova Metrix Ground Monitoring (Canada) Ltd.

monitoring at the 700 Area landfill from assessment monitoring. NMED SWB approved the request in August 2000 (NMED, 2000).

In response to a request from NMED (NMED, 2018), the following discussion is provided on Freon 11, TCE, and PCE in groundwater that have also been detected in 700 Area wells at low levels. Summaries of these constituents are provided in Table 6.3, Table 6.4, and Table 6.5, respectively. Freon 11 (Table 6.3) was first detected in 700-D-186 in April 1994 and in 700-A-253 in October 1997. Freon 11 has never been detected in well 700-H. In well 700-J-200, Freon 11 was only detected in one isolated event in January 2001 (Table 6.3). Low levels of TCE were detected mostly in 700 Area monitoring wells 700-D-186 and 700-J-200. TCE was only briefly detected in 700 Area well 700-A-253 in 1996 and again in May 1998, and only one isolated detection of TCE was present in 700-H in September 2014. TCE was first detected in well 700-D-186 in May 1996 and well 700-J-200 in December 1999 (Table 6.4). For PCE, low levels were detected only a few times in 700 Area wells 700-A-253, 700-D-186, and 700-H. PCE was not detected in well 700-J-200 (Table 6.5).

Freon 113 continues to be detected at low levels within groundwater monitoring well 700-A-253 and at higher levels in 700-D-186 (Table 6.1). Freon 11 continues to be detected at low levels within groundwater monitoring well 700-D-186 (Table 6.3). In 700 Area monitoring wells 700-D-186 and 700-J-200, TCE continues to be detected at low levels (Table 6.4). PCE has not been detected in 700 Area monitoring wells since July 2011 (Table 6.5). Detections of Freon 113, Freon 11, TCE, and PCE have not required assessment monitoring to date.

In February 2011, cadmium was detected at 0.0031 mg/L and confirmed at 0.003 mg/L in May 2011. Both results were above the AML of 0.0025 mg/L (NASA, 2012a). At NMED SWB's request, NASA provided a cadmium time-concentration graph to determine if cadmium concentrations were increasing over time (NMED, 2012). Cadmium concentrations have fluctuated from not detected to higher than the AML since 2011. As a result, NMED SWB requested that NASA provide a cadmium time-concentration graph within all reports when cadmium is detected above the AML (NASA, 2013d).

Occasionally, other constituents (e.g., sulfate and TDS in 1999) were detected in 700 Area groundwater monitoring wells above AMLs that required reporting to NMED SWB and additional sampling (NASA, 2000a). These constituents have not required assessment monitoring to date.

6.7 Methane Gas Monitoring

Methane gas monitoring at the 700 Area landfill (SWMU 49) was not initiated until the mid-1990s. The nearest building at WSTF to the landfill (SWMU 49) was located 3,500 ft away, as reported in January 1998 (NASA, 1998b), and therefore, methane gas monitoring was not considered a high priority environmental concern. The first methane gas monitoring event was conducted in a routine inspection conducted by NMED SWB in January 1993. Six methane gas samples were collected "throughout the old cells of the landfill." No methane gas was detected (NMED, 1993a). Figure 6.4 provides a map of the locations where the gas samples were collected.

Methane gas monitoring was required at both active and closed landfills as part of the revised NM SWMRs-4. NMED SWB personnel determined that NASA should begin methane monitoring at the 700 Area landfill "to establish a background" during a landfill closure consultation in February 1995. If methane gas was not detected, then NASA could request an annual PCC methane gas monitoring frequency (NASA, 1995c).

In preparation for landfill closure, ten methane monitoring wells were installed (NASA, 1996f). An example completion diagram for the methane soil gas wells is provided in Appendix B.

> "The gas monitoring system…consists of 10 monitoring locations at the landfill perimeter. Each monitoring well consists of a seven foot long, 1.25-inch diameter well point with 30 inches of #60 mesh screen set into a six-foot deep, four-inch diameter augered hole with a sand pack and bentonite seal. A four-foot square, 4-inch thick cement pad was poured around each well head and a brass cap was installed in the concrete which depicts the well name, Northing, Easting, and elevation" (NASA, 1996h).

Then on April 14, 1997, additional methane gas monitoring was conducted at the landfill. A description from the corrected closure and PCC plan follows:

> "Seven covered trench locations were monitored utilizing 5-foot long sandpoints that were driven 2 ½ to 3 feet into the cover of filled cells and a combustible gas monitor calibrated to methane at between 5 and 1,000 ppm. The sandpoints were sharpened, reinforced, threaded, and capped, 1 ½-inch-diameter carbon steel pipes that were made on site and steam cleaned prior to use. The sandpoints were inserted using a "T" post hammer. Following being driven to the prescribed depth, the caps were removed and the monitoring tube inserted to approximately 2 inches from the bottom of the perforated sandpoint. Reading durations were between 3 and 5 minutes in length, and the highest value registered was entered in the Landfill Methane Monitoring logbook…" (NASA, 1997e).

Cells 1 and 25 did not contain any methane gas. Cells 5 and 17 contained very small amounts of methane gas, 6 ppm and 8 ppm, respectively. Cell 11 was located adjacent to the Open Detonation Unit and contained 22 ppm (0.002 percent gas or 0.04 percent of the lower explosive limit [LEL]). Cell 23 contained 42 ppm, and Cell 3 contained 200 ppm (0.02 percent gas or 0.36 percent of the methane LEL; NASA, 1997d, 1997e).

Methane monitoring of the permanent landfill methane gas wells (MW-1 through MW-10) was conducted May 31, June 14, July 23, and October 18, 1996; January 21, April 9, July 21, and October 22, 1997; and January 21, and April 21, 1998. All results from these methane gas sampling events were non-detect (<5.0 ppm methane) using a Foxboro Hydrocarbon Analyzer Model OVA-128 (NASA, 1997c, 1998b, 1996h, 1999b).

On January 21, 1998, there was one detection of methane gas in well MW-5 of 7.6 ppm (NASA, 1998a). Then in April 1998, NASA began monitoring methane gas using a Gastec Gem 500 gas monitor. This monitor measured gas as percent LEL in air to one tenth of a percent instead of gas level in ppm. All wells were measured at 0% LEL except MW-5, which could not be located following placement of the closure cap. "MW-5 was apparently destroyed during cover and closure activities…MW-2 was damaged but is still functional" (NASA, 1998d).

> "MW-2 had been hit and the well had partially bent over. The well pad was intact, the pipe did not have any holes in it. The threaded cap was still functional, and the monitoring tube could still pass through the bent section of the pipe. The damage to MW-2 was thus determined to be inconsequential…MW-5 had completely vanished…surveyors located the site of the well, detected metal in the subsurface and dug. At 18-24 inches below surface they came across the remains of the well. The top section of pipe had…been removed from the coupling without stripping the threads. Part of the original bentonite plug was still intact. The remaining pipe was filled with dirt" (NASA, 1998f).

On April 22, WSTF facilities personnel repaired the well by removing the dirt from the pipe, installing an additional joint of pipe for well stick-up, filling the annulus to surface with bentonite, and pouring a cement pad with brass cap surrounding the well (NASA, 1998f). Methane gas was then measured at 0% (NASA, 1998e).

Methane gas monitoring was conducted with the new Gem-500 gas monitor on April 21, July 21, and October 22, 1997; January 21, April 21, July 21, and October 21, 1998; and February 1, April 26, and July 28, 1999. All results were 0.0% methane gas in air. On August 10, 1999, NASA requested that PCC landfill methane monitoring be changed from quarterly to annually based on the lack of methane detected in the 10 gas monitoring wells up to that time (NASA, 1999d), and NMED SWB approved the reduction in methane gas monitoring frequency for the 700 Area landfill on August 12, 1999. NMED SWB requested that NASA report the methane gas monitoring results with the groundwater monitoring results in the annual report (NMED, 1999a).

From October 1999 to December 2016 all methane gas monitoring results at the 10 landfill methane gas monitoring wells were 0.0% methane (NASA, 1999b, 2000a, 2001, 2002a, 2003, 2004a, 2005a, 2006, 2007, 2008a, 2009b, 2010a, 2011a, 2012a, 2013a, 2014a, 2015a, 2016, 2017a). In October 2002, methane gas was detected at well MW-8 (0.1% methane in air); however, the instrument read the same 0.1% methane in the ambient air and was re-zeroed prior to sampling MW-9, which measured 0.0% methane.

6.8 Closure

As early as May 1992, NASA began discussing the possible necessity for closing the 700 Area landfill (SWMU 49). A Plan for Landfill Operation was developed “due to the increased environmental regulation and increased usage during the last ten years.” This plan examined the landfill operations and outlined suggestions for continued solid waste disposal at WSTF. The options for solid waste disposal were listed as:

- Use the current landfill.
- Relocate the landfill to another site at WSTF.
- Participate in a cooperative Federal landfill with WSMR, Holloman Air Force Base (HAFB), and other surrounding federal facilities.
- Use a municipal sanitary landfill facility (NASA, 1992d).

By June 1994, NMED had completed a draft of the fourth revision of the NM SWMRs, and in a regulatory review, NASA personnel stated,

> “WSTF’s existing landfill is located within 200 ft of a watercourse…When NMED requests a permit, due to the landfill’s proximity to an arroyo and existing groundwater contamination, NASA will be required to submit closure and PCC plans for the facility…If stricter controls are implemented at the landfill, the landfill can continue operations until closure is initiated” (NASA, 1994h).
>
> “WSTF has two options available for future long-term disposal of solid wastes. WSTF can either contract waste disposal to an outside entity or attempt to permit a new facility on WSTF property” (NASA, 1994h).

Contracting an off-site company to dispose of WSTF solid waste would result in closing the 700 Area landfill (NASA, 1994h). If NASA chose to permit the current landfill, a protective layer (either geosynthetic liner or low conductivity soil layer) would need to be installed beneath the solid waste, and additional requirements would need to be met for monitoring systems, operation, maintenance, inspections, contingency plans, training, and record keeping. All landfills were also required to submit a permit application or closure plan to NMED SWB when requested. NASA estimated that the 700 Area landfill permit would be requested by NMED SWB between May and November 1995. For cost efficiency, it was recommended that NASA close the landfill and begin using an off-site firm for solid waste disposal (NASA, 1994d).

In a consultation with NMED SWB personnel regarding landfill closure procedures in February 1995, NMED SWB personnel stated that NASA would be required to submit a permit or closure/PCC plan within six months. Additional advice regarding cover material and drainage was provided. NMED SWB personnel stated that the cell caps must be compacted and tested to meet a hydraulic conductivity (K) of 10^{-5} cm/sec standard. NMED SWB personnel continued, “Preliminary K soils testing should be taken from the bottom of the existing open cell to compare to cover cap testing and demonstrate that the K value is less than or equal to the bottom liner (soil material).” Run-on water diversion could be accomplished by constructing a ditch or berm on the southeast end and minimal earthwork on the northeast side. Run-off was already controlled, since the 2-5% natural slope of the landfill site provided (and would continue to provide) adequate drainage (NASA, 1995c).

The 1995 solid waste facility annual report discussed the phase-out process for 700 Area landfill use. “Until October 1, 1995…dumpsters were serviced twice a week…The average solid waste volume was equal to 7.25 tons per week for the nine month time period. On October 1, 1995, WSTF issued a contract for dumpster pickup and off-site disposal… The NASA WSTF landfill will remain open for construction and demolition waste and dead animal disposal until closure and PCC plans are prepared for submittal to NMED” (NASA, 1996b).

NMED SWB personnel provided NASA with EPA computer software that was used for landfill cover liner performance demonstrations. Submittal of these demonstrations was required in the 700 Area landfill closure plan (NASA, 1996c). In April 1996, NASA began investigating Geosynthetic Clay Liners (GCLs) for use as the landfill closure cap. NMED SWB was contacted for advice in modeling the liner using the EPA computer software. NMED SWB personnel cautioned NASA that if a GCL liner was used, the liner would need to be installed carefully to ensure integrity. Root penetration information should also be included in the closure plan (NASA, 1996i, 1996e).

As part of the closure process, NASA attempted to locate all the historical covered cells at the 700 Area landfill by trenching in April 1996 (NASA, 1996b, 1996e). Ten soil samples were obtained in the landfill prior to April 15, 1996 to evaluate natural WSTF clay in preparation for closure. Four soil samples were obtained from the bottom of the trench, four samples were obtained from the stockpiles of soil planned for trench covering, and two soil samples were obtained from other clay soil locations. A revegetation specification for the landfill cover/cap was also received from the NM highway department (NASA, 1996e). Then, in May 1996, NASA made the decision to use the GCL liner instead of local WSTF clay to ensure the liner would be a proper low K barrier as required (NASA, 1996g).

From an NMED inspection conducted in June 1996, NMED SWB personnel stated that NASA was “getting ready for closure” and “operating one trench,” and “most of the waste is hauled away by Southwest Disposal now.” Personnel also stated that NASA was “surveying old cells” in preparation for closing (NMED, 1996).

NASA submitted the closure and PCC plan to NMED SWB on July 5, 1996. The closure plan provided additional landfill survey details. “The 26 cells were located and surveyed utilizing the following methods: survey data resurrection; trenching using a backhoe and ripper; site investigations of observed settling; aerial photographs; and interviewing WSTF employees familiar with early landfill operations” (NASA, 1996j). Figure 6.1 shows the landfill and the identified cells. “Cover has been placed over 25 of 26 cells…There is no existing documentation specifying final cell cover thickness; however, excavation trenches indicate that the general cover thickness exceeds two feet" (NASA, 1996j). "The area of cells requiring cover within the 24.32 acres is estimated to be 173,046 square feet (3.97 acres)" (NASA, 1996j).

"The one remaining cell, currently covered with six inches of soil, will be used until NASA notifies the NMED Secretary of intent to close…NASA currently has a contract with an off-site solid waste disposal company to haul a majority of WSTF's wastes to an off-site permitted landfill. One WSTF landfill cell remains open for demolition and construction debris; in addition, the dead animal pit is operational at present" (NASA, 1996j).

Planned closure activities comprised the following:

> "No erosion control measures have been taken at the site. Natural grade facilitates drainage. In addition, natural seeding has resulted in considerable revegetation on approximately 60 percent of the active area. Since the entire area will be cleared and redistributed to a uniform grade the material will be stock piled and used for revegetation…The final cover shall consist of a geosynthetic clay liner (GCL) sandwiched between two inches of select fill (screened to one quarter inch and less in diameter) above and below to prevent any large rocks from damaging its integrity. Each cell or area requiring the GCL will be excavated to 90% of modified proctor. Two inches of select fill will be deposited and compacted over the local fill. The GCL will be lain next, with edges in a trench 20-inches deep and 24-inches wide. The trench will be cut around the edges of the cells. Another two inches of select fill will be deposited over the GCL. This select fill and 10 inches of uncompacted screened local material (topsoil) will complete the cover" (NASA, 1996j).

Literature suggests that roots of growing vegetation on top of the GCL cover would turn 90 degrees and grow parallel to the GCL instead of growing vertically and perforating the GCL. A final grading of 2.5 $\pm$ 0.5% slope prior to cell cover was planned to control run-on and runoff.

> "Three-foot high diversion berms will be constructed three feet outside the perimeter fence on the northeastern and southwestern sides of the landfill to prevent run-on following rainfall events. The berms will divert water into the two arroyos…In addition to the landfill slope and run-on berms…a downgradient run-off ditch will be constructed inside the southwestern perimeter fence and beyond the covered cell ends. The ditch will be three feet deep, nine feet wide at the cover surface and approximately 900 feet long. The outlet fan will be lined with rip-rap acquired from material screened out of the final cover fill." No leachate collection (or removal) or vadose monitoring systems were proposed (NASA, 1996j).

PCC requirements included maintaining records documenting inspections, final cover maintenance, necessary repairs, monitoring, and control systems' data. Information submitted to NMED SWB would include monitoring performance, data collected from control systems, and maintenance summaries. The PCC plan also included requirements for groundwater monitoring, methane gas monitoring, inspections, and maintenance (NASA, 1996j).

NASA submitted requested corrections and elaborations to the closure and PCC plan to NMED SWB on May 2, 1997. This document included amended computer software modeling, proctor density test results, explanations of groundwater flow direction changes, an elaboration of the additional methane monitoring procedures conducted in 1997, the results from the 10 permanent methane monitoring wells, an explanation of open detonation unit operations, and an explanation of low water levels at monitoring well 700-B-510 (NASA, 1997e).

The Landfill closure and PCC plan was approved by NMED SWB on August 22, 1997 (NMED, 1997a). From the solid waste annual report submitted to NMED; "NASA continued to transfer the majority of WSTF- generated solid waste off site by utilizing an independent contractor…7.5 tons" (NASA, 1998b). The last waste was received at the 700 Area landfill on October 27, 1997 (NASA, 1998g).

By November 1997, NMED SWB personnel stated in a landfill inspection, "This landfill is not receiving any solid waste. Pit/trench [is] covered. [It is] in process [for] closure. [NASA] have received approved closure-PCC plan…NASA [is in the process of] bidding package preparation for actual closure. Waste [is] being picked up by Silva Sanitation" (NMED, 1997c).

NASA submitted a NOI to close the 700 Area landfill on February 3, 1998 (NASA, 1999a), and NASA submitted the final closure certification to NMED SWB on August 5, 1998 (NASA, 1998i). Actual closure activities were conducted by a subcontractor and included:

- Shaping, grading, and compacting the landfill cells and area;
- Constructing berms and a drainage channel;
- Installing the GCL liner over each cell area;
- Installing 12 in. of topsoil over the GCL liner;
- Completing final grading;
- Fencing the landfill; and
- Reseeding the landfill area (NASA, 1999b, 1999a).

Figure 6.8 shows a photograph of the installation of the GCL cover at the 700 Area landfill (SWMU 49). "…reseeding and the construction work were completed on June 12, 1998. NASA received the recorded plat, closure certification, and as-built drawings, and implemented the PCC care plan on July 31, 1998" (NASA, 1998i). Figure 6.9 shows a final WSTF drawing of the landfill closure.

On August 14, 1998, NMED SWB personnel conducted a landfill closure inspection and commented, "landfill fenced, closed, graded, covered, seeded, contoured to drain run off into ditch running southeast to northwest. Recent rain storm occurred two days ago and there is absolutely zero ponding. Berm exists outside fence line and new road constructed (Figure 6.1; Figure 6.9). Observed no violations" (NMED, 1998a).

"The WSTF landfill site will be maintained as an unused open space covered by selected and approved vegetation. Area entry will be restricted to inspections, damage repair and final cover integrity maintenance" (NASA, 1996j).

6.9 Post-Closure Care

The PCC Plan for the 700 Area landfill (SWMU 49) was implemented on July 31, 1998 and is effective for 30 years. NMED SWB established the official commencement of PCC on August 14, 1998 (NASA, 2000d). The plan includes requirements for groundwater monitoring, soil-gas monitoring, PCC quarterly inspections and maintenance for landfill cover integrity, adequate drainage, fencing for the landfill boundary, and vegetative cover (NASA, 1999a). Additional inspections are required for major rainfall events (1-in. or more; NASA, 1998h).

Since landfill closure, WSTF has performed quarterly inspections, annual methane gas monitoring, and mostly semi-annual groundwater monitoring, as part of the regularly scheduled PCC of the 700 Area landfill. Landfill inspections have resulted in removing or treating occasional deep-rooted vegetation (usually mesquite) with herbicide (NASA, 2013a).

NASA has also repaired the landfill cover several times since the PCC period began. On August 20, 1999, NASA requested permission from NMED SWB to modify the existing drainage channel at the landfill closure by lining the sides and bottom of the channel with a minimum of 6 in. of gravel (NASA, 1999e). NMED SWB approved the channel modification on August 25, 1999, if NASA used residual material from "sorting for the final cover material" (NMED, 1999b). NASA submitted the final repair drawings to NMED SWB on August 10, 2000. "The landfill channel was modified from a 1:1 slope to a 1:2 slope and lined with gravel to prevent channel scouring" (NASA, 2000d).

In January 2001, NMED SWB requested that NASA repair cracks in the covered 700 Area landfill, inspect the GCL cover and repair as needed, and submit a revised final 700 Area landfill contour map (NMED, 2001). NASA submitted a letter, soil sieve analyses of soil used in the repair, proctor density test results, seeding-contractor statement of work, photographs of the cracks and repairs, and a final contour map. "Repairs began with filling in the cracked areas with on-site clay material…The fill areas were shaped, graded, moistened, and compacted, and proctor density tests were conducted…The areas were graded to match existing lines and to preserve appropriate drainage. Drill seeding was conducted in the repaired areas" (NASA, 2002b). The soil used for cap repair was from WSTF near PFE-2 and Well J and had an average coefficient of permeability of 2.57 x 10^{-7} cm/sec (NASA, 2002b). NMED SWB approved the cap repairs on July 30, 2002 (NMED, 2002).

WSTF personnel again completed landfill cover repairs in December 2003 and cap and drainage ditch repairs in June 2005 (NASA, 2006a). For cover repair, work consisted of removing the top layer of soil, adding clay material, then shaping, grading, moistening, compacting, and performing proctor density tests. Soil used for repair was from the NASA soil borrow area (near Well J). The soil was tested, and the average coefficient of permeability (for three tests) was 1.01 x 10^{-6} cm/sec. "Repair work was also completed on the drainage trench that runs along the southern border of the landfill, which included debris removal and erosion repair" (NASA, 2005b).

Landfill repairs were needed again in late 2008. On December 17, 2008, NASA submitted a repair plan to NMED SWB for removing vegetation and repairing cracks and subsidence in the landfill cover (NASA, 2008c). NMED SWB approved the reseeding plan on February 12, 2009, and NASA submitted a repair summary letter on August 30, 2009 (NMED, 2009a; NASA, 2009c). "NASA has completed repairs to the 700 Area landfill closure in accordance with the landfill closure repair plan submitted on December 17, 2008, and February 9, 2009. In addition to repairing several areas of subsidence, and/or cracking, deep rooted vegetation was removed from the closure cap" (NASA, 2009c). The average coefficient of permeability was tested for three soil areas for use in repairing the landfill cap: one from a stockpile of soil at the 700 Area landfill (with an average permeability of 1.40 x 10^{-6} cm/sec), another from the WSTF borrow area south of Well J (with an average permeability of 3.41 x 10^{-6} cm/sec), and the last from the WSTF borrow area north of Well J (with an average permeability of 2.38 x 10^{-6} cm/sec). NMED SWB approved the repairs on September 30, 2009 (NMED, 2009b). Repairs of the 700 Area landfill (SWMU 49) were also completed on March 21, 2013, for five areas of subsidence on the landfill cap and one rutted area on the road. Soil from the WSTF borrow pit north of Well J was stockpiled in the 700 Area for use in cap repairs. The average coefficient of permeability for this soil was 1.44 x 10^{-5} cm/sec (NASA, 2014a). NMED SWB approved the repairs on July 3, 2013 (NMED, 2013a).

In March and April 2017, three areas within the landfill cap were repaired over identified cells 8, 8A, and 10 (Figure 6.9). Falling head permeability tests for fill soil were previously conducted. Fill soil was mixed with water, compacted, and placed on the damaged areas up to 9 in. thick, then compacted to at least 90% and density tested. The soil used for repairs was the same stockpiled soil originally from north of Well J used for repairs in 2013 and was previously tested to have an average coefficient of permeability of 1.44 x 10^{-5} cm/sec. Figure 6.10 shows the current repair locations and a contour map of the closure cap. NASA submitted a closure repair summary report to NMED SWB on June 1, 2017 (NASA, 2017b). NMED SWB approved the repair (in compliance with PCC requirements) on June 14, 2017 (NMED, 2017).

7.0 Findings

7.1 Tenant Waste Disposal

As discussed in Section 6.4, Operations, besides WSTF, other generators of solid waste that ultimately was disposed in the 700 Area landfill were TDRSS, STGT, and ADF-SW. No documents were located discussing solid waste generation at TDRSS or STGT; however, long-term personnel stated that only limited solvents and latex (water-based) paints were ever used at the facilities and the only wastes would be contaminated debris (rags, gloves, etc.) and empty paint cans. These would have been disposed historically in the 700 Area landfill, and then later, shipped off site for disposal like WSTF wastes (Appendix A). One document was located for wastes generated at ADF-SW in 1989.

> "The utility area is divided into several areas: an uninterrupted power supply and battery room, heating and air conditioning support, and a generator room, which is also used as a temporary storage area...The generator room is used for storage of chemicals and waste petroleum. Waste oils and diesel fuel are produced by generator maintenance at an annual rate of ~10 gal total. Disposal has not yet been necessary…Solvents are used for cleaning in the technical area; however, they are used in small quantities (less than 25 gal per year) and typically are used on rags, q-tips or swab. The swabs and rags are disposed of in separate containers and stored in the generator room for future disposal" (GeCL, 1989).

A long-term ADF-SW employee stated that buildings at ADF-SW were and are mostly used for data processing. Current wastes at ADF-SW are described below.

> "There are no hazardous wastes, only domestic and universal wastes. Used oil/batteries for fire alarms, lights, are all 'green' and shipped off-site for disposal…Very little maintenance is performed by ADF-SW personnel on-site. Government Services Administration maintains vehicles [at WSTF]. The only maintenance performed at ADF-SW involves changing oil in generators. At most, there would be 4-5 ounces of used oil absorbed with rags. The rags are then disposed of off-site. Batteries used at ADF-SW are sealed gel cells that require no maintenance. When they need service, they are disposed of off-site and new ones obtained. Any paints used were historically latex. Currently, items arrive painted, and no painting is done at ADF-SW."

Waste-generation has been the same since the employee began working at ADF-SW in 1995, and there was "no specific data available on any chemical used prior to 1997…" (Appendix A), after use of the 700 Area landfill had ceased.

7.2 WSTF Waste Disposal

From WSTF's inception until a full-time Environment Department was established in April 1985, almost no wastes were shipped off site for disposal. This was stated in an environmental resources document from 1980, "No chemicals are shipped off site for disposal except possibly small quantity [sic] of PCB's (polychlorinated biphenyls)" (NASA, 1980b). In a letter to De Leuw, Cather & Company in August 1985, it was also stated, "It should be emphasized that although no hazardous materials or wastes have been disposed off site except as noted, this practice will be changing in the near future. Spent solvents, flammable wastes, and other hazardous wastes are being considered for off-site disposal" (NASA, 1985a).

(Refer to Section 7.7, Hazardous Substances Used at WSTF, for a discussion of the items that were shipped off site for disposal prior to 1985.)

Liquid wastes in the propulsion areas were washed into the concrete-lined flumes and into the gunnite-lined HWMU impoundments. 200 Area liquid hazardous wastes were stored in underground storage tanks, then pumped out (after 1968) and transported to the 600 Area HWMU. Flammable liquids were provided to the WSTF Fire Department for fire-fighting training practice. Refer to the 200, 300, 400, and SWMUs 1, 3, and 15 HIS' for details (NASA, 2012b, 2011d, 2011e, 2014e). Long-term WSTF personnel also agreed that prior to the establishment of a full-time Environmental Department at WSTF, all wastes were disposed on site (Appendix A).

7.3 Non-Hazardous Wastes

As discussed in Section 6.4.1, Landfill (SWMU 49) Documentation, there were no landfill records prior to 1987. There were also no records located (and likely not produced), for the 700 Area landfill that tracked specific wastes and volumes disposed at the landfill. One employee stated, "There were no records. They (supervisors) would tell me what to dump, and I would take it to the 700 Area and dump it" (Appendix A). Other long-term WSTF employees stated that wastes disposed at the WSTF landfill included office paper, cafeteria wastes, organic wastes (landscaping, weeds, etc.), copy and toner wastes, typewriter ribbons, type correction-fluid bottles, metal parts from building renovations/additions, empty or dried water and oil-based paints and epoxies, and tires (Appendix A).

A 1967 NASA memorandum is the earliest known document that discussed waste management processes for the 700 Area landfill. It included the statement "The dump is primarily a sanitary land-fill type operation. The types of wastes are paper, metal bands, wood, rags, metal containers, etc." (NASA, 1967).

In a 1985 landfill inspection conducted by NMEID, personnel stated, "no residential collection," "office and contractor disposal," and "one food establishment" (NMEID, 1985b). In December 1986, the EPA required that NASA fill out a landfill survey. Wastes listed as disposed were loose bulk wastes from WSTF only, and consisted of 90% commercial wastes from office buildings, restaurants, or other businesses and government offices and 10% construction/demolition wastes, with dead animals listed as accepted within a separate disposal area of the landfill. Asbestos, bulk liquids, containerized liquids, inorganic and organic chemicals, bulk liquid or containerized solvents, hazardous wastes, infectious wastes, and sewage sludges were listed as not accepted for disposal. The source of this information was listed as "estimates" (NASA, 1986d).

Additional evidence that drums were historically disposed in the landfill includes a WSTF DR from February 1987. A deteriorated poly barrel was found in the container storage area. The DR stated, "transport deteriorated barrel to trash receptacle and dispose of as trash (ultimate disposition is WSTF landfill)" (NASA, 1987a).

Disposal of construction and demolition debris or yard refuse at the 700 Area landfill was conducted throughout the life of the landfill (NASA, 1991f). Within the solid waste facility annual report, types of solid wastes disposed in the 700 Area landfill were listed as yard/landscaping, construction/demolition, and industrial (office, shop, and non-hazardous laboratory) wastes (NASA, 1992c).

Drilling mud and additives used to drill groundwater monitoring wells and drill cuttings were also disposed in the 700 Area Landfill. Several TPS' discuss disposal of drilling mud/cuttings in the landfill in the 1980s (NASA, 1984a, 1988b, 1989b). A small trench was also added in the landfill to contain mud/cuttings from portable mud pits (Figure 7.1; NASA, 1984a).

7.4 Banned Items

When a full-time Environmental Department was established in 1985, waste reduction through recycling, and waste management practices were initiated at WSTF to ensure compliance with federal and state regulations. This resulted in the identification of items that were prohibited from being disposed in the 700 Area landfill (SWMU 49). With prohibited items, oversight of landfill wastes needed to be initiated. As discussed in Section 6.4.1, Landfill (SWMU 49) Documentation, weekly inspections were conducted after May 1987, to ensure that no prohibited items were disposed at the 700 Area landfill. Long-term WSTF personnel also stated that landfill operators were also trained to ensure compliance with waste disposal practices (Appendix A). As stated in the landfill groundwater monitoring plan, "The operators are trained to recognize wastes which are prohibited from disposal at the landfill. Additionally, the site contractor Environmental Department inspects the landfill on an at least weekly basis" (NASA, 1994g). These weekly inspection logs, and associated DRs, provide evidence for items that were banned from the 700 Area landfill, and by extension, items that were likely disposed in the landfill prior to 1985. Banned, "unpermitted", or prohibited items documented included:

- In a DR in 1987, personnel stated that three metal drums discovered in the 700 Area landfill were placed there against procedures. They were not removed, however, due to subsequent trash covering the drums (NASA, 1987d).
- From a weekly inspection log in October 1987, it was stated, "some residue [was] remaining in [a] ~40 gal oakite®[3] container" (NASA, 1987c).
- A DR was completed in March 1988: "Metal, grating & metal cabinet found in landfill" (NASA, 1988c). The DR does not specify corrective actions. However, a long-term WSTF employee stated that the metal would have been removed for recycling (Appendix A).
- In August 1988, "During routine inspections, an aerosol can containing pesticides was found in the WSTF landfill. Aerosol cans which have emptied during normal use may be placed in the landfill. Full or partially full aerosol cans containing hazardous materials should not be disposed in the landfill. As with any waste material, the Environmental Section is available to provide disposal recommendations for aerosol cans and their contents" (NASA, 1988e).
- In 1988, two drums (in May) and wood pallets (in July) were documented (NASA, 1988a).
- In January 1989, one 5-gal container of hydraulic fluid, two 5-gal containers of THR-Petroleum (possibly a roof sealant), pipe, angle iron, and polyvinyl chloride (PVC) were discovered in the 700 Area landfill during routine weekly inspections and documented in a DR. The containers were removed and the refuse was covered (NASA, 1988a, 1989a). The pipe and angle iron were metal and could be recycled; however, it is unknown why PVC was listed as part of the prohibited landfill items.
- In July 1989, more metal items were documented on the weekly inspection logs. These metal items consisted of a cabinet, a metal chair, and "other large metal objects" (NASA, 1989c).
- From an internal memorandum in May 1989, "Infectious waste (sharps, blood, etc.) currently generated at WSTF are disposed of in our landfill…The most cost effective solution for the small quantities of infectious waste generated at WSTF is off-site incineration" (NASA, 1989d). This statement indicates that all medical or infectious wastes generated at WSTF prior to May 1989 were disposed in the landfill but would be banned thereafter.

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[3] Oakite is a registered trademark of Oakite Products, Inc.

- It was commented in a weekly landfill inspection in April 1990 that personnel “found chemicals in [a] jar (soldering flox [sic]), [and] some boxes.” Soldering flux is a paste or liquid that consists of soldering metals and chemicals for use in soldering. Appendix C provides several sample material safety data sheets (MSDS). The items were removed from the landfill. This statement suggests that chemicals and boxes were banned items as well. The boxes were likely used for fire-fighting practice.
- In the 1990 solid waste annual report, it was stated that two loads were rejected because they contained paint and wood (NASA, 1991a). Wood at WSTF was stacked in a pile located in the area just east of the GSA building in the 100 Area and used periodically for fire-fighting training. Refer to the SWMUs 1, 3, and 15 HIS for details (NASA, 2014e). Paint was shipped off site for disposal due to solvents and/or lead constituents in the paint (Appendix A).
- In May 1991, 13 poly drums were discovered in the 700 Area landfill (NASA, 1991c). The drums were removed (and recycled).
- On November 25, and December 6, 1991, “Unpermitted” items included two pieces of conduit (NASA, 1991c). These items were also removed and recycled (Appendix A).
- The NM SWMR were revised (third edition), with the result that NASA could no longer dispose of contaminated soils, including chemical or petroleum-contaminated soils, as of the effective date of the regulations, January 31, 1992 (NASA, 1991f). Refer to Section 6.1, Landfill (SWMU 49) Regulatory History, for details.
- In January 1992, through weekly inspections, copper wiring was listed as an unpermitted item in the landfill (NASA, 1992a). The copper wiring was removed and recycled (Appendix A).
- In November 1992, metal flanges with plastic pipe and wood were disposed in the landfill and a DR was written. “Flanges were removed by Heavy Equipment Section. Wood & other pipe debris removed by construction section.” Flanges were delivered to the warehouse for “salvage” (NASA, 1992e).
- In July 1993, six metal fan shrouds, wire spools, and 10-12 glass ceiling tiles were discovered in the landfill (NASA, 1993a). The metal and wire were recycled, and the glass ceiling tiles may have contained asbestos that would have been shipped off site for disposal.
- In August 1993, two electrical test boxes and one clock were listed as unpermitted items (NASA, 1993a). These items were removed and recycled with other electrical equipment at WSTF (Appendix A).
- In 1994, paint cans with residual paint, wire (copper and other), wood, metal copper flex line, rebar, and an unspecified type and number of drums were listed as prohibited items discovered in the 700 Area landfill. In March 1994, an unspecified quantity of paint cans (containing over the allowable limit of paint) were listed in the weekly inspection log (NASA, 1994a). The paint cans were removed and sent off site for disposal, the wood was removed and added to the WSTF wood pile in the Firemen’s training area, and the drums, wire, and metal were removed and sent for scrap/recycling (NASA, 1993a).
- In June 1995, “Thinner & PVC cement removed for proper disposal.”
- Empty paint cans were listed in the comments section of the weekly inspection log in August 1995; however, since they were empty, it was not a banned item and they were not removed (NASA, 1995a).

From the 1994 solid waste facility annual report, “Landfill Inspection Procedures” section, it was stated, “White Sands Test Facility (WSTF) procedures currently require that the Quality Assurance (QA) Office inspect the WSTF Landfill weekly for the following prohibited items: metal, wood, concrete, hazardous materials/waste, and soils not originating at the facility" (NASA, 1994b).

7.5 Waste Reduction/Recycling

The first material recycled at WSTF was vehicle batteries. From a waste inventory generated in 1985, it was listed that approximately 30 (vehicle) batteries per year were shipped to HAFB for recycling (between 1963 and 1985; NASA, 1985a). Long-term WSTF personnel stated that WSTF vehicle batteries were recycled from WSTF's inception to the present (2014; Appendix A).

In 1977, NASA evaluated the recycling of office paper. In a letter from NASA headquarters to WSTF, it was stated, "EPA Guidelines for Source Separation for Materials Recovery (40 CFR 246) which was published in the Federal Register on April 23, 1977, requires office paper recycling in Federal facilities with 100 or more office workers." Decisions regarding compliance were required to be submitted by July 24, 1977 to the EPA. In response, NASA WSTF personnel submitted a cost analysis to NASA headquarters. The number of employees at WSTF at the time was 240. "The small volume of waste at this installation and the low price offered for high grade office paper on the local market makes it uneconomical to initiate source separation at this time" (NASA, 1977).

As stated in Section 6.1, 700 Area Landfill (SWMU 49) Regulatory History, the Hazardous and Solid Waste Amendments of 1984 required facilities to certify annually that the volume and toxicity of wastes was reduced to the greatest extent practicable. This resulted in the beginning of waste reduction at WSTF. This regulation was first implemented at the landfill by finding alternate disposal methods or recycling for items such as metals.

In a DR, it was stated,

> "On July 7, 1987, NASA QA [quality assurance] personnel discovered three metal drums in the WSTF landfill. Disposal of metal drums in the landfill is prohibited by Lockheed Procedure…Before the Environmental Section could require the removal of the drums and their delivery to the warehouse as scrap, the drums were covered by loads of trash subsequently delivered to the landfill. Please require your landfill operator to survey the contents of the landfill for the presence of unacceptable items prior to burying them with trash. Notify the Environmental Section in the event these items, or anything questionable, are discovered" (NASA, 1987d).

This shows that by 1987, metal drums were not allowed to be disposed in the 700 Area landfill, but were disposed/sold as scrap metal instead (NASA, 1987d).

In a solid waste questionnaire completed in November 1990, NASA stated that a pilot recycling program had been implemented at WSTF to recycle up to 10% of the total solid waste (NASA, 1990i). Items recycled in the pilot program were not specified, but assumed to be paper, based on information provided in the solid waste facility annual report to NMEID submitted in February 1991. "The site has been recycling paper on a trial basis for about three months. Information regarding the approximate quantity of waste recycled is unavailable. The paper waste is segregated at the point of generation and shipped off site" (NASA, 1991a).

For the first time, NMEID requested that the solid waste facility annual report for 1993 include an accounting of the final disposition of any waste materials generated that were not landfilled:

- "Waste oil, used anti-freeze, scrap metals, and non-hazardous products are recycled through the Defense Reutilization and Marketing Organization at Holloman Air Force Base;

- Aluminum cans [are] recycled off site;
- Scrap lumber and tree branches [are] collected and used for firefighter training with Burn Permits; and
- Concrete and asphalt [are] used for flood control and riprap" (NASA, 1994b).

The annual report for 1994 also listed the disposition of items not landfilled. Most items were the same as in 1993; however, lead acid batteries and rubber tires were added to the list of materials that were recycled through HAFB (NASA, 1995b).

The annual report to NMED SWB for 1994 listed, for the first time, specific amounts of recycled materials:

- 2 tons tires, 2,050 gal waste oil,
- 209 tons scrap metal, and
- 3 tons lead acid batteries were recycled through HAFB (Defense Reutilization and Marketing Organization; NASA, 1995b).

On October 1, 1995, NASA began recycling cardboard through Southwest Disposal Corp. as part of the solid waste disposal service (NASA, 1996b). Other items recycled in 1995 included:

- Scrap metal: 100 tons,
- Electrical wire/cable: 56 tons,
- Waste oil: 7.2 tons,
- Lead acid batteries: 3 tons,
- Tires: 1.75 tons, and
- Toner cartridges: 500 each (NASA, 1997b).

For FY 1996, amounts of solid material recycled were:

- Scrap metal: 67 tons,
- Electrical wire/cable: 7 tons,
- Waste oil: 11 tons,
- Lead acid batteries: 1.7 tons,
- Toner cartridges: 500 each, and
- Cardboard: 1.7 tons (NASA, 1997b).

For FY 1997, NASA recycled 23% of solid wastes, including:

- Scrap metal: 81 tons,
- Electrical wire/cable: 6 tons,
- Waste oil: 4.3 tons,
- Lead acid batteries: 1.6 tons,
- Tires: 1.3 tons,

- Toner cartridges: 287 each, and
- Cardboard: 8.2 tons (NASA, 1998c).

Besides the documented recycling or waste reduction procedures listed above, NASA conducted additional recycling efforts. Long-term personnel stated that NASA recycled:

- Broken, non-functional, or excess electrical equipment/instruments/meters through HAFB,
- Empty pressurized gas canisters were exchanged for full canisters at a local Las Cruces business,
- Computers, and
- Equipment not in use at WSTF.

Employees could not recall when these programs began at WSTF, but it was likely after 1985. One employee stated, “Recycling at WSTF early on was only for money or if there was no place to throw it away. There was no environmental control until later on in the Shuttle program” (Appendix A).

7.6 Landfill Burning

In the 1981 application to register the 700 Area landfill (SWMU 49), it was stated that no burning of solid waste was permitted, and a sign was posted to that effect (NASA, 1981); however, burning was conducted at the 700 Area landfill (SWMU 49). NMEID personnel stated in a landfill inspection in 1983: “You may wish to ask for a variance to the solid waste regulations or a burn permit to allow the burning of controlled paperwork” (NMEID, 1983). No burn permits were located; however, long-term WSTF personnel concurred that sensitive documents and computer cards were burned at the landfill, reportedly every Saturday or twice a week, until the mid-1980s. These items were burned within the trench that was active at the time. Since these fires were conducted in the trench that contained additional waste, any flammable waste would also burn within the trench (such as paper, rags, etc.). The WSTF Fire Department doused the fires with water to extinguish them. Evidence of these fires was noted by a WSTF employee who stated that while locating historical trenches for landfill closure activities, most trenches located contained burned material (Appendix A).

An accidental fire also started in the landfill, reportedly in the mid-1970s, when WSTF personnel had detonated small engines within the active trench. (Refer to Section 7.8.3, Evidence from Interviews, for details of these explosions.) This caused “paper and things” within the active trench to begin burning and also ignited waste within the adjacent covered trench. The WSTF Fire Department responded, and the fire was extinguished with water. Subsidence occurred in the area of the fire (Appendix A), and the subsided area was filled in with clean soil excavated from the active trench.

Another employee reported seeing a “spontaneous” fire of flammable rags occurring in the landfill in the late 1970s (Appendix A). The WSTF Fire Department extinguished the fire with water. Finally, regarding burning at the 700 Area landfill, it was stated within the landfill closure and PCC plans, “Trash was burned in open cells prior to the open burning regulation implementation” (NASA, 1996j).

7.7 Hazardous Substances Used at WSTF

Since records of the specific waste types and measured amounts of solid wastes disposed at the 700 Area landfill (SWMU 49) were not generated at WSTF, and few long-term WSTF employees recalled detailed disposal data, WSTF solid waste information is only estimated. As usual for a HIS, historical waste generation records were reviewed. Because recent NASA testing activities and waste generation are comparable, recent WSTF wastes were also reviewed as an analog to what may have been historically disposed at the 700 Area landfill.

Wastes that are, or have been, shipped off site for disposal were likely disposed in the 700 Area landfill prior to waste disposal shipments at WSTF (1985). Some solid wastes currently or historically generated and shipped off site, reused, or recycled at WSTF are described in this section.

From 1994 and 1995 waste reduction reports and correspondence:

- Batteries (mercury, lead, acid),
- Paints (with lead, chromates, and barium),
- Fluorescent lamps (with mercury),
- Scrap metal,
- Toner cartridges (NASA, 1994e, 1995d).

Prior to shipment off site for recycling in 1985, it was reported that acid from vehicle batteries was emptied into the 600 Area HWMU impoundment (NASA, 1985a). However, both long-term WSTF personnel and historical documents suggest that the 600 Area HWMU began to be used for hazardous liquid wastes, in 1968. Refer to the 200 Area HIS for details (NASA, 2012b). Prior to that time, it is unknown how the acid from recycled batteries was disposed. One employee speculated that it may have been disposed in the 700 Area landfill (Appendix A).

NMED SWB personnel stated during an inspection of the 700 Area landfill in April 1991 that NASA shipped asbestos and infectious waste off site for disposal (NMED, 1991). This was stated again in a regulatory review in November 1991, "WSTF generates medical and asbestos waste which are both special wastes, however, these wastes are shipped off-site for disposal" (NASA, 1991e). Shipping these wastes off site for disposal occurred by late 1991, likely in preparation for regulation changes in January 1992 (Section 6.1, 700 Area Landfill [SWMU 49] Regulatory History). Medical and asbestos wastes were disposed at the 700 Area landfill prior to the early 1990s (NASA, 1989b). Examples of asbestos-containing material used at WSTF may include: packings, gaskets, floor tiles, ceiling tiles, roofing products, and insulation (Appendix A).

WSTF spill reports documented chemicals/substances spilled at WSTF subsequent to 1985. Hazardous substances shipped off site for disposal (after 1985), and likely deposited in the 700 Area landfill prior to 1985, included contaminated soils from:

- Mercury,
- Oakites (Oakites used at WSTF include Oakite 33 [phosphoric acid], Oakite HD 126 [sodium hydroxide], Oakite Liqui-Det 2 [phosphates, amine, surfactants], Oakite Rustripper [caustic, alkaline salt, surfactants], Oakite Vistrip),
- Oils,
- Rust removal chemicals,
- Freons (Freon 11 and Freon 113),
- Acids,
- Bases,
- Ammonia,
- Isopropyl alcohol (IPA),

- Gasoline,
- Diesel fuel,
- Fuel (MMH, hydrazine) spills,
- Hazardous waste drainline spills,
- Photographic chemicals (developer, fixer, etc.), and
- Fuel contaminated vacuum pump oils.

Finally, a list of recent hazardous wastes shipped off site for disposal was reviewed to estimate past hazardous wastes disposed at the 700 Area landfill prior to 1985. Solid wastes that were shipped off site for disposal between September 2013 and September 2014 included:

- Contaminated debris (fuels [hydrazine, methylhydrazine, 1,1-dimethylhydrazine], oxidizer [nitrogen dioxide], arsenic, barium, cadmium, lead, chromium, mercury, benzene, methyl ethyl ketone [MEK], trichloroethene [TCE], tetrachloroethene [PCE] corrosive wastes, ignitable wastes, reactive wastes, F001 wastes, F002 wastes, and F005 wastes),
- Waste aerosol cans (barium, benzene, MEK, TCE, PCE, ignitable waste, corrosive waste, and reactive waste),
- Spent metal sludge (chromium),
- Spent mercury lamp debris (mercury),
- Contaminated oil (arsenic, cadmium, chromium, lead, benzene),
- Petroleum contaminated soils (lead and benzene),
- Fuel contaminated soils (benzene),
- Spent oil filters (benzene),
- Lead acid batteries (lead, corrosive waste),
- Nickel cadmium (NiCad) batteries (cadmium and corrosive waste),
- Paint related materials (barium, benzene, MEK, and ignitable wastes), and
- Unused chemicals (lead, mercury, and MMH sulfate; NASA, 2013c).

F001 wastes contain: “The following spent halogenated solvents used in degreasing: Tetrachloroethylene, trichlorethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures” (EPA, 2017a).

F002 wastes contain: “The following spent halogenated solvents: Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2- trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2, trichloroethane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F001, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures” (EPA, 2017a).

F005 wastes contain: “The following spent nonhalogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2- nitropropane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above nonhalogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures” (EPA, 2017a).

Finally, hazardous spent lamps that are currently shipped off site for disposal were likely disposed in the 700 Area landfill prior to 1985. “During routine operation of the facility, WSTF generates a variety of spent lamps. Typically, these lamps would be hazardous due to toxicity for mercury, lead, or other heavy metals…WSTF currently manages spent lamps in accordance with the universal waste regulations per 40 CFR 273…Examples of common universal waste electric lamps include, but are not limited to, fluorescent, high intensity discharge, neon, mercury vapor, high pressure sodium, and metal halide lamps…” (NASA, 2012a).

7.8 Evidence of Hazardous Substances Disposed at the Landfill

7.8.1 Evidence from Documentation

This section provides information on some wastes disposed in the 700 Area landfill and identified through WSTF documents. In a 1980 environmental resources document, it was stated, “scrap, garbage, and other solid wastes are picked up on a regular basis and disposed of through an onsite operated, state approved, landfill…All unused pesticides listed are stored in a locked building. All empty containers are disposed of in state-approved [WSTF] landfill.” These pesticides included “spike, Hyvarx, MB Rat Guard, Pyrethrin, and Diazinon 4E” (NASA, 1980b). MSDS are provided in Appendix C. As stated in Section 6.1, 700 Area landfill (SWMU 49) Regulatory History, NASA originally listed warfarin rat poison as having been disposed in the 700 Area landfill, but in 1984, stated that this was not the case (NASA, 1984b).

From a 1985 WSTF waste inventory provided to DeLeuw, Cather & Company, WSTF disposed approximately 10 to 30 gal per year of latex and oil-based paint in the 700 Area landfill from the site’s inception (listed as 1963) to the present time (of 1985). Included as part of this inventory, was a list of SWMUs that had been previously provided to the EPA. The 700 Area landfill was listed as a SWMU in the 700 Area. Types of waste disposed at the landfill were listed as, “Paper, rubbish, and assorted non-industrial materials…Except for the paint, the landfill, to the best of our knowledge, has not been used for the disposal of hazardous wastes” (NASA, 1985a).

Then, in May 1989, WSTF Environmental Department personnel performed a regulatory review of revised NM SWMRs. “New Mexico has recently issued new regulations (effective May 15, 1989) for solid waste landfills restricting the disposal of infectious waste. Infectious waste (sharps, blood, etc.) currently generated at WSTF are disposed of in our landfill” (NASA, 1989d). (Refer to Section 6.1, Landfill (SWMU 49) Regulatory Review for a continued discussion of this regulation.)

Asbestos was also historically disposed in the 700 Area landfill. An internal WSTF memorandum describes asbestos disposal in September 1989. “The 150 Yard has received several items, such as pipes, which contain or are coated with asbestos containing material…Because these items are non-friable asbestos, they may be placed in the WSTF landfill” (NASA, 1989f). It is unknown if friable asbestos was also disposed at the 700 Area landfill.

Contaminated soils were disposed at the 700 Area landfill until 1991. In a November 1991 regulatory review of NMSWMR-3 (third edition), it was stated, “Petroleum contaminated soils are the only special wastes the WSTF landfill currently receives that fall under the amended regulations…” (NASA, 1991f).

In the site assessment submitted to NMED SWB in June 1993, NASA reported, "Hazardous waste was disposed of at this site," based on interviews with long-term WSTF employees (NASA, 1993c). When asked if hazardous waste was disposed at the WSTF landfill, employee statements were:

- "Prior to the hazardous waste laws the landfilled materials would surely have exhibited current hazardous waste characteristics."
- "Probably, because at the time (prior to 1976) we were not aware of hazardous waste and now almost everything is hazardous."
- "In the early years there was no hazardous waste distinction; therefore, most probably we did."
- "Previous discussions with long time site employees indicated that the following wastes were probably placed in the landfill: paints (oil and water based), adhesives, fillers, batteries (mercury, NiCad, lead acid), glassware and soft goods contaminated with fuel (primarily monomethylhydrazine), and various solvents" (NASA, 1993c).

In the landfill closure and PCC plans, hazardous wastes disposed at the landfill were discussed:

> "WSTF employees familiar with historical landfill operations in the late 1960s, feel that it is likely that these installations disposed of the following hazardous wastes:

- Spent solvents,
- Waste paints,
- Hydrazine-contaminated soft goods, and
- Various spent sample materials that may have contained residual hazardous wastes" (NASA, 1996j).

7.8.2 Spill Reports

NASA WSTF personnel did not maintain any records of spills of chemicals/substances to the environment prior to waste management changes introduced by the full-time Environmental Department. The first spill report was written at WSTF in November 1985. This section summarizes spills at WSTF that were documented as disposed in the 700 Area landfill (SWMU 49). Appendix D provides the original spill report documents.

- SPL001 (4/3/1988): 7 gal of transmission fluid was spilled at the WSTF Fire Department. The spill was soaked up with spill dry and disposed in the dumpster (for transport to the 700 Area landfill).
- SPL002 (4/13/1987): the Southern transformer in Building 201/203 substation leaked ~1 quart of non-PCB containing oil after sampling 4/7/88. The spill was cleaned with spill dry and paper towels, which were taken to the 700 Area landfill for disposal.
- SPL005 (6/1/1987): stained soil under building 253 (the historical 200 Area chemical storage building) on the east side was determined to be approximately 5 gal Texaco Soluble oil D (stored since 1984). Contaminated soil was approximately 4 ft in diameter. The soil was drummed and spread at the 700 Area landfill.
- SPL009 (6/24/1987): approximately 1 gal of water-based paint was spilled at the WSTF warehouse. It was initially washed with water, cleaned with spill pillows, and disposed at the 700 Area landfill. This spill indicated the lack of employee training for environmental issues and the lack of written spill procedures at WSTF (Appendix D).

- SPL015 (11/18/1988): Approximately 1 gal of Given Black Enamel Paint was spilled on the floor of the WSTF warehouse. MSDS could not be located. The paint was cleaned up with “mineral spirits,” rags, and spill pillows. Liquids were drummed and taken to the drum storage facility (for shipment off site), and the rags and spill pillows were allowed to dry and placed in the 700 Area landfill.
- SPL016 (12/5/1988): IPA leaked into soil from two stock tanks during cleaning procedures for the 400 Area 10,000-gal IPA storage tank. There was approximately 147 cubic ft of contaminated soil. The IPA soil was analyzed for flash point (69ºC or 156ºF). Since the result was >140ºF, the soil was disposed in the 700 Area landfill.
- SPL018 (12/19/1988): A package of eight 1-gal containers of 52% hydrofluoric acid had leaked when it arrived at the WSTF warehouse. The containers were decontaminated at the 200 Area clean room pad. “The boxes and other decontaminated items” were put in the trash (for disposal at the 700 Area landfill). The hydrofluoric acid was added to Building 253 for use in the 200 Area.
- SPL023 (1/10/19890): one 8-ounce bottle of plastic polish (containing IPA) spilled at the WSTF warehouse. The spill was cleaned up with rags that were disposed in the 700 Area landfill. (The flash point of the product was 200ºF).
- SPL024 (2/2/1989): approximately 5-10 gal of gasoline were spilled when the gas pump did not shut off. Vermiculite (Floor-Dri) was used to clean up the spill. The vermiculite will be disposed at the 700 Area landfill “after airing out.”
- SPL025 (2/15/1989): The automatic gas shut-off did not function properly and 2-3 gal of gasoline was spilled. The gas was cleaned up with spill dry, which was disposed in the 700 Area landfill “after airing out.”
- SPL026 (2/21/1989): 2 liters hydraulic fluid was spilled in Room 119, 800 Area. The spill was cleaned up with rags, which were disposed in the 700 Area landfill.
- SPL031 (3/16/1989): <1 ounce total (estimated) of sulfuric acid (electrolyte battery fluid) leaked during transport to WSTF. The damaged containers were rinsed into the ETUs. The contaminated cardboard boxes and rinsed containers were placed in the 700 Area landfill.
- SPL033 (4/17/1989): approximately 2 quarts non-contaminated oil leaked from water pumps at test stand 401. The oily soil was allowed to dry and disposed in the 700 Area landfill.
- SPL034 (4/18/1989): an estimated <1 gal of Kodak 1st Dev. Replenisher Proc. R3 had leaked during transit to WSTF. The containers were rinsed (into the 100 Area sewage lagoon) and the box was put in the dumpster (for disposal at the 700 Area landfill).
- SPL035 (4/28/1989): an estimated <1 ounce tetraethylene pentamine had leaked during transit to WSTF. The cardboard box, vermiculite, and paper towels were placed in the dumpster (for disposal in the 700 Area landfill).
- SPL036 (5/4/1989): approximately 2 gal diesel spilled at the 400 Area diesel pad. Contaminated soil was “exposed” for five days then disposed in the 700 Area landfill.
- SPL037 (5/8/1989): < 1 pint Bioact DG-1 petroleum leaked in transit to WSTF contaminating papers. Cleaned cans with wipes, then wipes and contaminated papers “discarded.” It is assumed that papers and wipes were disposed in the 700 Area landfill.
- SPL038 (5/9/1989): This may be the same spill as SPL027. Details are the same, except the date and this spill report stated that the box and packing materials were placed in the dumpster (for disposal in the 700 Area landfill).

- SPL041 (6/14/1989): Unknown quantity of diesel and cutting/motor oil was spilled to soil 100 ft northeast of monitoring well BW-5-298. 20-30 ft of the arroyo contained discolored soil to at least 1 ft depth. Disposition of the contaminated soil was not reported, but assumed to be at the 700 Area landfill.
- SPL045 (no date): This is the same spill as SPL041 but provides greater detail. This spill was reportedly caused by a subcontracted construction company that was building the road to the STGT. The contaminated soil was "spread out on the hard pack area to the south to be broken down by exposure." It is assumed that the soil was then disposed in the 700 Area landfill.
- SPL047 (7/17/1989): 2-3 gal of diesel fuel overflowed onto the ground east between Building 200 and the North high bay. Spill dry was used to soak up the spill, and the spill dry was disposed at the 700 Area landfill.
- SPL051 (12/16/1989): 100 gal of diesel spilled from an overhead diesel tank in the 150 yard. A 10 ft x 10 ft puddle had formed, contaminating soils 2-3 in. deep. Free diesel was absorbed. The absorbent and contaminated soils were "transported to the WSTF landfill and spread on the ground to degrade."
- SPL054 (1/18/1990): <1 gal oil-based paint spilled in transit to WSTF. The spill was wiped up with rags. It is assumed that the rags were disposed in the 700 Area landfill.
- SPL058 (5/2/1990): approximately 15 gal leaded gasoline was spilled onto gravel. The contaminated gravel was transported to the 700 Area landfill and "spread out to air dry on a vinyl vapor barrier."
- SPL060 (10/5/1990): 40-50 gal IPA was spilled in the 400 Area at the alcohol run tank. Liquid IP was pumped to a barrel. Contaminated soil was excavated and placed on plastic to air dry. "The solid would then be placed in an open head drum." Final disposition of the soil was not reported.

As stated in Section 6.1, Landfill (SWMU 49) Regulatory History, the revision of NM SWMRs-3 expanded the definitions of special wastes and implemented special requirements for disposal; therefore, WSTF stopped placing contaminated soils in the 700 Area landfill. This was stated in several documents, and is corroborated in WSTF spill reports, since no spill reports were located that discussed disposal in the landfill after SPL060.

7.8.3 Evidence from Interviews

Long-term WSTF employees interviewed for this HIS also provided information regarding what was or may have been disposed in the 700 Area landfill (SWMU 49). Personnel stated that many items were placed in the landfill prior to use of a full-time Environmental Department at WSTF (1985). One employee stated, "There seemed to be no historical procedure to deal with occasional extra, leftover, or off-specification liquids/chemicals" (Appendix A).

When asked if any hazardous substances or petroleum products, tires, or automotive or industrial batteries had been buried at WSTF, one employee stated, "The old dump. Everything went into it" referring to the 700 Area landfill. Some items disposed in the landfill that employees identified included:

- Both soft goods (e.g., cloths/rags, disposable PPE [gloves, outer clothing, aprons, face shields, goggles, SCAPE gear, splash gear, hard hats], wipes, elastomer parts from the valve shop, o-rings, gaskets, Tygon®[4] tubing, plastic, etc.) and hardware (e.g., glass bottles, other glassware,

[4] Tygon is a registered trademark of Saint-Gobain Performance Plastics Corporation.

tubing, piping, plastic, spent 800 Area test samples, Teflon®[5] gaskets, "anything on an aerospace panel," etc.) contaminated with:

- Fuels (UDMH, A-50, MMH, and hydrazine),
- Oxidizer (N_2O_4),
- All 200 Area laboratory chemicals (e.g., Freon 11, Freon 113, TCE, PCE, other solvents, alcohol, acetone, IPA, MEK, phosphorus, etc.),
- Hydrocarbons (e.g., diesel, gasoline, hydraulic fluid, lubricating oils, motor oils, etc.),
- Krytox®[6] lubricant (Appendix C contains SDSs),
- Teflon grease,
- Mercury (cloth used to clean broken thermometers or spills prior to off-site shipment).

Other waste items disposed at the 700 Area landfill reported by long-term WSTF employees included:

- Small amounts of metals (stainless steel 306, carbon steel, chrome decorations, titanium, aluminum, iron, machine shop metal tubing and residual or excess metal parts, mercury, copper, tin, gold, silver),
- Steel or aluminum cabinets,
- Photographic negatives and photo papers (silver [silver bromide]),
- Etching plates (metals),
- Contaminated spill dry (chemicals, oils, fuels),
- Fluorescent lamps (containing lead, cadmium, and mercury),
- Fluorescent light ballasts (containing PCBs; Refer to Section 7.9. Polychlorinated Biphenyls below for details),
- Asbestos containing materials (insulation for wires and pipes, floor and ceiling tiles, automotive brake materials, etc.),
- Plastics,
- Meter cases,
- Oil-based paints (ignitable and contained chromium and lead),
- Latex (water-based) paints,
- Primers (contained lead),
- Waste epoxy coatings (dried and liquid),
- Resins,
- Adhesives,
- Filters (air, oil, etc.),
- Batteries (alkaline, mercury, lead-acid, NiCad),

[5] Teflon is a registered trademark of E.I. du Pont de Nemours & Company Corporation (Dupont).
[6] Krytox is a registered trademark of E.I. du Pont de Nemours & Company Corporation (Dupont).

- Automotive waste (tires, brake parts, filters, antifreeze, used oil, etc.), automotive wastes (rags, oils, greases, antifreeze residuals),
- Broken or inoperable equipment (meters and meter parts [wiring, inductors, capacitors, resistors, etc.]),
- Insulated wires,
- Pipes/plumbing,
- Respirators,
- Lumber/wood/pallets,
- Oils (not containerized),
- Spent activated charcoal from fluorine testing (may have been reactive),
- Aerosol cans (most empty, but some full),
- Engine cleaning solutions,
- Residual liquids left in empty steel or fiberboard drums (55-gal), bottles, or containers (1 gal, 2 gal, 5 gal) [included but not limited to: acetone, solvents, Freon 11, Freon 113, TCE],
- Liquids within containers up to half full (especially Freon 113) during clean-up activities for off-specification, leaking, or old chemicals/containers prior to a well-managed hazardous waste disposal program through the full-time Environmental Department (1985).

An employee that worked at WSTF during the Apollo program from 1965-1971 stated, “We used a lot of Freon, also Trich (TCE) was primarily used. Most evaporated…Landfilled most of waste. Used to be very generous with use of Trich (TCE). The landfill site north of the usage areas was used to dispose of drums of Freon waste” (Appendix A). This suggests that there may be buried 55-gal drums of Freon 11 and/or Freon 113 in the 700 Area landfill and perhaps TCE as well. Another employee stated that there was “no limit on the type of stuff that went into the landfill.”

One employee remembered pouring liquids directly into the landfill and adding mostly unmarked 55-gal drums and containers of chemicals (e.g., Freon 11, Freon 113, acetone, IPA, hydraulic fluids, engine oil, diesel fluid, spent oakites, spent MEK, spent Brulin®[7] solutions; Appendix A).

Long-term WSTF personnel also stated that some small propulsion engines and/or thrusters had been destroyed within the trenches of the landfill during three different propulsion testing programs at WSTF: one program in the 1960s (as part of the Apollo missions), one in the 1970s (Orbital Maneuvering System engines for the Space Shuttle), and again approximately in 1985. One employee explained that engine designs were proprietary and the designers required secrecy for each engine design. The engine contractor personnel did not want the engines returned after testing; therefore, the long-term WSTF employee stated that C4 explosives had been used to destroy these engines within trenches at the 700 Area landfill. Landfill procedure required a bulldozer to be present at the landfill, so when an engine needed to be disposed, a new trench was excavated, the disposal explosion was conducted, and then the remains were covered with soil. These engines contained minute residual amounts of fuel (UDMH, A-50, MMH, or hydrazine) and oxidizer (N_2O_4; Appendix A).

In addition to these liquid propellant engines, solid propellant engines with “trident propellant” and “BATES” (Ballistic Test and Evaluation System) motors for the Navy and U.S. Army were also

[7] Brulin is a registered trademark of Brulin & Company, Inc.

destroyed within 700 Area landfill trenches in approximately 1985. The BATES engines were small (able to be hand carried), 40 to 50-lb thrust engines and "had a habit of blowing up." For WSTF testing personnel safety, the engines were routinely x-rayed prior to testing to determine if the engines might explode during the testing process. If any engines contained internal anomalies (e.g., voids, cracks, etc.) on the x-ray film, these engines were deemed unsafe to test and were taken to the landfill and destroyed. The engines would have been full to capacity of solid propellant/oxidizers when they were destroyed. The composition of the solid propellant/oxidizer was not specified; but one employee guessed that it could have been aluminum/ammonium perchlorate, which could possibly result in perchlorate contamination. Another employee stated that 50 engines would arrive at WSTF for testing at a time, and on one occasion, five of the 50 engines required destruction. Like the earlier disposal of the liquid propellant engines, when a solid propellant engine/thruster was disposed in the landfill, a new trench was excavated so that the explosion would not cause other items within the landfill to burn. After the explosions, any remaining small parts were left in the landfill and the trench was used for routine landfill waste disposal (Appendix A).

Items that personnel stated may have been disposed in the 700 Area landfill also included:

- Steel tanks (75-100-gal to 1,200-gal capacity) decontaminated with MEK,
- Titanium tanks (approximately 2 ft in diameter),
- Wastewater lagoon (sewage) sludge.

Sludge was cleaned out of the 100 Area wastewater lagoon at least once historically. There are conflicting accounts from long-term WSTF employees regarding whether this sewage lagoon sludge was ever disposed in the 700 Area landfill. One employee remembered wastewater lagoon sludge being placed in the 700 Area landfill; however, several other long-term employees from the facilities department stated that sludge from the WSTF 100 Area sewage lagoon was placed in SWMU 16, the 600 Area BLM off-site pile (and sludge from other WSTF wastewater/sewage lagoons has never been removed to date).

All long-term WSTF personnel interviewed for this HIS stated that early in WSTF's history, no solid wastes were shipped off site for disposal and everything thrown away would have ended up in the 700 Area landfill. Several employees stated that hazardous wastes were also placed in the landfill prior to 1985 (both by being placed in dumpsters and taken directly to the landfill by individual employees), but these items were not considered a safety hazard at the time. "Garbage was just thrown away" (Appendix A). Several long-term WSTF employees also stated that even after the establishment of a full-time Environmental Department and a formal waste management and waste reduction program, ending hazardous waste disposal at the 700 Area landfill was a gradual process, beginning in 1985. Changing long-term informal waste management and disposal practices took time. "Environmental concerns were not in the mentality of workers…There were educational battles." Designing employee education programs and ensuring employees were trained adequately also took time (Appendix A). But by 1990, one employee stated, there was nothing hazardous being disposed at the 700 Area landfill, just paper, office supply items, cafeteria scraps, alkaline batteries, empty paint cans (with less than 1 in. of paint within the cans), etc. (Appendix A).

7.9 Polychlorinated Biphenyls

According to the EPA website, the manufacture of PCBs in the United States was banned in 1979; however, PCBs may be present in products produced prior to the 1979 ban. Historical items that may have contained PCBs included:

- Transformers and capacitors,

- Other electrical equipment including voltage regulators, switches, reclosers, bushings, and electromagnets,
- Oil used in motors and hydraulic systems,
- Old electrical devices or appliances containing PCB capacitors,
- Fluorescent light ballasts,
- Ceiling tiles,
- Cable insulation,
- Thermal insulation material including fiberglass, felt, foam, and cork,
- Adhesives and tapes,
- Oil-based paint,
- Coatings,
- Caulking,
- Window glazing,
- Spray-on fireproofing,
- Plastics,
- Copy paper,
- Floor finish (EPA, 2017b).

Known items at WSTF containing PCBs were transformers (pole and pad), oil capacitors, oil circuit reclosers, filters, and light ballasts (NASA, 1985b). From approximately 1980, some PCB-containing items at WSTF were shipped off site for disposal (NASA, 1980b; NASA, 1982; Lockheed, 1983). By 1985, and the establishment of a full-time Environmental Department, any types of equipment known to have contained PCBs in the past, were treated as PCB-containing items to ensure environmental compliance and protection of the environment (NASA, 1986b); however, any PCB-containing items disposed prior to 1980 would likely have been disposed in the 700 Area landfill (SWMU 49).

A long-term WSTF employee provided evidence for 700 Area landfill disposal of one type of PCB-containing item. This employee related WSTF electrician's statements that fluorescent light ballasts, which likely contained PCBs, were disposed in the 700 Area landfill "in the old days" (prior to 1980; Appendix A). It is unknown if any other materials identified above (e.g., copy paper, floor finish, oils, adhesives, tapes, caulking, paint, plastics, cable or thermal insulations, or capacitors from electrical equipment) potentially disposed at the 700 Area landfill contained any PCBs; and no documentation at WSTF discusses the possibility that these materials contained PCBs.

The only materials identified at ADF-SW, TDRSS, and STGT that could potentially contain PCBs were transformers. According to a long-term employee, all transformers at ADF-SW were sampled for PCBs in 1997/1998 with no PCBs detected. Additionally, due to the age of the facility (constructed in 1983/1984 after the manufacture of PCBs were banned), it is unlikely that any PCB-containing materials were used in the construction or operations of the facility. Several long-term TDRSS and STGT personnel stated that the transformers at both facilities have always been dry, contained no oils, and therefore contained no PCBs. STGT was also constructed and began operations (1988/1989) after the manufacture of PCBs were banned; therefore, it is also unlikely that any PCB-containing materials were disposed at the 700 Area landfill from construction or use at STGT. It is unknown if any PCB-containing materials were present, used, or disposed at the 700 Area landfill from the TDRSS facility.

7.10 Indication of Releases to the Environment

Evidence for releases from the 700 Area landfill to the environment was provided by long-term WSTF personnel. In the site assessment submitted to NMED SWB in June 1993, NASA reported that less than 5,000 gal of liquids had been disposed at the 700 Area landfill based on statements from long-term employees. Four employees interviewed as part of the landfill site assessment stated that liquids had been historically disposed in the 700 Area landfill. Examples of the types of liquids included paints (including off-specification paints), epoxies, solvents, residues from cleaning operations and within drums, and electrolytes from batteries. One employee stated that many liquid paints collected while cleaning out paint locker(s) were disposed in the landfill. When asked the amount of liquids landfilled, one employee stated, “A little bit of everything, but not a lot of anything.” Another employee estimated the amount of liquids historically landfilled to be tens to hundreds of gals annually (NASA, 1993c).

The first regulations that banned bulk liquids in landfills were the RCRA Hazardous and Solid Waste Amendments of 1984, which banned land disposal of hazardous liquids after May 8, 1985 and any liquids after November 8, 1985. As discussed in Section 7.2, WSTF Waste Disposal, the Environmental Department at WSTF was established in April 1985, and ensured that NASA adhered to federal and state regulations and modified procedures/waste management practices when new regulations were enacted. Therefore, it is likely that no liquids were disposed in the 700 Area landfill after 1985.

There was an unknown stain documented at the landfill in January 1995 in the weekly landfill inspection log. It was stated, “stain NE side 18” in diam[eter]” (NASA, 1995a). The stain origin is unknown; however, it is believed that this stain could have resulted from a vehicle leak. Disposition of the soil was not documented.

The final evidence of 700 Area landfill releases to the environment (SWMU 49) is that the groundwater adjacent to the landfill contains low levels of Freon 113, Freon 11, TCE, and PCE. Refer to Section 6.6, Groundwater Monitoring, for details.

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Figures

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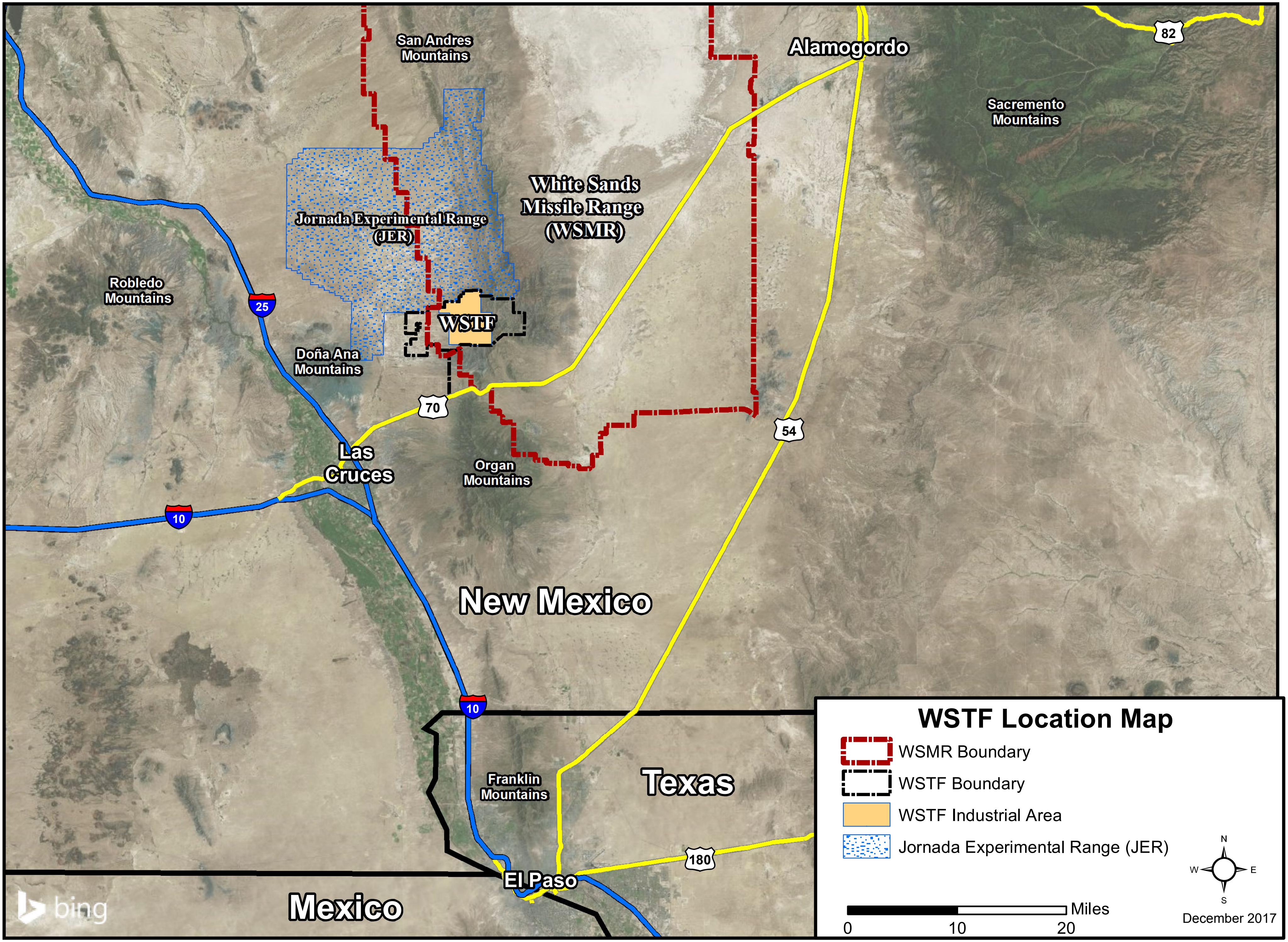
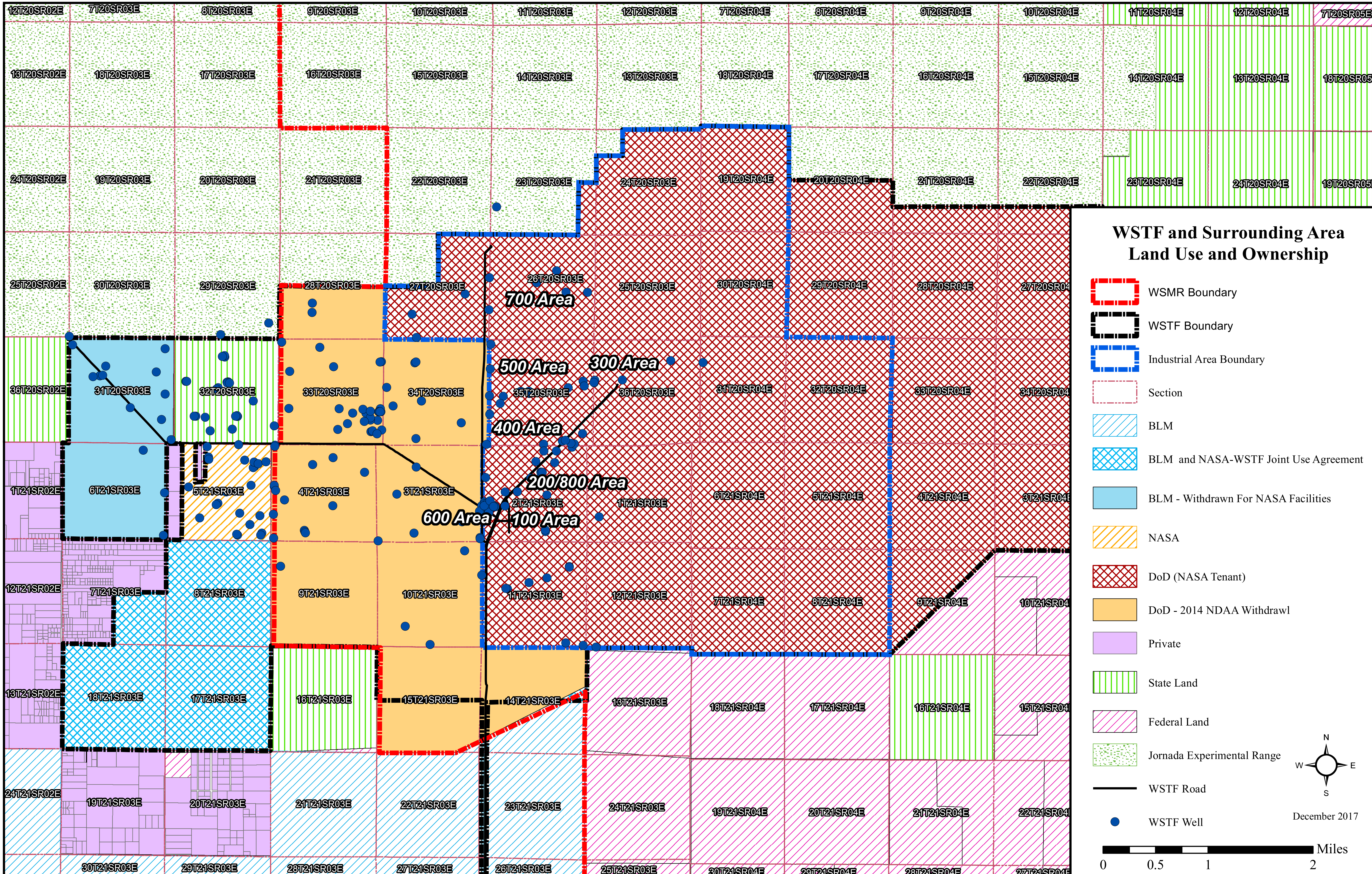

San Andres Mountains
Alamogordo
82
Sacremento Mountains
White Sands Missile Range (WSMR)
Jornada Experimental Range (JER)
Robledo Mountains
25
WSTF
Doña Ana Mountains
70
54
Las Cruces
Organ Mountains
10
New Mexico
Franklin Mountains
Texas
180
El Paso
Mexico
bing
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
N
W
E
S
Miles
0
10
20
December 2017

Figure 2.2 **Land Ownership Map**

(SEE NEXT PAGE)


WSTF and Surrounding Area
Land Use and Ownership
WSMR Boundary
WSTF Boundary
Industrial Area Boundary
Section
BLM
BLM and NASA-WSTF Joint Use Agreement
BLM - Withdrawn For NASA Facilities
NASA
DoD (NASA Tenant)
DoD - 2014 NDAA Withdrawl
Private
State Land
Federal Land
Jornada Experimental Range
WSTF Road
WSTF Well
N
W
E
S
December 2017
Miles
0
0.5
1
2
700 Area
500 Area
300 Area
400 Area
200/800 Area
600 Area
100 Area
12T20SR02E
7T20SR03E
8T20SR03E
9T20SR03E
10T20SR03E
11T20SR03E
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28T20SR03E
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26T20SR03E
25T20SR03E
30T20SR04E
29T20SR04E
28T20SR04E
36T20SR02E
31T20SR03E
32T20SR03E
33T20SR03E
34T20SR03E
35T20SR03E
36T20SR03E
31T20SR04E
32T20SR04E
33T20SR04E
1T21SR02E
6T21SR03E
5T21SR03E
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18T21SR03E
17T21SR03E
16T21SR03E
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14T21SR03E
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18T21SR04E
17T21SR04E
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19T21SR03E
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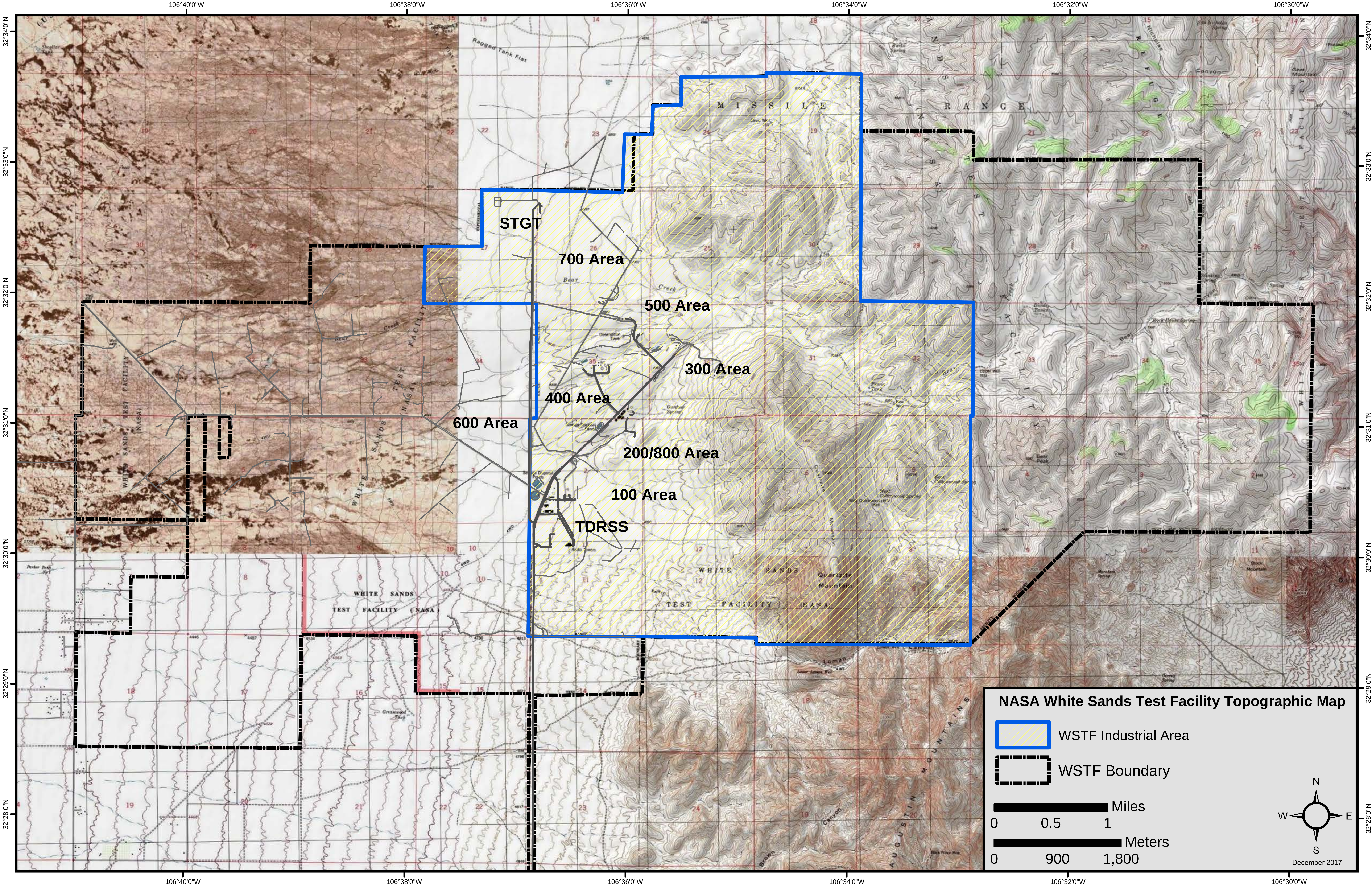
29T21SR04E
28T21SR04E
27T21SR04E

Figure 2.3 WSTF Topographic Map

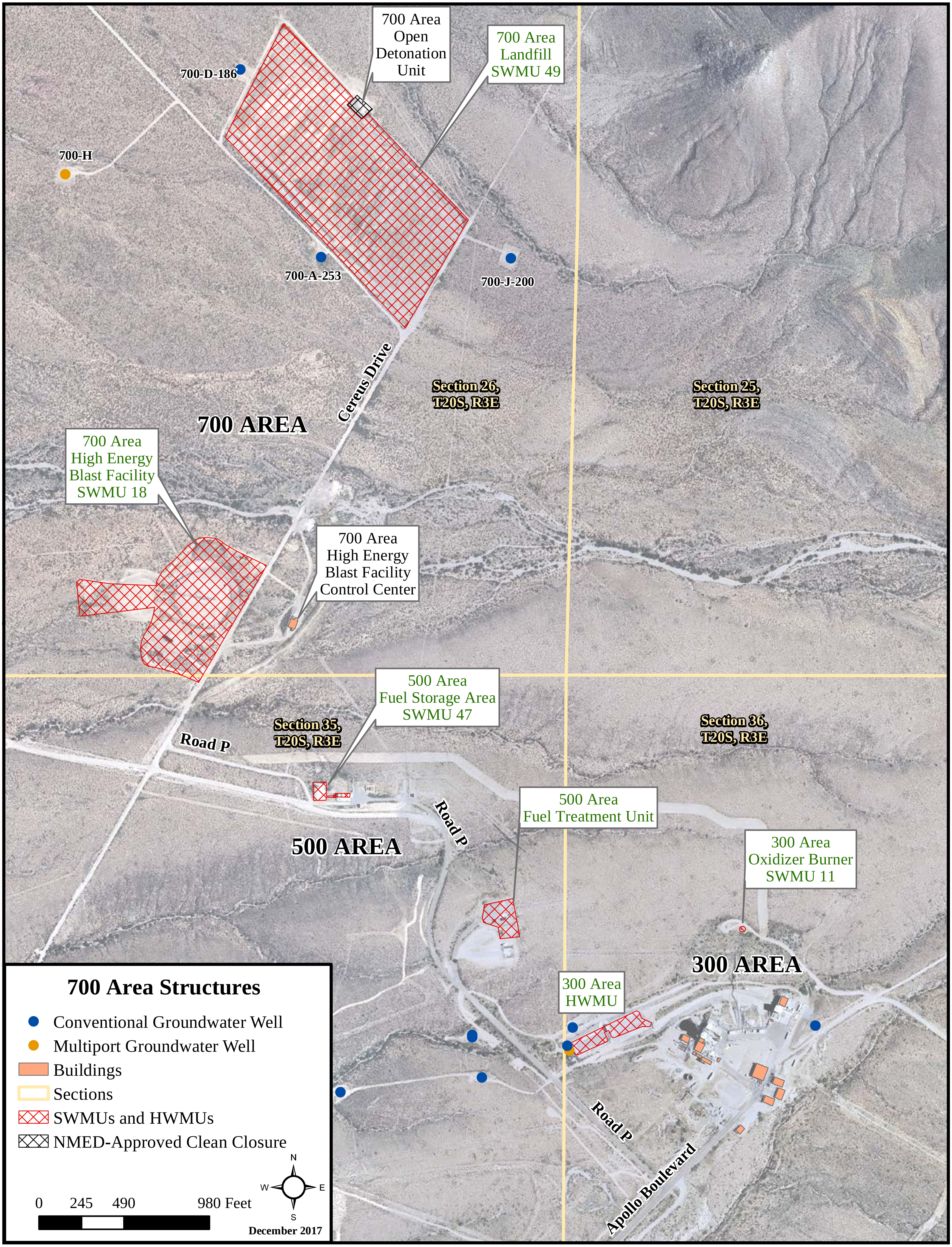
(SEE NEXT PAGE)



NASA White Sands Test Facility Topographic Map
WSTF Industrial Area
WSTF Boundary
Miles
0 0.5 1
Meters
0 900 1,800
N
S
E
W
December 2017
STGT
700 Area
500 Area
300 Area
400 Area
600 Area
200/800 Area
100 Area
TDRSS
106°40'0"W
106°38'0"W
106°36'0"W
106°34'0"W
106°32'0"W
106°30'0"W
32°34'0"N
32°33'0"N
32°32'0"N
32°31'0"N
32°30'0"N
32°29'0"N
32°28'0"N

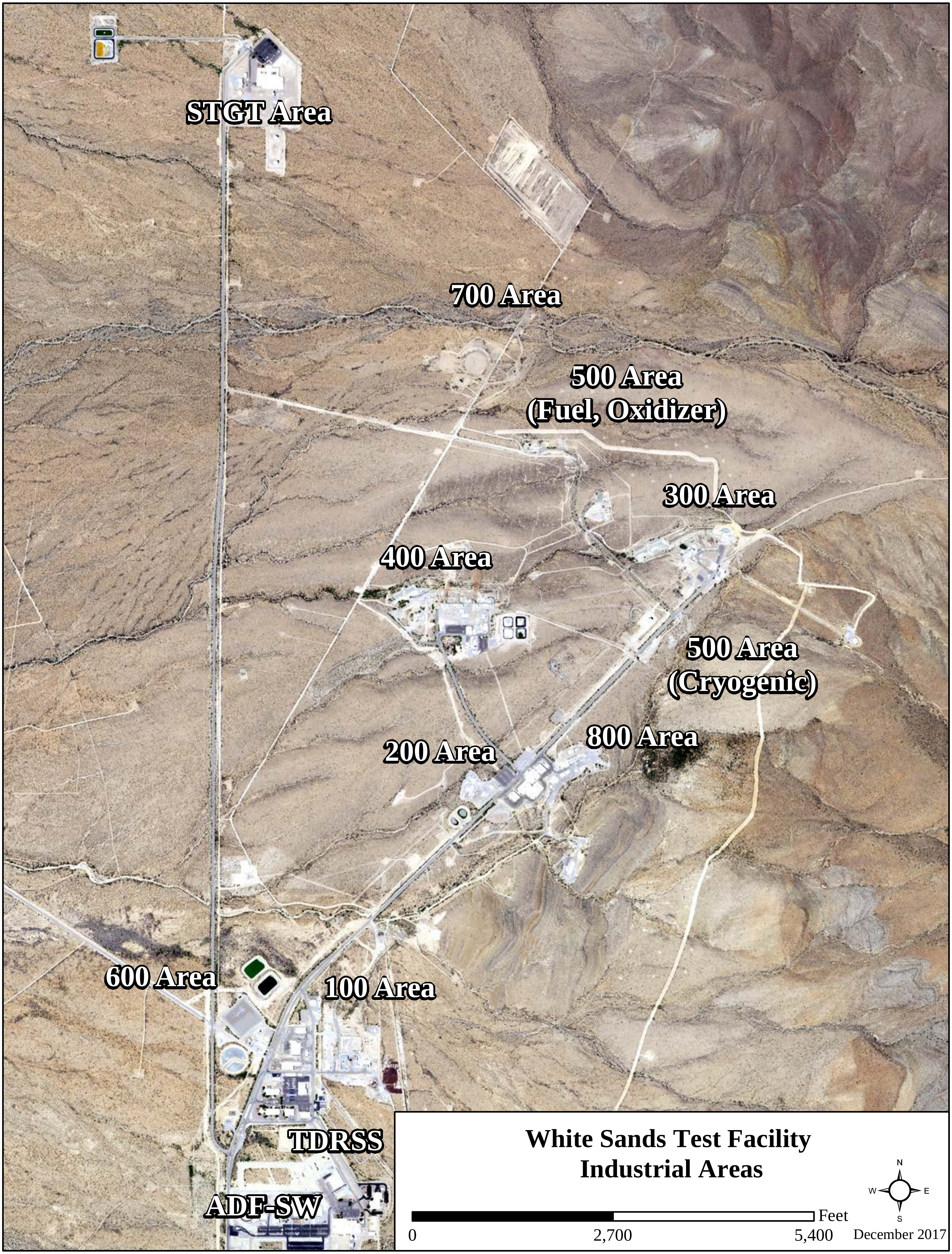
Figure 3.1 **700 Area Structures and SWMUs**

(SEE NEXT PAGE)

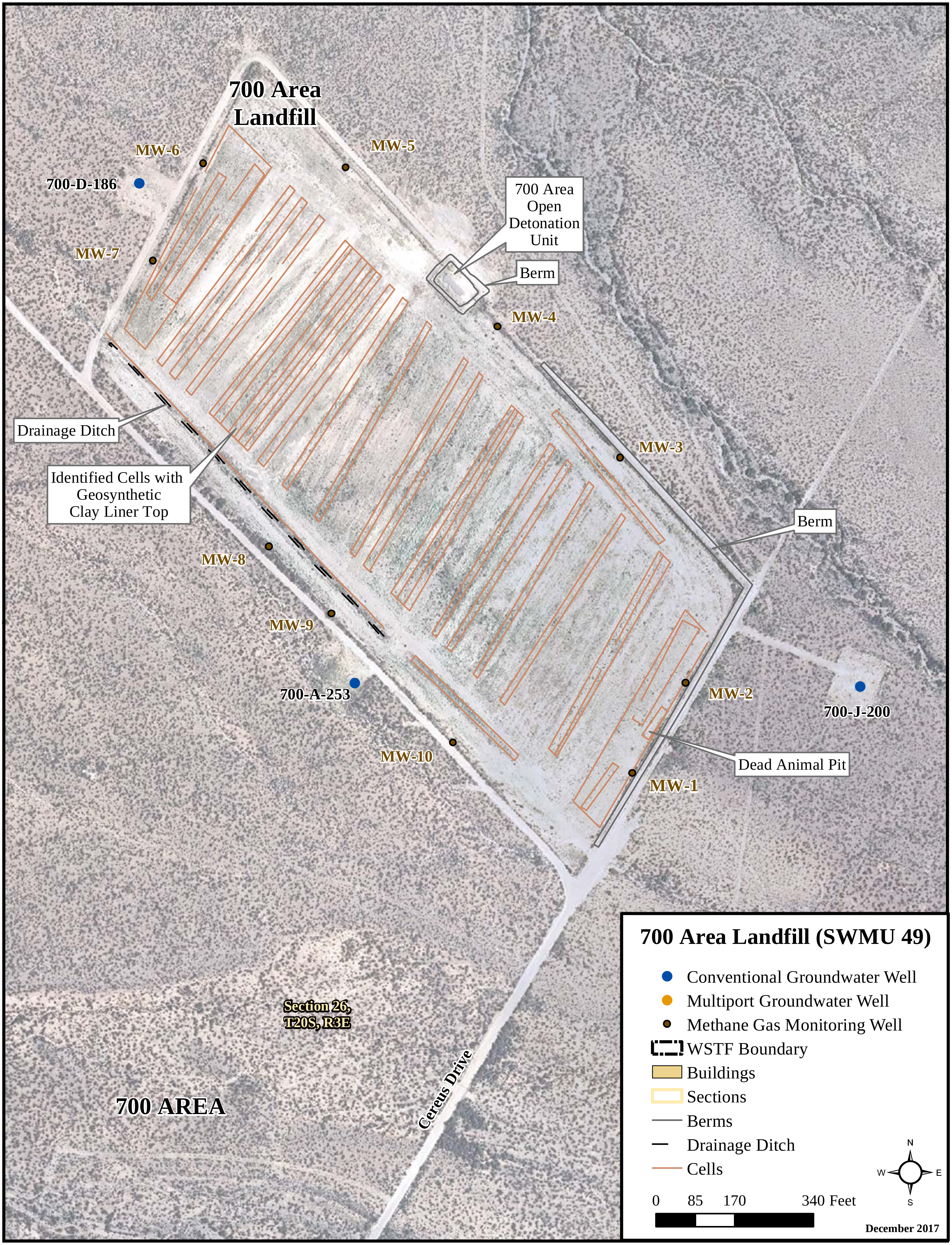


700 Area Open Detonation Unit
700 Area Landfill SWMU 49
700-D-186
700-H
700-A-253
700-J-200
Cereus Drive
Section 26, T20S, R3E
Section 25, T20S, R3E
700 AREA
700 Area High Energy Blast Facility SWMU 18
700 Area High Energy Blast Facility Control Center
500 Area Fuel Storage Area SWMU 47
Section 35, T20S, R3E
Section 36, T20S, R3E
Road P
500 Area Fuel Treatment Unit
Road P
500 AREA
300 Area Oxidizer Burner SWMU 11
300 AREA
300 Area HWMU
Road P
Apollo Boulevard
700 Area Structures
Conventional Groundwater Well
Multiport Groundwater Well
Buildings
Sections
SWMUs and HWMUs
NMED-Approved Clean Closure
0
245
490
980 Feet
N
W
E
S
December 2017

(SEE NEXT PAGE)


STGT Area
700 Area
500 Area
(Fuel, Oxidizer)
300 Area
400 Area
500 Area
(Cryogenic)
800 Area
200 Area
600 Area
100 Area
TDRSS
ADF-SW
White Sands Test Facility
Industrial Areas
N
W
E
S
Feet
0
2,700
5,400
December 2017

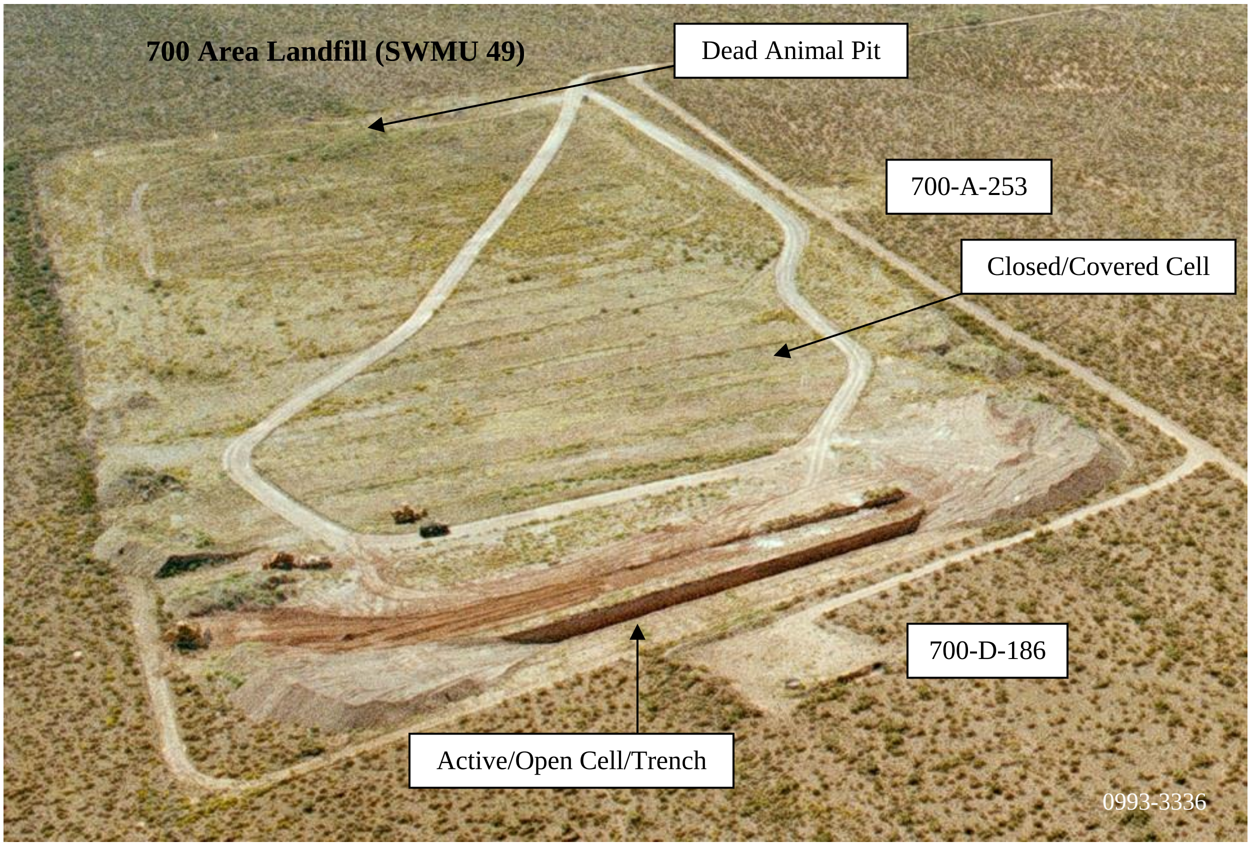
(SEE NEXT PAGE)



700 Area Landfill
MW-6
MW-5
700-D-186
700 Area Open Detonation Unit
Berm
MW-7
MW-4
Drainage Ditch
MW-3
Identified Cells with Geosynthetic Clay Liner Top
Berm
MW-8
MW-9
MW-2
700-A-253
700-J-200
MW-10
Dead Animal Pit
MW-1
700 Area Landfill (SWMU 49)
Conventional Groundwater Well
Multiport Groundwater Well
Methane Gas Monitoring Well
WSTF Boundary
Buildings
Sections
Berms
Drainage Ditch
Cells
Section 26, T20S, R3E
Cereus Drive
700 AREA
N
W
E
S
0 85 170 340 Feet
December 2017

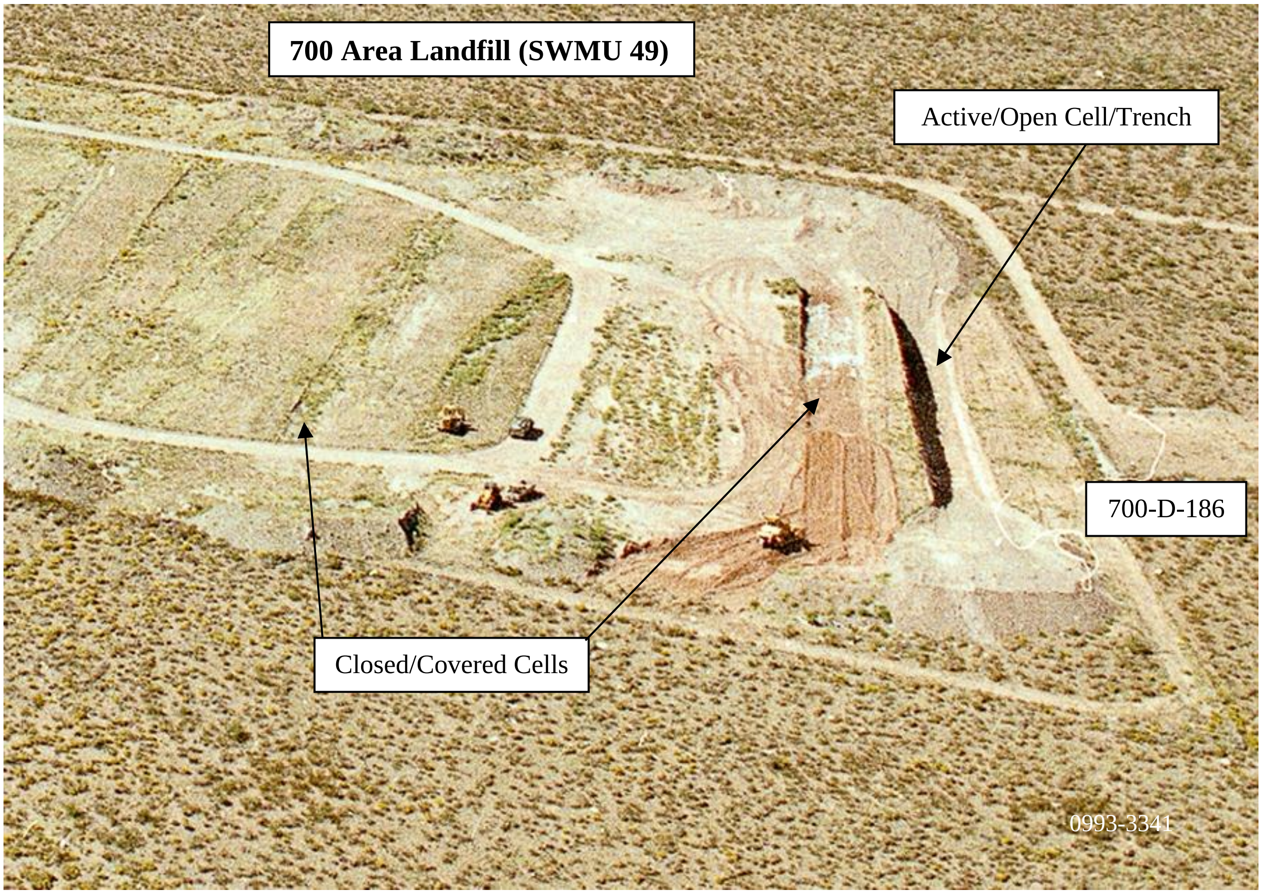
Figure 6.2 **WSTF Landfill-SWMU 49 (1993)**

(September 1993 – view to the southeast)



This photograph shows the WSTF landfill (SWMU 49) in September 1993, when the landfill was still in use at WSTF. Note that some closed and covered trenches are still visible due to some subsidence. The dead animal pit was located near the entrance to the landfill (shown at the top of this photograph), and groundwater monitoring wells 700-A-253 (cross-gradient) and 700-D-186 (downgradient) are present on the sides of the landfill.

(September 1993 – view to the southwest)

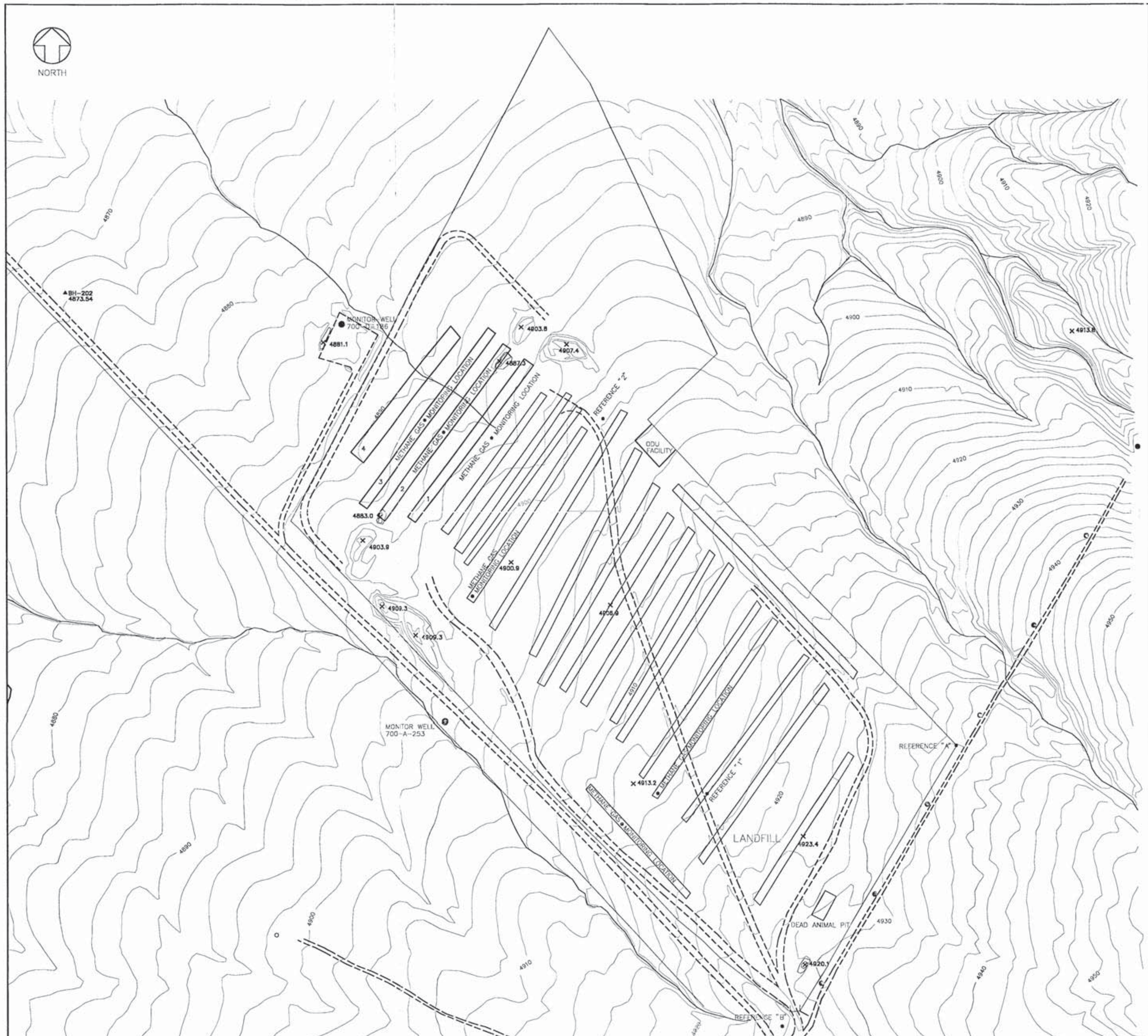


This photograph shows an aerial view of an open trench at the WSTF landfill (SWMU 49) in September 1993. Notice the heavy equipment used for landfill operations, including the newly purchased bulldozer and compactor. Also note that some closed and covered trenches are still visible due to some subsidence and vegetation growth.

Figure 6.4 29-Acre Boundary and Supplemental Methane Gas Sample Locations

(SEE NEXT PAGE)

SYMBOL	LETTER	ZONE	DESCRIPTION	DATE	APPROVAL
	A		REVISED PER DCN A-3 1-15-92 G.P.M.	1-21-92	D. TRUE T. CONDON R. MONJARAS
	B		REVISED PER DCN B-1, 3-10-93, R.E.M. REVISED PER DCN B-2, 4-19-93, R.E.M.		



NOTES:

1. OPEN 5/30/89 CLOSED 12/26/90 — 75,600 CU.FT. 15% GROUND FILL
2. OPENED 12/21/90 CLOSED 10/21/91 — 75,600 CU.FT. 15% GROUND FILL
3. OPENED 10/19/91 CLOSED 10/16/92 — 75,600 CU.FT. 15% GROUND FILL
4. OPENED 10/13/92

▲ BH-208
4986.51

REQ'D PER ASS'Y	ITEM NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	SHT. NO.

NEXT ASS'Y / RELATED DWG'S

DIMENSIONAL TOLERANCE UNLESS NOTED OTHERWISE
.0± ANGLES ±
.00± FRACTIONS ±
.000±
DIMENSIONS ARE IN INCHES.

SURFACE FINISH IN MICRO INCHES RMS UNLESS OTHERWISE NOTED. √

UNLESS NOTED OTHERWISE REMOVE ALL SHARP EDGES AND BURRS.

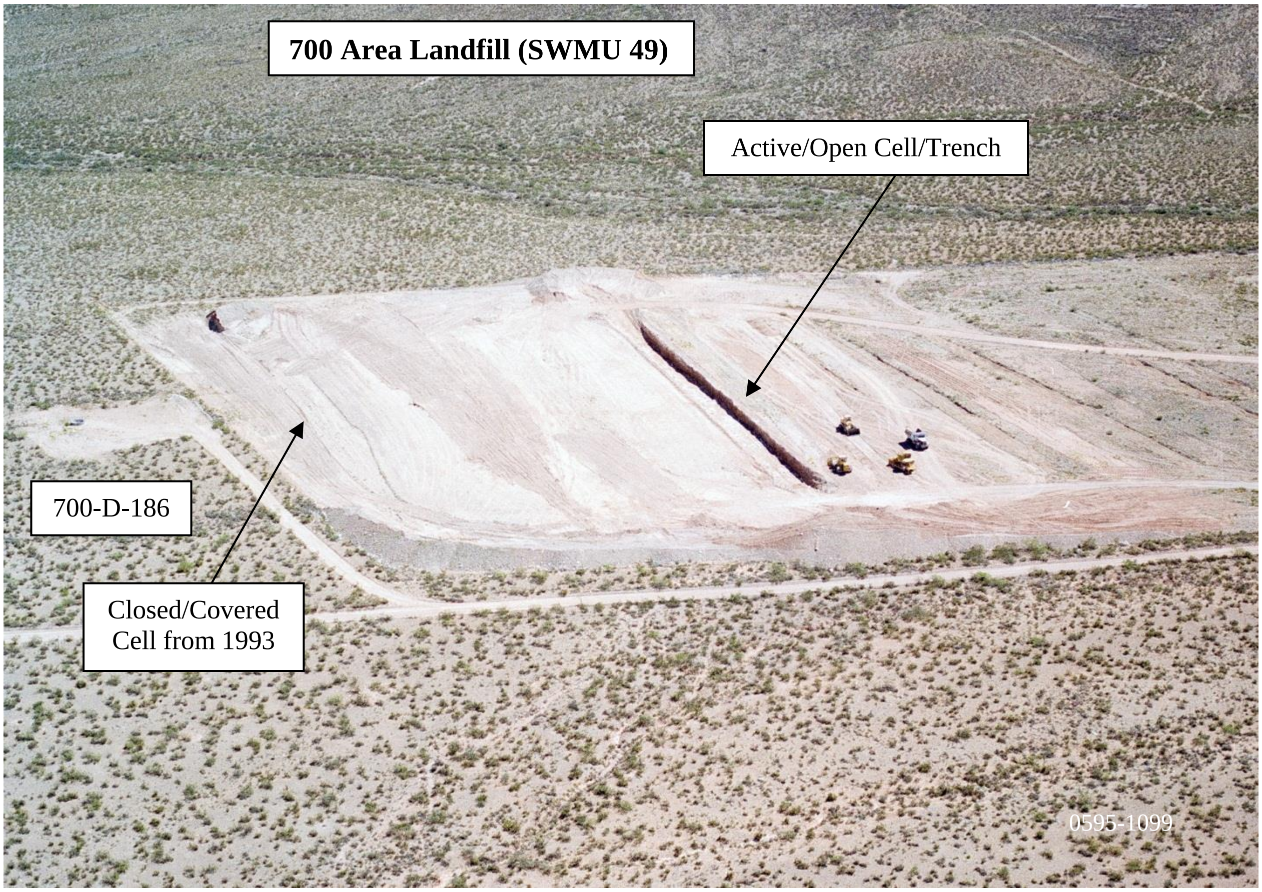
DRAWN BY	GPM/REM	3-11-93
ENGINEER	J.B. HOSSLEY	11-18-87
DESIGNED BY		
CHECKED BY	J.B. HOSSLEY	11-18-87
APPROVAL	J. B. HOSSLY	11-18-87
APPROVAL	R. MITCHELL	11-18-87
AUTHORIZED	K. FARRAH	11-18-87
RELEASE	B. MELENDEZ	11-18-87

National Aeronautics and Space Administration — NASA
Lyndon B. Johnson Space Center
White Sands Test Facility

SANITARY LANDFILL DETAIL SITE MAP

CODE IDENT.	A.B. DWG. NO.	SCALE	SHEET	REV
		1"=100'	1 OF 1	
SIZE F	DWG. NO. 019-13998			B

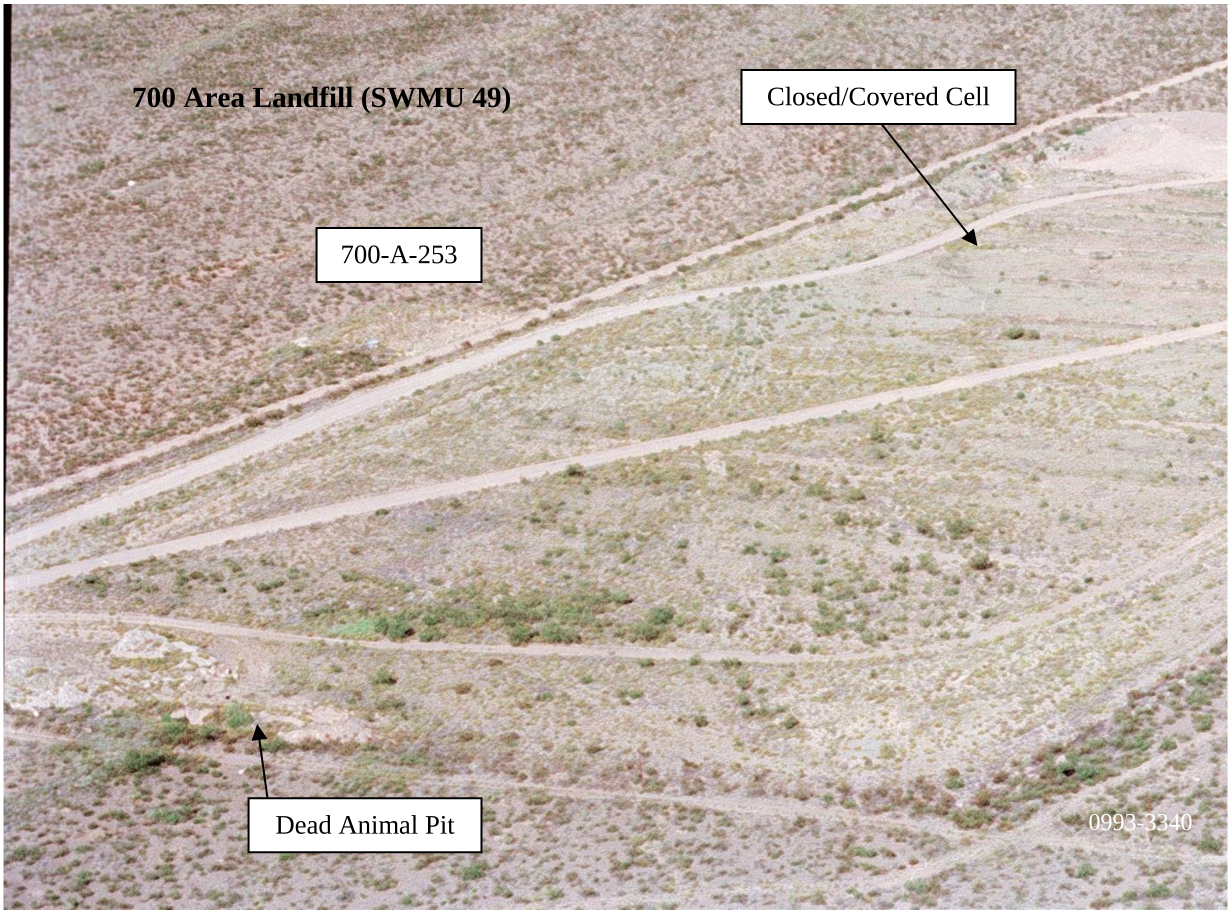
(May 1995 – view to the northeast)



This photograph shows an aerial view of an open trench at the WSTF landfill (SWMU 49) in May 1995. Notice the location of the trench is not adjacent to the cell from 1993, and this cell is located between older previously existing closed/covered cells. (Refer to Figure 6.3.)

Figure 6.6 **Dead Animal Pit (1993)**

(September 1993 – view to the west)



This photograph shows an aerial view of the dead animal pit at the WSTF landfill (SWMU 49) in September 1993. Note the white caliche layer around and within the dead animal pit. Groundwater monitoring well pad 700-A-253 and some previously closed and covered cells are visible as well.

Figure 6.7 700 Area Landfill and Monitoring Wells

(SEE NEXT PAGE)

700 Area Landfill Area
Methane Gas Monitoring Well
Conventional Groundwater Well
Multiport Groundwater Well
Graded Roads
WSTF Boundary
Sections
Buildings
Drainage Ditch
Berms
Cells
N
W
E
S
0 200 400 800 Feet
December 2017
700-F-455
Section 22, T20S, R3E
Section 23, T20S, R3E
STGT Firing Range SWMU 29
STGT Wastewater Lagoon AOC 51
STGT
MW-6
MW-5
700-D-186
700 Area Open Detonation Unit
MW-7
MW-4
700-B-510
700-H
MW-3
700 Area Landfill SWMU 49
MW-8
MW-9
700-J-200
700-A-253
MW-2
MW-10
Section 27, T20S, R3E
Section 26, T20S, R3E
Dead Animal Pit
MW-1
Cereus Drive
BW-6-355
700 AREA
700-E-458

Figure 6.8 **Geosynthetic Clay Liner Cover (1998)**

(March 1998 – view to the west)

This photograph shows the installation of the Geosynthetic Clay Liner cover at the WSTF landfill (SWMU 49) in March 1998.

Figure 6.9 **Final Landfill Closure Diagram August 1998**

(SEE NEXT PAGE)

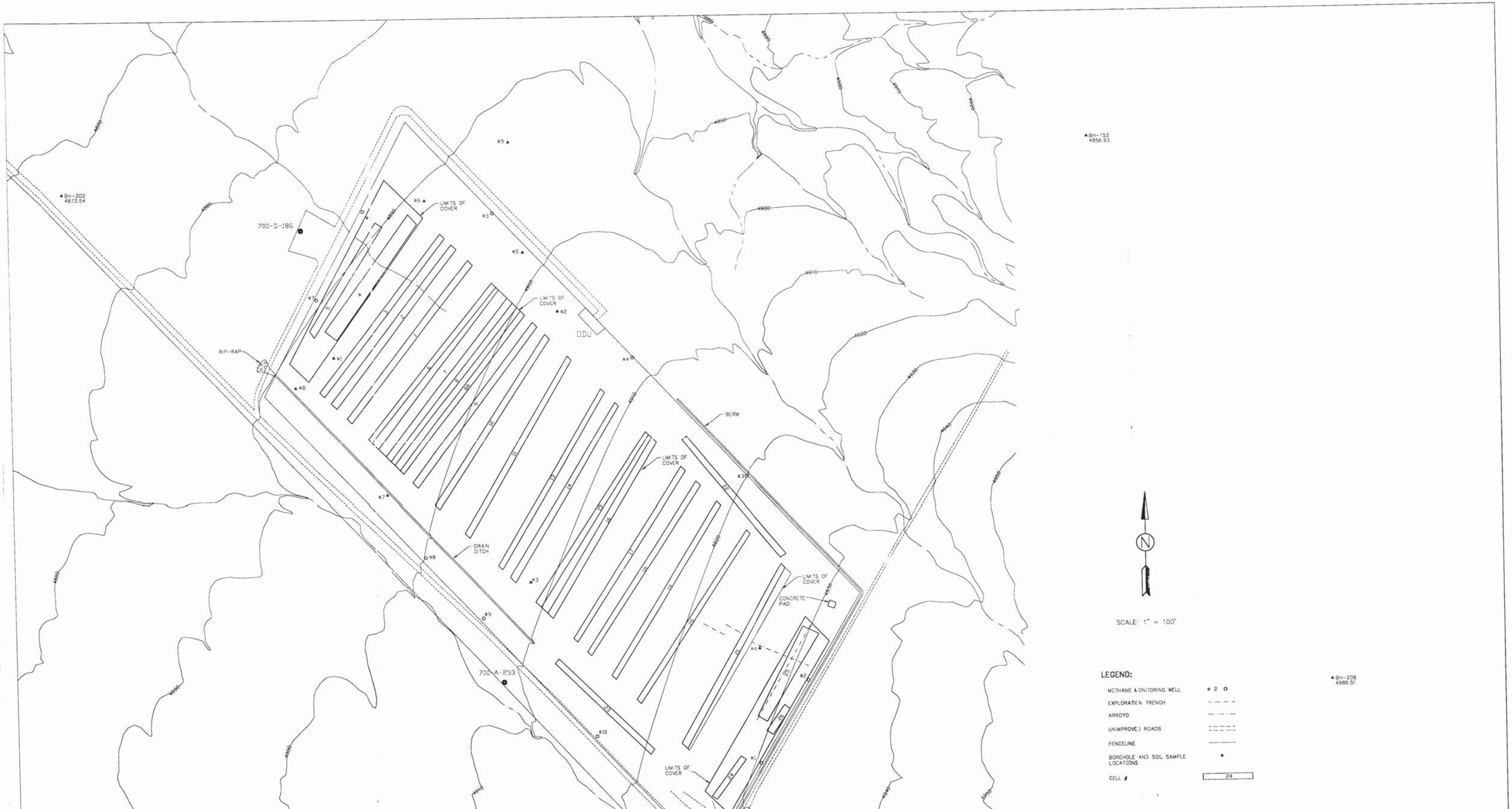
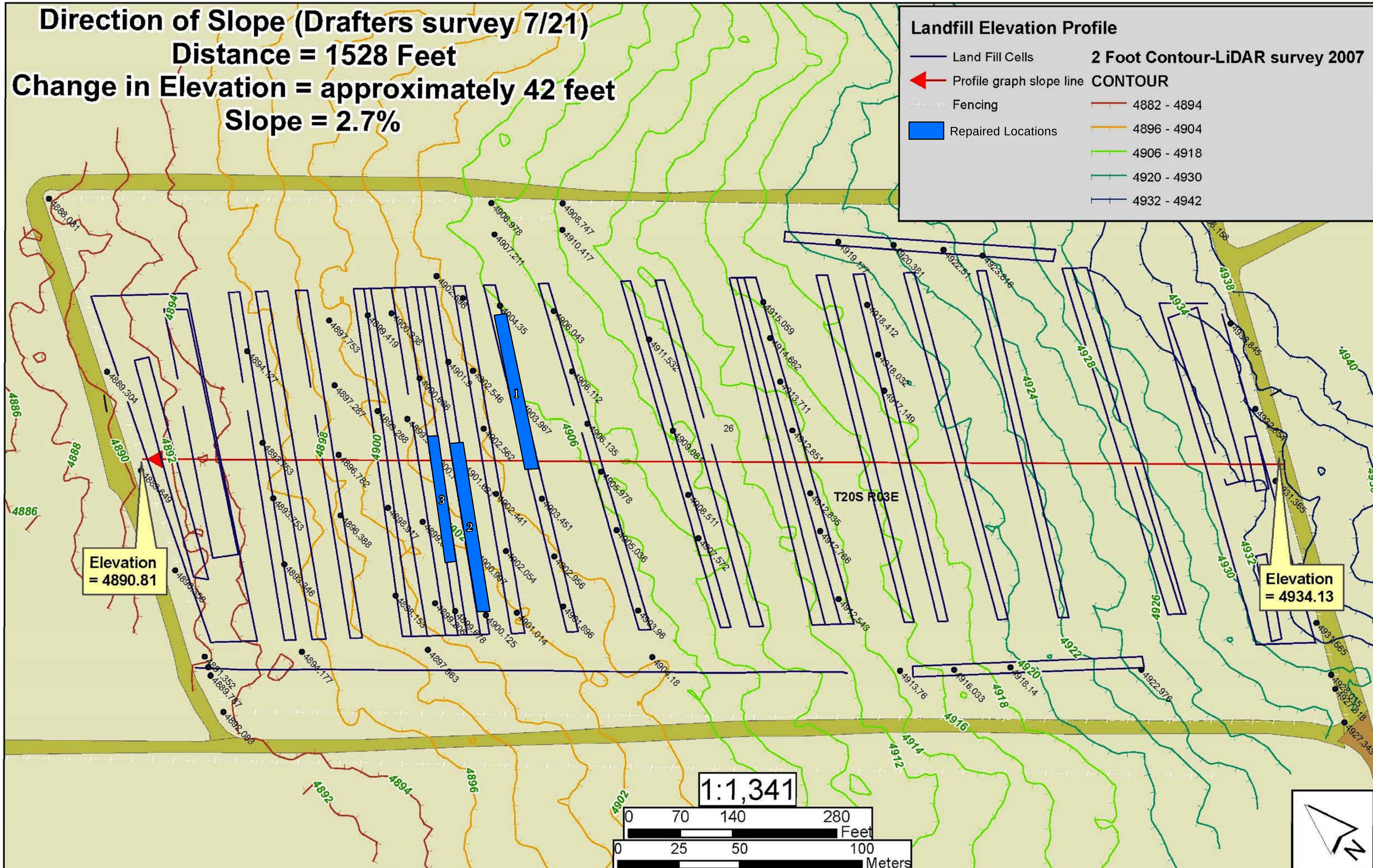


PLATE 3
PLANNED FINAL LANDFILL SITE
CONFIGURATION AND INVESTIGATIVE TRENCH LOCATIONS

Figure 6.10 **Landfill Elevation Profile**

(SEE NEXT PAGE)

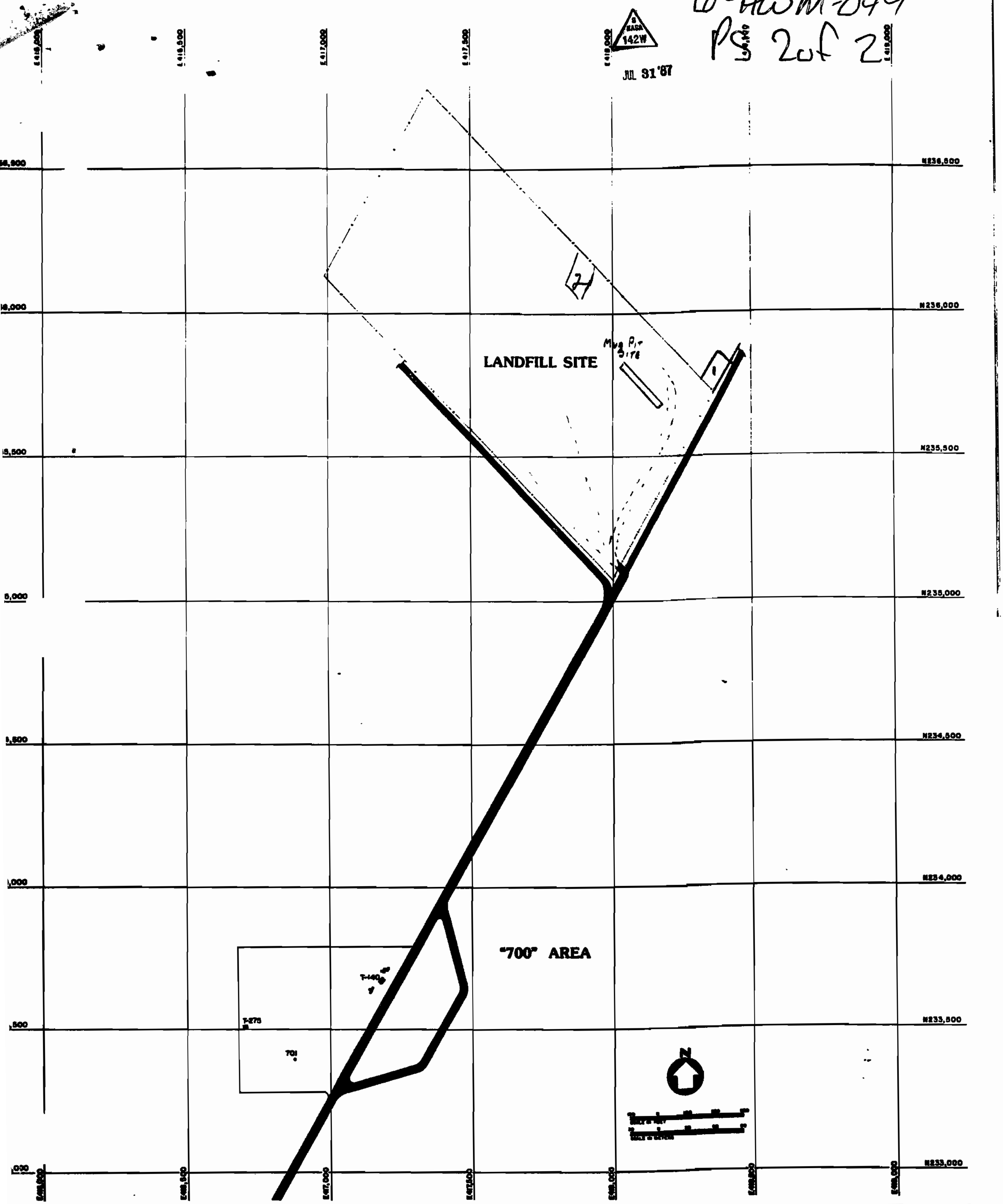


Direction of Slope (Drafters survey 7/21)
Distance = 1528 Feet
Change in Elevation = approximately 42 feet
Slope = 2.7%
Landfill Elevation Profile
Land Fill Cells
Profile graph slope line
Fencing
Repaired Locations
2 Foot Contour-LiDAR survey 2007
CONTOUR
4882 - 4894
4896 - 4904
4906 - 4918
4920 - 4930
4932 - 4942
Elevation = 4890.81
Elevation = 4934.13
T20S R03E
1:1,341
0 70 140 280 Feet
0 25 50 100 Meters

Figure 7.1 **Mud Pit Trench Location**

(SEE NEXT PAGE)

6-HWM-049
PS 2 of 2



WSTF "700" REMOTE TEST AREA

FACILITIES MASTER PLAN

DRAWING FMP 113

Tables

Table 6.1 Maximum Freon 113 Detections in Groundwater (µg/L)

Freon 113 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-90	NI	NI	4	0.5	84	0.5	NI	NI
Apr-90	NI	NI	2	0.5	61	5	NI	NI
Jul/Aug-90	NI	NI	1	0.5	46	0.5	NI	NI
Oct-90	NI	NI	0.6	0.5	64	0.5	NI	NI
Jan-91	NI	NI	1	0.5	75	0.5	NI	NI
Apr-91	NI	NI	NA	NA	79	0.5	NI	NI
Jul-91	NI	NI	1	0.5	88	0.5	NI	NI
Nov-91	NI	NI	NA	NA	84/210 QD	5	NI	NI
Jan-92	NI	NI	2	0.5	110	0.5	NI	NI
Apr-92	NI	NI	3	0.5	83	0.5	NI	NI
Jul-92	NI	NI	0.8	0.5	110	0.5	NI	NI
Oct/Nov-92	NI	NI	1	0.5	110	0.5	NI	NI
Jan/Feb-93	NI	NI	2	0.5	98 AD	5	NI	NI
Apr/May-93	NI	NI	3	0.5	68	0.5	NI	NI
Jul/Aug-93	NI	NI	3	0.5	76	0.5	NI	NI
Nov-93	NI	NI	1	0.5	97	5	NI	NI
Feb-94	NI	NI	2	0.5	60	0.5	NI	NI
Apr/May-94	NI	NI	2	0.5	62	0.5	NI	NI
Aug-94	NI	NI	3	0.5	65	0.5	NI	NI
Oct/Nov-94	NI	NI	2	0.5	67	5	NI	NI
Jan/Feb-95	NI	NI	3	0.5	79	0.5	NI	NI
Apr/May-95	NI	NI	4	0.5	84	0.5	NI	NI
Aug-95	NI	NI	3	0.5	46	0.5	NI	NI
Nov-95	NI	NI	2	0.5	67	5	NI	NI
Jan-96	NI	NI	2	0.5	70	0.5	NI	NI
May-96	NI	NI	3 J	5	73	0.5	NI	NI
Jul-96	NI	NI	3.4	0.5	61	0.5	NI	NI
Aug-96	NI	NI	1.9	0.5	73	0.5	NI	NI
Oct-96	NI	NI	2.7	0.5	73	0.5	NI	NI
Nov-96	NI	NI	3.9	0.5	77	2.5	NI	NI
Feb-97	NI	NI	2.8	0.5	42	10	NI	NI
Apr-97	NI	NI	2.6	0.5	76	0.5	NI	NI
Jul-97	NI	NI	1.3	0.5	NA	NA	NI	NI
Sep-97	NI	NI	0.9	0.5	38	0.5	NI	NI
Oct-97	NI	NI	1.1	0.5	66	5	NI	NI
Jan/Feb-98	NI	NI	0.32 J	0.5	41	0.5	NI	NI
May-98	NI	NI	1.2 J	5	48	1	NI	NI
Oct-98	NI	NI	2.2	0.5	75	3	NI	NI
Jan-99	NI	NI	0.96	0.5	44	1	NI	NI
Jul-99	NI	NI	3.8	0.5	62	5	NI	NI
Oct-99	2.1	0.5	NA	NA	NA	NA	ND	0.5
Dec-99	20.9	0.5	NA	NA	NA	NA	ND	0.5
Jan/Feb-00	ND	0.5	2.8	0.5	81	1.2	0.64	0.5
Apr-00	ND	0.5	NA	NA	NA	NA	ND	0.5
Jun-00	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-00	ND	0.5	NA	NA	NA	NA	ND	0.5

Freon 113 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Aug-00	ND	0.5	2.6	1	52 Q	1	ND	0.5
Nov-00	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-01	0.46 J	0.5	2.3	0.5	120	1.2	ND	0.5
Apr-01	0.32 J	0.5	NA	NA	NA	NA	ND	0.5
Jul-01	ND	0.5	1.7	1	58	1	ND	0.5
Jan-02	ND	0.5	2	0.5	65	0.5	ND	0.5
Apr-02	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-02	ND	0.5	2.6	1	75	1	ND	0.5
Oct-02	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-03	ND	0.5	3	0.5	61	0.5	ND	0.5
Feb-03	ND	1	3.9	1	57	1	ND	1
Apr-03	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-03	ND	0.5	3.6	1	67	1	1.4	1
Oct-03	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-04	ND	0.5	1.7	1	59	0.5	ND	0.5
May/Jun-04	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-04	ND	0.5	1.8	1	66	1	ND	1
Sep/Oct-04	ND	0.5	NA	NA	NA	NA	ND	0.5
Dec-04	ND	1	1.9	1	66	1	ND	0.5
Jan-05	1.2	1	0.72	0.5	57	0.5	NA	NA
Mar/Apr-05	ND	0.5	NA	NA	NA	NA	ND	0.5
Oct-05	0.45 J	0.5	NA	NA	NA	NA	ND	0.5
Jan-06	1.1	1	1 J	1	61	1	ND	0.5
Apr-06	0.68	0.5	NA	NA	NA	NA	ND	0.5
Jul-06	1.8	1	6.3	0.5	50	0.5	ND	0.5
Oct/Nov-06	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-07	1.6	1	2	1	49	0.5	ND	0.5
Apr-07	0.39 J	1	NA	NA	NA	NA	ND	0.5
Jul-07	0.73 J	1	1	0.5	48	0.5	ND	0.5
Oct-07	ND AD	0.5	NA	NA	NA	NA	ND A	0.5
Jan-08	0.7 J	1	1.3	0.5	39	1	ND	0.5
Apr-08	0.7 J	1	NA	NA	NA	NA	ND	0.5
Jul-08	0.69 J	1	3.2	0.5	27	0.5	ND	0.5
Oct-08	0.95 J	1	NA	NA	NA	NA	ND	0.5
Feb-09	1.4 J	5	1.8 J	5	20	0.5	ND	0.5
May/Jun-09	0.65 J	1	NA	NA	NA	NA	ND	0.5
Jul-09	0.74 J	1	2.6	0.5	24	0.5	ND	0.5
Oct-09	0.85 J	1	NA	NA	NA	NA	ND	0.5
Feb-10	0.98 J	1	1.7	0.5	26	0.5	ND	0.5
May-10	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-10	0.83 J	1	1.7	0.5	24	0.5	ND	0.5
Oct-10	0.7 J	1	NA	NA	NA	NA	ND	0.5
Feb-11	0.5 J	1	2.4	1	35	1	ND	1
Jul-11	0.67 J	1	1.8	1	37	1	ND	1
Feb-12	0.58 J	1	NA	NA	NA	NA	ND	1
Aug-12	0.58 J	1	1.4	1	39	1	ND	1
Mar-13	0.67	0.5	1.3	0.5	39	0.5	ND	0.5

Freon 113 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Sep-13	0.54 J	1	1.5	1	44	1	ND	1
Mar-14	0.73 J	1	0.76 J	1	33	1	ND	1
Sep-14	0.57 J	1	1.3	1	43	1	ND	1
Mar-15	0.67 J	1	0.48 J	1	33	10	ND	1
Oct-15	0.54 J	1	0.58 J	1	27	1	ND	1
Mar-16	0.49 J	1	0.55 J	1	33	5	ND	1
Oct-16	0.76 J	1	0.62 J	1	28	0.5	ND	0.5
Mar-17	0.53 J	1	1	1	36	1	ND	1
Sep-17	0.61 J	1	0.58 J	1	28	1	ND	1
Mar/Apr-18	0.73 J	1	0.67 J	1	26	1	ND	1
Oct-18	0.69 J	1	0.34 J	1	27	1	ND	1

A = The result of an analyte for a laboratory control sample, initial calibration verification or continuing calibration verification was outside standard limits.
AD = Relative percent difference for analyst (laboratory) duplicates was outside standard limits.
J = The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA = Not Applicable. The well was not sampled for that event.
ND = Not Detected
NI = Not Installed. The event was prior to the installation of the well.
Q = The result for a blind control sample was outside standard limits.
QD = The relative percent difference for a field duplicate was outside standard limits.

Table 6.2 Bis(2ethylhexyl)phthalate (BEHP) Detections in Groundwater (µg/L)

Bis(2ethylhexyl) phthalate Date Sampled	700-J-200	Detection Limit	700-A-253	Detection Limit	700-D-186	Detection Limit	700-H	Detection Limit
May-96	NI	NI	15	2[a]	NA	NA	NI	NI
Jul-96	NI	NI	33	2[a]	17	2[a]	NI	NI
Aug-96	NI	NI	37	2[a]	9.6	2[a]	NI	NI
Oct-96	NI	NI	32	2[a]	24	2[a]	NI	NI
Apr-97	NI	NI	24	2[a]	23	2[a]	NI	NI
Sep-97	NI	NI	10	10[a]	3.5	10[a]	NI	NI
Oct-98	NI	NI	8.0 J	10[a]	4.4 J	10[a]	NI	NI
Jan-99	NI	NI	5.96	0.441	4.8	0.441	NI	NI
Jul-99	NI	NI	ND	0.441	ND	2.9	NI	NI
Oct-99	3.8 J	2.9	NA	NA	NA	NA	ND	2.9
Dec-99	ND	2.9	NA	NA	NA	NA	ND	2.9
Jan/Feb-00	ND	2.9	ND	2.9	ND	2.9	ND	2.9
Apr-00	1.8	0.441	NA	NA	NA	NA	0.58 J	0.441
Jul-00	ND	2.9	NA	NA	NA	NA	ND	2.9
Aug-00	ND	2.9	ND	2.9	ND	2.9	ND	2.9
Jan-01	ND	2.9	ND	2.9	ND	2.9	ND	2.9
Jul-01	ND	2.9	ND	2.9	ND	2.9	ND	2.9
Jan-02	ND	0.0019	ND	0.0019	ND	0.0019	0.005 J	0.0019
Mar-02	NA	NA	NA	NA	NA	NA	ND	0.441
Jul-02	ND	0.0031	ND	0.0031	ND	0.0031	ND	0.0031
Feb-03	ND	1.57	ND	1.57	ND	1.57	1.3 J	1.57
Apr-03	ND	1.57	ND	1.57	ND	1.57	ND	1.57
Jul-03	ND	1.57	ND	1.57	ND	1.57	ND	1.57
Jan-04	ND	1.04	ND	1.04	ND	1.04	0.3 J	1.04
Jul-04	ND	1.04	0.55 J	1.04	ND	1.04	1.6 J	1.04
Dec-04	ND	1.04	ND	1.04	ND	1.04	ND	1.04
Jan-06	ND	1	ND	1	ND	1	ND	1
Jul-06	ND	1.67	ND	1.67	ND	1.67	1.8	1.67
Jan-07	ND	1	66	1	ND	1	ND	1
Jul-07	ND	1	ND	1	ND	1	ND	1
Jan-08	ND	1	ND	1	ND	1	ND	1

Bis(2ethylhexyl) phthalate Date Sampled	700-J-200	Detection Limit	700-A-253	Detection Limit	700-D-186	Detection Limit	700-H	Detection Limit
Jul-08	ND	1	1.3 J	1	ND	1	17	1
Sep-08	NA	NA	NA	NA	NA	NA	ND	1
Feb-09	ND	1	ND	1	ND	1	ND	1
Jul-09	ND	1	1.1 J	1	ND	1	ND	1
Feb-10	ND	1	ND	1	ND	1	ND	1
Jul-10	ND	1	ND	1	ND	1	ND	1
Feb-11	ND	3.7	ND	3.5	ND	3.5	ND	3.5
Jul-11	ND	1	ND	1	ND	1	ND	1
Feb-12	ND	0.5	NA	NA	NA	NA	1.8	0.5
Aug-12	ND	2	ND	2	ND	2	ND	2
Mar-13	ND	1.2	ND	1.2	ND	1.2	ND	1.2
Sep-13	ND	1	ND	1	ND	1	ND	0.5
Mar-14	ND	2	ND	2	ND	2	ND	2
Sep-14	ND	2	ND	2	ND	2	ND	2
Mar-15	ND	2	ND	2	ND	2	ND	2
Oct-15	0.55	0.50	14	0.50	ND	0.50	0.28	0.50
Mar-16	ND	2	ND	2	ND	2	ND	2
Oct-16	ND	0.1	1.1 FB	0.1	ND	0.1	ND	0.1
Mar-17	4	0.1	ND	0.1	ND	0.1	0.63	0.1
Sep-17	ND	0.1	ND	0.1	ND	0.1	0.85 RB	0.1
Apr-18	ND	0.2	ND	0.2	ND/3.8 QD	0.2	ND	0.2
Oct-18	ND	0.2	ND	0.2	14	0.2	1.3	0.2

Notes:

[a] = No detection limit was reported. The value listed is a reporting limit.
FB = The analyte was detected in the field blank.
J = The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA = Not Applicable. The well was not sampled for that event.
ND = Not Detected
NI = Not Installed. The event was prior to the installation of the well.
QD = The relative percent difference for a field duplicate was outside standard limits.
RB = The analyte was detected in the method blank.

Table 6.3 Maximum Freon 11 Detections in Groundwater (µg/L)

Freon 11 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-90	NI	NI	ND	0.5	ND Q	0.5	NI	NI
Apr-90	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul/Aug-90	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct-90	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan-91	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr-91	NI	NI	NA	NA	ND FB	0.5	NI	NI
Jul-91	NI	NI	ND	0.5	ND	0.5	NI	NI
Nov-91	NI	NI	NA	NA	ND	0.5	NI	NI
Jan-92	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr-92	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul-92	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct/Nov-92	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan/Feb-93	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr/May-93	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul/Aug-93	NI	NI	ND	0.5	ND	0.5	NI	NI
Nov-93	NI	NI	ND	0.5	ND	0.5	NI	NI
Feb-94	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr/May-94	NI	NI	ND	0.5	0.5	0.5	NI	NI
Aug-94	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct/Nov-94	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan/Feb-95	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr/May-95	NI	NI	ND	0.5	ND	0.5	NI	NI
Aug-95	NI	NI	ND	0.5	1	0.5	NI	NI
Nov-95	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan-96	NI	NI	ND	0.5	ND	0.5	NI	NI
May-96	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul-96	NI	NI	ND	0.5	ND	0.5	NI	NI
Aug-96	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct-96	NI	NI	ND	1	ND	1	NI	NI
Nov-96	NI	NI	ND	1	1.2 J FB	5	NI	NI
Feb-97	NI	NI	ND	1	ND	1	NI	NI
Apr-97	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul-97	NI	NI	ND	0.5	NA	NA	NI	NI
Sep-97	NI	NI	ND	0.5	0.27 J	0.5	NI	NI
Oct-97	NI	NI	0.25 J	0.5	ND	0.5	NI	NI
Jan/Feb-98	NI	NI	ND	0.5	ND	0.5	NI	NI
May-98	NI	NI	0.3 J	0.5	4.6	0.5	NI	NI
Oct-98	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan-99	NI	NI	ND	0.5	0.58	0.5	NI	NI
Jul-99	NI	NI	2.8	0.5	ND	5	NI	NI
Oct-99	ND	10	NA	NA	NA	NA	ND	10
Dec-99	ND	0.5	NA	NA	NA	NA	ND	10
Jan/Feb-00	ND Q	0.5	0.9	0.5	1	0.5	ND	0.5
Apr-00	ND	10	NA	NA	NA	NA	ND	10
Jun-Aug-00	ND	0.5	ND	0.5	0.4 J	2	ND	0.5
Nov-00	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-01	0.22 J	0.5	ND	0.5	0.6 J	10	ND Q	0.5
Apr-01	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-01	ND	0.5	ND Q	0.5	0.43 J	2	ND	0.5
Oct-01	ND	0.5	NA	NA	NA	NA	ND	0.5

Freon 11 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-02	ND	0.5	ND	0.5	0.66	0.5	ND	0.5
Apr-02	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-02	ND	0.5	ND	0.5	0.5	0.5	ND	0.5
Oct-02	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan/Feb-03	ND	0.5	ND	0.5	0.54	0.5	ND	0.5
Apr-03	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-03	ND	0.5	0.5	0.5	1.1	0.5	ND	0.5
Oct-03	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-04	ND	0.5	ND	0.5	0.62	0.5	ND	0.5
May-Jul-04	ND	0.5	ND	0.5	0.81 J	1	ND	0.5
Sep/Oct-04	ND	0.5	NA	NA	NA	NA	ND	0.5
Dec-04	ND	2	ND	2	0.61 J	2	ND	0.5
Jan-05	ND	0.5	ND	0.5	0.5	0.5	NA	NA
Mar/Apr-05	ND	0.5	NA	NA	NA	NA	ND	0.5
Oct-05	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-06	ND	0.5	ND	0.5	0.8 J	1	ND	0.5
Apr-06	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-06	ND	0.5	ND	0.5	2.2 J	10	ND	0.5
Oct/Nov-06	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-07	ND	0.5	ND	0.5	0.56 J	10	ND	0.5
Apr-07	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-07	ND	0.5	ND	0.5	0.52	0.5	ND	0.5
Oct-07	ND	1	NA	NA	NA	NA	ND	0.5
Jan-08	ND	0.5	ND	0.5	1.2 J	10	ND	0.5
Apr-08	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-08	ND	0.5	ND	0.5	1.8	0.5	ND	0.5
Oct-08	ND	0.5	NA	NA	NA	NA	ND	0.5
Feb-09	ND	0.5	ND	0.5	1.2	0.5	ND	0.5
May/Jun-09	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-09	ND	0.5	ND	0.5	1.6	0.5	ND	0.5
Oct-09	ND	0.5	NA	NA	NA	NA	ND	0.5
Feb-10	ND	0.5	ND	0.5	1.2	0.5	ND	0.5
May-10	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-10	ND	0.5	ND	0.5	1.1	0.5	ND	0.5
Oct-10	ND	0.5	NA	NA	NA	NA	ND	0.5
Feb-11	ND	1	ND	1	1.5	1	ND	1
Jul-11	ND	1	ND	1	1.1	1	ND	1
Feb-12	ND	1	NA	NA	NA	NA	ND	1
Aug-12	ND	1	ND	1	0.83 J	1	ND	1
Mar-13	ND	0.5	ND	0.5	0.67	0.5	ND	0.5
Sep-13	ND	1	ND	1	0.67 J	1	ND	1
Mar-14	ND	1	ND	1	0.56 J	1	ND	1
Sep-14	ND	1	ND	1	0.61 J	1	ND	1
Mar-15	ND	1	ND	1	0.54 J	1	ND	1
Oct-15	ND	1	ND	1	0.57 J	1	ND	1
Mar-16	ND	1	ND	1	0.63 J	1	ND	1
Oct-16	ND	1	ND	1	0.44 J	0.5	ND	0.5
Mar-17	ND	1	ND	1	0.74 J	1	ND	1
Sep-17	ND	1	ND	1	0.63 J	1	ND	1
Mar/Apr-18	ND	1	0.26 J	1	0.6 J	1	ND	1
Aug-Oct-18	ND	1	ND	1	0.51 J	1	ND	1

Notes:

FB =	The analyte was detected in the field blank.
J =	The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA =	Not Applicable. The well was not sampled for that event.
ND =	Not Detected
NI =	Not Installed. The event was prior to the installation of the well.
Q =	The result for a blind control sample was outside standard limits.

Table 6.4 Maximum TCE Detections in Groundwater (µg/L)

TCE Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-90	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr-90	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul/Aug-90	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct-90	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan-91	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr-91	NI	NI	NA	NA	ND	0.5	NI	NI
Jul-91	NI	NI	ND	0.5	ND	0.5	NI	NI
Nov-91	NI	NI	NA	NA	ND	0.5	NI	NI
Jan-92	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr-92	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul-92	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct/Nov-92	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan/Feb-93	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr/May-93	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul/Aug-93	NI	NI	ND	0.5	ND	0.5	NI	NI
Nov-93	NI	NI	ND	0.5	ND	0.5	NI	NI
Feb-94	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr/May-94	NI	NI	ND	0.5	ND	0.5	NI	NI
Aug-94	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct/Nov-94	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan/Feb-95	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr/May-95	NI	NI	ND	0.5	ND	0.5	NI	NI
Aug-95	NI	NI	ND	0.5	ND	0.5	NI	NI
Nov-95	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan-96	NI	NI	ND	0.5	ND	0.5	NI	NI
May-96	NI	NI	0.2	0.1	0.3	0.1	NI	NI
Jul-96	NI	NI	0.1	0.1	0.2	0.1	NI	NI
Aug-96	NI	NI	0.2	0.1	0.2	0.1	NI	NI
Oct-96	NI	NI	ND	0.5	ND	0.5	NI	NI
Nov-96	NI	NI	ND A	0.5	0.3 J A FB	0.5	NI	NI
Feb-97	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr-97	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul-97	NI	NI	ND	0.5	NA	NA	NI	NI
Sep-97	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct-97	NI	NI	ND	0.5	1.1	0.5	NI	NI
Jan/Feb-98	NI	NI	ND	0.5	ND	0.5	NI	NI
May-98	NI	NI	0.27 J	0.5	3	0.5	NI	NI
Oct-98	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan-99	NI	NI	ND	0.5	0.27 J	0.5	NI	NI
Jul-99	NI	NI	ND	0.5	0.8	0.5	NI	NI
Oct-99	ND	1	NA	NA	NA	NA	ND	1
Dec-99	0.21 J	0.5	NA	NA	NA	NA	ND	1
Jan/Feb-00	ND	0.5	ND	0.5	0.53	0.5	ND	0.5
Apr-00	ND	1	NA	NA	NA	NA	ND	1
Jun-Aug-00	ND	0.5	ND	0.5	0.34 J	1	ND	0.5
Nov-00	0.68	0.5	NA	NA	NA	NA	ND	0.5
Jan-01	0.54 J	1	ND	0.5	0.22 J	0.5	ND	0.5
Apr-01	0.39 J	1	NA	NA	NA	NA	ND	0.5
Jul-01	0.38 J	1	ND	0.5	0.39 J	1	ND	0.5
Oct-01	ND	0.5	NA	NA	NA	NA	ND	0.5

TCE Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-02	0.38 J	1	ND	0.5	0.44 J	1	ND	0.5
Apr-02	0.54	0.5	NA	NA	NA	NA	ND	0.5
Jul-02	0.38 J	1	ND	0.5	0.45 J	1	ND	0.5
Oct-02	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan/Feb-03	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Apr-03	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-03	ND	0.5	ND	0.5	0.75	0.5	ND	0.5
Oct-03	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-04	ND	0.5	ND	0.5	ND	0.5	ND	0.5
May-Jul-04	ND	0.5	ND	0.5	0.58	0.5	ND	0.5
Sep/Oct-04	0.56 J	1	NA	NA	NA	NA	ND	0.5
Dec-04	ND	1	ND	1	0.65 J	1	ND	0.5
Jan-05	4.1	0.5	ND	0.5	ND	0.5	NA	NA
Mar/Apr-05	ND	0.5	NA	NA	NA	NA	ND	0.5
Oct-05	1.8	0.5	NA	NA	NA	NA	ND	0.5
Jan-06	2	1	ND	0.5	0.8 J	1	ND	0.5
Apr-06	1.8	1	NA	NA	NA	NA	ND	0.5
Jul-06	1.9	0.5	ND	0.5	0.67	0.5	ND	0.5
Oct/Nov-06	1.2	0.5	NA	NA	NA	NA	ND	0.5
Jan-07	1	0.5	ND	0.5	ND	0.5	ND	0.5
Apr-07	0.85	0.5	NA	NA	NA	NA	ND	0.5
Jul-07	0.81 J	1	ND	0.5	ND	0.5	ND	0.5
Oct-07	0.7 RB A	0.2	NA	NA	NA	NA	ND A	0.2
Jan-08	0.67	0.5	ND	0.5	0.59 J	0.5	ND	0.5
Apr-08	0.85	0.5	NA	NA	NA	NA	ND	0.5
Jul-08	0.75	0.5	ND	0.5	0.87	0.5	ND	0.5
Oct-08	0.75	0.5	NA	NA	NA	NA	ND	0.5
Feb-09	0.61 J	1	ND	0.5	0.51	0.5	ND	0.5
May/Jun-09	0.65	0.5	NA	NA	NA	NA	ND	0.5
Jul-09	0.65	0.5	ND	0.5	0.68	0.5	ND	0.5
Oct-09	0.47 J	0.5	NA	NA	NA	NA	ND	0.5
Feb-10	0.47 J	0.5	ND	0.5	0.57	0.5	ND	0.5
May-10	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-10	0.49 J	1	ND	0.5	0.44 J	0.5	ND	0.5
Oct-10	0.49 J	1	NA	NA	NA	NA	ND	0.5
Feb-11	0.38 J	1	ND	1	0.53 J	1	ND	1
Jul-11	0.56 J	1	ND	1	0.6 J	1	ND	1
Feb-12	0.41 J	1	NA	NA	NA	NA	ND	1
Aug-12	0.31 J	1	ND	1	0.5 J	1	ND	1
Mar-13	0.35 J	0.5	ND	0.5	0.44 J	0.5	ND	0.5
Sep-13	0.35 J	1	ND	1	0.53 J	1	ND	1
Mar-14	0.33 J	1	ND	1	0.41 J	1	ND	1
Sep-14	0.34 J	1	ND	1	0.41 J	1	0.23 J	1
Mar-15	0.32 J	1	ND	1	0.45 J	1	ND	1
Oct-15	0.23 J	1	ND	1	0.37 J	1	ND	1
Mar-16	0.27 J	1	ND	1	0.42 J	1	ND	1
Oct-16	0.27 J	1	ND	1	0.54	0.5	ND	0.5
Mar-17	0.25 J	1	ND	1	0.57 J	1	ND	1
Sep-17	0.26 J	1	ND	1	0.44 J	1	ND	1
Mar/Apr-18	0.17 J	1	ND	1	0.47 J	1	ND	1
Oct-18	ND	1	ND	1	0.36 J	1	ND	1

A = The result of an analyte for a laboratory control sample, initial calibration verification or continuing calibration verification was outside standard limits.
FB = The analyte was detected in the field blank.
J = The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA = Not Applicable. The well was not sampled for that event.
ND = Not Detected
NI = Not Installed. The event was prior to the installation of the well.
RB = The analyte was detected in the method blank.

Table 6.5 Maximum PCE Detections in Groundwater (µg/L)

PCE Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-90	NI	NI	ND	1	ND	1	NI	NI
Apr-90	NI	NI	ND	1	ND	1	NI	NI
Jul/Aug-90	NI	NI	ND	1	ND	1	NI	NI
Oct-90	NI	NI	ND	1	ND	1	NI	NI
Jan-91	NI	NI	ND	1	ND	1	NI	NI
Apr-91	NI	NI	NA	NA	ND	1	NI	NI
Jul-91	NI	NI	ND	1	ND	1	NI	NI
Nov-91	NI	NI	NA	NA	ND	1	NI	NI
Jan-92	NI	NI	ND	1	ND	1	NI	NI
Apr-92	NI	NI	ND	1	ND	1	NI	NI
Jul-92	NI	NI	ND	1	ND	1	NI	NI
Oct/Nov-92	NI	NI	ND	1	ND	1	NI	NI
Jan/Feb-93	NI	NI	ND	1	ND	1	NI	NI
Apr/May-93	NI	NI	ND	1	ND	1	NI	NI
Jul/Aug-93	NI	NI	ND	1	ND	1	NI	NI
Nov-93	NI	NI	ND	1	ND	1	NI	NI
Feb-94	NI	NI	ND	1	ND	1	NI	NI
Apr/May-94	NI	NI	ND	1	ND	1	NI	NI
Aug-94	NI	NI	ND	1	ND	1	NI	NI
Oct/Nov-94	NI	NI	ND	1	ND	1	NI	NI
Jan/Feb-95	NI	NI	ND	1	ND	1	NI	NI
Apr/May-95	NI	NI	ND	1	ND	1	NI	NI
Aug-95	NI	NI	ND	1	ND	1	NI	NI
Nov-95	NI	NI	ND	1	ND	1	NI	NI
Jan-96	NI	NI	ND	1	ND	1	NI	NI
May-96	NI	NI	ND	0.2	ND	0.2	NI	NI
Jul-96	NI	NI	ND	0.2	ND	0.2	NI	NI
Aug-96	NI	NI	ND	0.2	ND	0.2	NI	NI
Oct-96	NI	NI	ND	1	ND	1	NI	NI
Nov-96	NI	NI	ND	0.5	ND	0.5	NI	NI
Feb-97	NI	NI	ND	0.5	ND	0.5	NI	NI
Apr-97	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul-97	NI	NI	ND	0.5	NA	NA	NI	NI
Sep-97	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct-97	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan/Feb-98	NI	NI	ND	0.5	ND	0.5	NI	NI
May-98	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct-98	NI	NI	ND	0.5	ND	0.5	NI	NI
Jan-99	NI	NI	ND	0.5	ND	0.5	NI	NI
Jul-99	NI	NI	ND	0.5	ND	0.5	NI	NI
Oct-99	ND	0.5	NA	NA	NA	NA	ND	0.5
Dec-99	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan/Feb-00	ND	0.5	ND	0.5	ND	0.5	0.21 J	0.5
Apr-00	ND	0.5	NA	NA	NA	NA	ND	0.5
Jun-Aug-00	ND	0.5	ND	0.5	0.51	0.5	ND	0.5
Nov-00	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-01	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Apr-01	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-01	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Oct-01	ND	0.5	NA	NA	NA	NA	ND	0.5

PCE Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-02	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Apr-02	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-02	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Oct-02	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan/Feb-03	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Apr-03	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-03	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Oct-03	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-04	ND	0.5	ND	0.5	ND	0.5	ND	0.5
May-Jul-04	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Sep/Oct-04	ND	0.5	NA	NA	NA	NA	ND	0.5
Dec-04	ND	1	ND	1	ND	1	ND	0.5
Jan-05	ND	0.5	ND	0.5	ND	0.5	NA	NA
Mar/Apr-05	ND	0.5	NA	NA	NA	NA	ND	0.5
Oct-05	ND	0.5	NA	NA	NA	NA	0.06 J	0.5
Jan-06	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Apr-06	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-06	ND	0.5	0.24 J	0.5	0.33 J	0.5	0.25 J	0.5
Oct/Nov-06	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-07	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Apr-07	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-07	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Oct-07	ND A AD SP	0.5	NA	NA	NA	NA	ND	0.5
Jan-08	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Apr-08	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-08	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Oct-08	ND	0.5	NA	NA	NA	NA	ND	0.5
Feb-09	ND	0.5	ND	0.5	ND	0.5	ND	0.5
May/Jun-09	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-09	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Oct-09	ND	0.5	NA	NA	NA	NA	ND	0.5
Feb-10	ND	0.5	ND	0.5	ND	0.5	ND	0.5
May-10	ND	0.5	NA	NA	NA	NA	ND	0.5
Jul-10	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Oct-10	ND	0.5	NA	NA	NA	NA	ND	0.5
Feb-11	ND	1	ND	1	ND	1	ND	1
Jul-11	ND	0.5	ND	0.5	0.28 J	0.5	ND	0.5
Feb-12	ND	0.5	NA	NA	NA	NA	ND	0.5
Aug-12	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Mar-13	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Sep-13	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Mar-14	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Sep-14	ND	1	ND	1	ND	1	ND	1
Mar-15	ND	1	ND	1	ND	1	ND	1
Oct-15	ND	1	ND	1	ND	1	ND	1
Mar-16	ND	1	ND	1	ND	1	ND	1
Oct-16	ND	1	ND	1	ND	0.5	ND	0.5
Mar-17	ND	1	ND	1	ND	1	ND	1
Sep-17	ND	1	ND	1	ND	1	ND	1
Mar/Apr-18	ND	1	ND	1	ND	1	ND	1
Oct-18	ND	1	ND	1	ND	1	ND	1

A = The result of an analyte for a laboratory control sample, initial calibration verification or continuing calibration verification was outside standard limits.
AD = Relative percent difference for analyst (laboratory) duplicates was outside standard limits.
J = The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA = Not Applicable. The well was not sampled for that event.
ND = Not Detected
NI = Not Installed. The event was prior to the installation of the well.
SP = The matrix spike recovery and/or the relative percent difference for matrix spike duplicates was outside standard limits.

Appendix A
Interview Summary

Position/ Location	**Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information**	**Other Information or Comments**
Aerospace Data Facility-Southwest (ADF-SW) 1995-present (2014)	• No waste documentation or history was available prior to the employee beginning work in 1995, and there was "no specific data available on any chemical used prior to 1997…" • Buildings at ADF-SW are used for data processing. "There are no hazardous wastes, only domestic and universal wastes. Used oil/batteries for fire alarms, lights are all 'green' and shipped off-site for disposal." • "Very little maintenance is performed by ADF-SW personnel on site. Government Services Administration maintains vehicles" (at WSTF). "The only maintenance performed at ADF-SW involves changing oil in generators. At most, there would be 4-5 ounces of used oil absorbed with rags. The rags are then disposed of off-site. Batteries used at ADF-SW are sealed gel cells that require no maintenance. When they need service, they are disposed of off-site and new ones obtained." • "Any paints used were historically latex [water-based]. Currently items arrive painted, and no painting is done at ADF-SW." • ADF-SW originally had 56 employees; currently, approximately 800 employees work 24 hours per day, 365 days per year, 2-3 shifts per day. • All transformers at ADF-SW were sampled for Polychlorinated biphenyls (PCBs) in 1997/1998 with no PCBs detected. No other potential PCB-containing items were identified at ADF-SW. • Waste generation has been the same since the employee began working at ADF-SW in 1995. • The facility was constructed in 1983/1984. Building 10 addition was added in 1991, along with the gymnasium and warehouse. In 2004, another addition was constructed onto Building 10.	• Interviewed in 2012
Tracking and Data Relay Satellite System (TDRSS) 1989-present (2014) and Second TDRSS Ground Terminal (STGT) 1997-present (2014)	• At STGT, "Degreasers and oils were always containerized and shipped off-site for disposal." [since 1997, when the employee began working at STGT] • Currently paint and paint brushes used at STGT are shipped off site for disposal. • The only solvent ever used was "Virginia 10", but it was always containerized and disposed of off-site [since 1997]. • STGT transformers never contained any oil, so no PCBs. There were never any other PCB type components at STGT due to the recent age of the facility (1988/1989). • All TDRSS transformers were (and are) dry and contained no PCBs. There were light ballasts containing PCBs historically, but they all were replaced by 2010. There were never any spills of PCBs to the employee's knowledge.	• Interviewed in 2012

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• Wastes included solvents, oils, and latex (water-based) paints and debris (rags, gloves, etc.).	
TDRSS and STGT 1997-present (2014)	• The only solvent used at STGT was "Virginia 10". It was containerized and shipped off-site for disposal. • STGT transformers never contained any oil, so there were no PCBs within them.	• Interviewed in 2012
TDRSS 1989-present (2014) and STGT mid 1990s-present (2014)	• Wastes for TDRSS and STGT included "non leaded paint" and "mineral spirits."	• Interviewed in 2012

WSTF 200 Area 1981-1987; Environmental Department 1987-present (2014)	• The dead animal pit was located by the entrance road and was for the disposal of dead animals hit on WSTF roads or found on WSTF property.
	• Wastes the employee remembers seeing in the 700 Area landfill were:
	  ○ "Empty bottles of every chemical known to man" at WSTF,
	  ○ Metal 5-gal drums of acetone, solvents, and other chemicals,
	  ○ Cleaning debris, such as wipes, gloves, rags
	  ○ Decontaminated self-contained atmospheric protection ensemble (SCAPE) suits,
	  ○ Old negatives and etching plates,
	  ○ Vegetable oil,
	  ○ Cafeteria waste,
	  ○ Aerosol cans (partially full and empty),
	  ○ Resins,
	  ○ Stainless steel tubings,
	  ○ Hard hats and other PPE,
	  ○ Pressurized canisters (rarely),
	  ○ Titanium tanks (~2 ft diameter),
	  ○ Automotive materials (brake parts, tires, filters, rags with antifreeze, used oil,
	  ○ Construction wastes (including floor tiles, ceiling tiles, piping, "anything thrown away in remodels")
	• Automotive battery cores were recycled off-site and liquids from batteries were placed in the 600 Area Hazardous Waste Management Unit (HWMU).
	• Control of environmental wastes at WSTF began in 1985, but did not immediately change all procedures and personnel behaviors.
		• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• Drums of chemicals were stored in the Drum Storage Facility (DSF) to await shipment off-site for disposal.	

WSTF 200 Area 1978-late 1980s; Environmental Department late 1980s-present (2014)	• No shipments of wastes off-site occurred prior to 1985.
	• Liquid wastes were stored in the 300, 400, and 600 Area impoundments. Solid wastes were disposed of in the 700 Area landfill.
	• The proactive management of wastes began at WSTF in 1985, when a permanent Environmental Department was established. This was a gradual process of waste management and reduction.
	• Hazardous wastes after 1985 were stored in a special facility (DSF) and shipped off-site for disposal.
	• Small quantities of laboratory wastes had been disposed of in the 700 Area landfill prior to 1985.
	• Empty drums, mostly, were disposed of in the landfill; however, the employee recalled approximately half-full small cylinders (5 gal) of chemicals/wastes being discarded in the 700 Area landfill between approximately 1980 and 1985, when Environmental Protection Agency (EPA) inspections prompted a site cleaning initiative.
	• Only a small volume of waste liquids were placed in the landfill because full drums of waste oils/liquids were delivered to the WSTF Fire Department for fire-fighting practice.
	• Drums were made of steel or fiberboard (a hard pressed cardboard).
	• Other material the employee remembered seeing in the 700 Area landfill were:
	  ○ Debris contaminated with wastes (gloves, wipes, rags),
	  ○ Glass bottles,
	  ○ Old negatives,
	  ○ Personal protective equipment (PPE),
	  ○ Spill dry, oils,
	  ○ Solvent-contaminated rags,
	  ○ Trash,
	  ○ Paper,
	  ○ Cafeteria wastes,
	  ○ Landscape materials,
	  ○ Organics,
	  ○ Weeds,
		• No additional information or comments

Position/ Location	**Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information**	**Other Information or Comments**
	○ Toner Cartridges, ○ Type writer ribbons, ○ Correction fluid bottles, ○ Chemical containers, ○ Metal parts from buildings, ○ Paint cans (with lead paint), ○ Minor amounts of liquid paint, ○ Dried paint, ○ Epoxies, ○ Lab contaminated wastes (rags, gloves, aprons) contaminated with solvents, Trichloroethene (TCE), Freons (Trichlorofluoromethane [Freon 11] and 1,1,2-Trichloro-1,2,2-trifluoroethane [Freon 113], acetone, isopropyl alcohol (IPA), Tetrachloroethene (PCE), etc., ○ Automotive wastes (rags with oil, greases, antifreeze; tires), ○ Construction wastes (including asbestos-containing wastes), • The employee did not believe that bulk hazardous wastes had been disposed of in the 700 Area landfill.	
WSTF 100, 200, 800, 300, and 400 Areas; over 25 years	• The employee was not aware of any 700 Area landfill operational documents. “They [supervisors] would tell me what to dump and I would take it to the 700 Area and dump it.” • When the employee began working at WSTF, there was no [off-site] trash service for the site. “There was no need for it, since WSTF had its own landfill for disposal.” • The employees stated that most wastes were taken to the landfill until an off-site trash service began. • “Any operation on-site that was conducted at the time the landfill was open that generated waste would use the landfill for disposal purposes.” • The employee recalled seeing the following materials in the 700 Area landfill: ○ “Plenty of liquids were placed into the landfill either directly poured or were in a container of some sort.” Liquids included: ▪ Decontamination liquids such as MF and TF Freon (Freon 11 and Freon 113), ▪ Spent automotive liquids such as hydraulic fluids, engine oil, and diesel fluids, ▪ Spent oakites (Oakite 33, Oakite 126,	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	▪ Spent methyl ethyl ketone (MEK), and ▪ Spent Brulin (solutions). o Some tires (The employee recalled vehicle batteries and most tires being recycled) o Small automotive wastes (vehicle filters, oil filters, contaminated rags) o All disposable PPE (including gloves, SCAPE gear, splash gear, face-protection gear). No PPE was decontaminated prior to disposal. o Bottles and containers of Freons (Freon 11 and Freon 113), TCE, acetone, alcohol, PCE, MEK, o Paints (both water-based and oil-based, some containing lead, o Epoxies (liquid and dried), o "Plenty of primer," o All metal components (such as 306 stainless steel, carbon steel, titanium, Tygon tubing, aluminum, wire insulation). The employee recalled specifically spools of 1-in., 1.5-in., and 2-3-in. lines of 306 stainless steel were disposed of in the landfill. o Other metals (chromium, mercury) o Large 1,200-gal to small 75 to 100-gal tanks were decontaminated with MEK and disposed of in the 700 Area landfill. o "small flashlight-type batteries" [alkaline] o Empty aerosol cans (occasionally full or partially full when the "nozzle broke") o Adhesives, Teflon, Tygon, Kevlar, and gasket materials o Fuel-contaminated debris (contaminated with unsymmetrical dimethylhydrazine [UDMH], A-50, Monomethylhydrazine [MMH], and hydrazine) and oxidizer-contaminated debris (contaminated with nitrogen tetroxide-N_2O_4). Debris included: ▪ Tubing, ▪ Valves, ▪ Soft goods, ▪ A large number of O-rings, ▪ Teflon gaskets, ▪ Splash gear, ▪ "Anything on an aerospace panel"	

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• The employee recalled personally disposing of 55-gal drums full of acetone and IPA in the 700 Area landfill. "Most drums were unmarked, but MEK and Freons were definitely placed in the landfill" (since they were decontamination agents). • "Most engine-cleaning solutions were placed into the landfill." • Wooden pallets were used to transport multiple drums at a time. When the load was added to the 700 Area landfill, the wood pallet was also added. • "There was a time when wood was separated and placed in a scrap wood pile." • The employee stated that there had been an asbestos abatement initiative, possibly in 1983, where asbestos-lined piping was removed from buildings and placed in drums. The employee did not know the disposition of the drums of asbestos. • During the "shuttle build-up" (when the test stands in the 300 and 400 Areas were being modified from Apollo program testing to configurations for space shuttle testing), there had been a lot of construction and building modifications. This construction debris "most likely" was disposed of in the 700 Area landfill. Concrete and asphalt had been placed in arroyos within the WSTF site. (Another employee [Lela Hunnicutt-Mack] stated that the concrete and asphalt was removed from arroyos in 2012). • The employee witnessed one fire at the 700 Area landfill "due to spontaneous combustion of rags" in the early 1980s or late 1970s. • The employee believed that when sludge was removed from a WSTF wastewater (sewage) lagoon, the sludge was disposed of in the 700 Area landfill. • Since there was no shipment of wastes off-site and no off-site trash service early on, the employee suspected that photographic wastes, and spent fluorescent lights were also disposed of in the landfill. • No K-bottles or pressurized canisters were placed in the landfill because a company in Las Cruces provided an exchange service where empty tanks would be exchanged for full tanks. • "There was no organization with how the material was placed into the landfill. The trenches were really high."	
WSTF Environmental Department summers 1987 and 1989; 1990-2010	• When the employee was hired at WSTF, the DSF was already being used to store hazardous wastes prior to shipment off-site for disposal. • The employee stated that by the time the employee was hired full-time (in 1990), nothing hazardous was being disposed of in the 700 Area landfill.	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments

	• The employee remembered seeing the following materials in the 700 Area landfill:
	  ○ Paper,
	  ○ Cafeteria wastes,
	  ○ Office supply items,
	  ○ Alkaline batteries,
	  ○ Empty paint cans (with less than 2.5 cm of paint remaining).
	• There are two trenches at the landfill that are along the long edge of the landfill and all the others are perpendicular and located within.
	• The employee stated that there had been many fires at the 700 Area landfill. The employee recalled seeing smoke when he was first hired, and many burned items within the trenches. The employee was unsure of the cause of the fires, but believed WSTF personnel were burning sensitive documents.
	• Earlier trenches were covered by the fill (rock/soil) from digging later trenches.
	• There was a dead animal pit located near the gate, immediately to the right, approximately 50 yards to the northeast.
	• Approximate dimensions of the dead animal pit were 20 ft long by 14 ft wide by 5 or 6 ft deep (by 1990).
	• The same dead animal pit had been used, at least from when the employee was hired until landfill closure.
	• During the closure process for the 700 Area landfill, a backhoe had been used to dig through the landfill to locate trenches.
	• The employee reported that many of the trenches located contained char (burned material).
	• The reason for landfill closure was new and more stringent regulation requirements. The landfill was closed in the late 1990s.
	• Refuse had been compacted at the 700 Area landfill by using a caterpillar to “take the mound of rocks/soil at the end of the trench and cover the area up, then driving the caterpillar over the area many times to compact it. Dump trucks on either end of the trench assisted.”
	• The employee stated that on many occasions, “they had trouble compacting the landfill.”
	• The employee stated that when banned items were discovered in the landfill, the items were removed and disposed of properly. Paint was shipped off-site for disposal due to lead and solvents within the paint.	

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• Copper wire, conduit, electrical equipment were recycled. • The employee stated that there was only one waste disposal transport truck at WSTF, and the driver was trained to recognize unpermitted items. "When the driver saw something that he knew should not be in the trash/landfill, he would tell me, and also the person who threw the thing away (if he knew). If not, then he would tell the supervisor for the building/area that the trash had been picked up from." • There were ramps located on either end of active trenches as part of the way the trenches were excavated; however, the ramps were not for driving into the trench for waste disposal. Wastes were "dumped from the sides, usually on the south side." • "A Cell Allis Chalmers cat [caterpillar] blade was used to dig out across and push dirt out on either end." • The WSTF Quality Assurance department conducted landfill inspections "early on". Then the WSTF Environmental Department "took over." • The employee was asked to explain why NASA referred to the 700 Area landfill as "modified" in the 1978 landfill registration form to the New Mexico Environmental Improvement Division. The employee was unsure but stated that the likely explanation was that the word 'modified' was referring to the difference in the wastes the 700 Area landfill disposed of than most landfills. (The WSTF 700 Area landfill never accepted commercial or residential wastes, but accepted only wastes generated at WSTF.)	

WSTF 400 Area 1985-1992; Environmental Manager 1992-2001	• The employee guessed that prior to shipping wastes off-site for disposal (beginning in 1985), any solid wastes, including types of materials shipped off-site currently, were disposed of in the 700 Area landfill.
	• The employee only remembered "the usual office wastes" being disposed of at the landfill, including:
	  ○ "The usual office wastes",
	  ○ Cardboard,
	  ○ Cafeteria wastes.
	• The employee clarified information regarding exploding small propulsion engines in the 700 Area landfill trenches.
	  ○ One of the descriptions of engine type were discussing disposal of Orbital Maneuvering System engines for the space shuttle program. "It was a matter of proprietary engine designs and the engine designer did not want any other engine designer to see their design.
		• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	○ BATES engines were associated with the Ballistic Missile Defense Organization. ○ When discussing engines, a 50-lb engine refers to the amount of thrust the engine can produce. ○ The liquid propellant engines would have been purged of fuel and oxidizer prior to being exploded in the landfill, "so very little to no contamination would be expected." ○ The solid propellant motors would likely have contained hydrochloric acid and aluminum oxide or aluminum and ammonium perchlorate. If the latter could possibly result in perchlorate contamination.	
WSTF Facilities 1985-1995; 2000-present (2014)	• The employee remembers seeing: ○ Trash, ○ Papers, ○ Tree/weed trimmings, ○ Paint cans (both water and oil-based), ○ 55-gal drums, ○ Respirators, ○ Protective suits, ○ Metal flashing, ○ Alkaline batteries, ○ Fluorescent light bulbs, ○ Construction wastes. • No vehicle batteries would be present because the cores were exchanged for working batteries. • The employee assisted with constructing the closure cap at the 700 Area landfill. "It was fabric on top of a clay layer."	• No additional information or comments
WSTF Facilities 1978-present (2014)	• Sludge had been removed once from the 100 Area wastewater lagoon (both cells) in 1979-1980. The sludge was placed in a pile along the WSTF well road (the BLM or Off-Site Soil Pile). • No sludge was ever removed from the 200 or 600 Area wastewater lagoons. Sludge was placed on plastic sheeting and "wind-rolled" to let it dry. Facilities personnel would turn the sludge occasionally until it was dry. • Only very small amounts of liquids were disposed of in the 700 Area landfill. • Prior to 1985, except for vehicle batteries, no wastes were shipped off-site for	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments

	disposal.
	• The dead animal pit was a separate, smaller trench located right next to the fence on the southeast side of the landfill. There was only one pit in the life of the landfill. Dimensions of the dead animal pit were approximately 10 ft deep by 20 ft long by 8-10 ft wide.
	• The employee recalled seeing the following items in the 700 Area landfill:
	  ○ Tires,
	  ○ 55-gal drums,
	  ○ PPE.
	• The employee remembered seeing WSTF Fire Department personnel burning sensitive documents in the active trenches of the landfill. This may have been in the early 1980s.	

28 years in WSTF Facilities	• Sludge taken from a wastewater (sewage) lagoon were allowed to air dry prior to disposal.
	• The employee stated that all sludge was taken to a disposal facility in Utah (in the mid-1980s), including sludge from the 300, 400, and 600 Area HWMUs, was allowed to dry on plastic, then shipped off site for disposal.
	• The employee remembered the landfill receiving:
	  ○ Metals (machine shop tubings, carbon steel, stainless steel),
	  ○ Automotive materials (oil filters, air filters, used rags, tires),
	  ○ Boxes (cardboard),
	  ○ Paint cans,
	  ○ Lights, maybe ballasts.
		• No additional information or comments

32 Years in WSTF 200 Area	• The employee stated, “The old dump…was used for general trash and disposal.” • “The old dump. Everything went into it.”	• No additional information or comments

WSTF 200 Area Calibration Laboratory and later Office Chief 1969-1990	• The employee stated that most things were thrown away. “Very few things were taken to Holloman [Air Force Base].”
	• The employee recalled discarding (for disposal in the landfill):
	  ○ Meters, parts to volt meters (meters contained aluminum, copper, tin, gold, silver, chrome decorations),
	  ○ Rags, soft goods, gloves (contained lubricating oils, WD-40, petroleum),
	  ○ Perhaps video tapes from high speed cameras,
	  ○ Photo paper,
	  ○ Burned paper,
		• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	○ Trans-circuit boards (the employee could not recall exact chemicals, but mentioned sodium persulfate, aluminum persulfate, and ferric oxide) ○ "Freons were dumped in arroyos" at the landfill. ○ "Old parts from the Cal. Lab. ended up in the landfill." ○ Plastic, meter cases, steel or aluminum cabinets, ○ Inductors, ○ Capacitors, ○ Resistors (iron, insulated wires paint), ○ Epoxies, ○ Batteries, ○ Loose floor and ceiling tiles (containing asbestos), ○ Mercury (manometer broke and mercury was cleaned up with a cloth that was discarded in the landfill). ○ Fragments left from 800 Area testing (metals, fabrics, plastics, burned material), ○ Rags containing grease, acetone, alcohol, Krytox lubricant (an oxygen compatible lubricant), and Teflon grease. • Later, (mid-1980s?), "if it was salvageable, it could go to Holloman, if workers took the time. Sometimes they just threw things away because it was easier." • The employee stated that the mindset of employees during the Apollo program was that if you had something to dispose of, you just went out and did it. There was no concern for the environment at that time. When items were recycled, it was only because they could provide money or there was no place to throw the item away. • "There was no environmental control until later in the Shuttle program." • Wastes were not shipped off-site prior to a full-time Environmental Department. • Personnel were always concerned with safety of the workers, avoiding physical harm to workers, not the environment.	
WSTF Propulsion Areas (300/400) 1963/1964-1986 (consultant to present)	• The employee stated that items disposed of in the 700 Area landfill included: ○ Bottles of chemicals from the 200 labs (like phosphorus). • The employee had personally exploded many engines within the trenches of the landfill over time. For the 1960s (Apollo program), early 1970s (Shuttle program), and then in 1985 (solid propellant engines). For several liquid propellant engines, the designs were proprietary, and the designers/contractors did not want the engines returned after testing. Therefore, the employee used C4 explosives to destroy the	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	engines at the landfill. • A bulldozer was present at the landfill all the time. When the employee needed to destroy an engine, the employee would supervise the excavation of a new trench, then conduct the explosions, and then cover the area again. • The employee stated that the engines would have contained a small residual amounts of fuels and oxidizer. • Solid propellant engines with "trident propellant" and "BATES" (Ballistic Test and Evaluation System) motors for the Army and Navy were tested at WSTF. These engines "had a habit of blowing up." • To ensure the engines were safe for testing, engines were routinely x-rayed upon arrival at WSTF. If there were any voids or abnormalities evident in the x-rays, then the employee would destroy these engines with C4 in the landfill trenches. • Approximately 50 engines would arrive at WSTF at a time, and the employee remembered one time when 5 of the 50 needed destroying. The same procedures applied to destroying the solid propellant engines as destroying the liquid propellant engines; however, the solid propellant/oxidizer was fully loaded in these engines, not small residuals. • The employee did not specify the propellant/oxidizer used in the BATES motors.	

WSTF Engineer 1974-2003	• No wastes were shipped off-site prior to 1985.
	• Chemicals and liquids were generally disposed of in the surface impoundments (300, 400, and 600 HWMUs), not the 700 Area landfill.
	• Vehicle batteries were always recycled through HAFB.
	• Materials the employee remembers being disposed of in the landfill included:
	    ○ Photographic solid wastes,
	    ○ Paints, epoxies, aerosol cans,
	    ○ Anything that was thrown away,
	    ○ Oils and contaminated soils (loose, not in drums),
	    ○ Small amounts of liquids left in cans, drums,
	    ○ Broken equipment, furniture.
	• The WSTF warehouse had a recycling program for electric motors, computer parts
	• "In the early days, no one paid attention to what went into the landfill."
		• No additional information or comments

Various positions 1976-1990	• There were no written records, only verbal procedures for the 700 Area landfill early on. The employee stated that paper records were developed in the early 1990s.	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• Only vehicle batteries were shipped off-site prior to the mid-1980s. • "In 1987, we were just starting to establish written records." • The employee stated that "things were taken to the landfill that should not have been, but there were no environmental policies at that time." • Environmental protection was not the mentality of the employees at WSTF. • Hazardous wastes were disposed of at the landfill and in dumpsters prior to the Environmental Department. It was not considered a safety hazard back then. • May have had some hazardous wastes disposed of improperly up to perhaps 1989. • "Garbage was just thrown away." • "There were educational battles," trying to change employee attitudes and habits.	

200 Area 1966-1992	• The employee did not have much information regarding the 700 Area landfill.
	• Waste disposed of in the landfill included:
	  ○ Trash, garbage,
	  ○ 800 Area test remnants (some were retained for the client or in the 800 Area for "future inspection.")
	• There was no effort at WSTF to develop any knowledge of solid waste streams to the landfill.
	• Liquid wastes were not disposed of in the landfill as a usual process. There were other areas at WSTF for liquid disposal/storage.
		• No additional information or comments

WSTF Facilities Department 1965-at least 1993	• The employee stated that the 700 Area landfill opened in October 1965. • "The waste was being transferred to the first cell on the SW end when I started delivering site waste." • Hazardous waste was likely disposed of in the landfill. The employee stated "…at the time, we were not aware of hazardous waste and now almost everything is hazardous." • Small quantities of liquids were added to the landfill, "A little bit of everything, but not a lot of anything."	• Interviewed in 1993 as part of the landfill site assessment
WSTF Environmental Department 1985-2005	• Prior to establishment of a full-time Environmental Department at WSTF, no chemicals/hazardous wastes were shipped off site. • "There seemed to be no historical procedure to deal with occasional extra, leftover, or off-specification liquids/chemicals." • There were at least three waste shipments to ENSCO in 1985. "the waste shipments were PCB's and haz[ardous] waste to the best of my recall."	• Interviewed in 1993 as part of the landfill site assessment; also interviewed in May 2014 as part of the investigation for this HIS

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments

	• The employee recalled long-term 200 Area clean room employee statements:
	  ○ Prior to 1985, items contaminated with hydrazine, oxidizer, all 200 Area laboratory chemicals (such as Freons [Freon 11 and Freon 113], TCE, PCE, alcohol, acetone, MEK, etc.) were disposed of in the landfill.
	  ○ Small quantities of gold and other metals from aerospace parts.
	  ○ Fluorescent light ballasts (containing PCBs).
	  ○ Contaminated items included:
	    ▪ Software (gloves, cloths, PPE),
	    ▪ Hardware (tubing, piping, plastic).
	• The employee assisted in destroying the off-specification solid propellant engines in the 700 Area landfill trenches in the mid-1980s.
	• Five lbs of C4 were used per explosion.
	• The engines were small enough to be carried by a person.
	• When interviewed in 1993:
	  ○ The landfill opened in the mid-1960s “subsequent to the commencement of site operations.”
	  ○ “Previous discussions with long time site employees indicate that the following wastes were probably placed in the landfill”
	    ▪ Paints (oil and water based),
	    ▪ Adhesives,
	    ▪ Fillers,
	    ▪ Batteries (mercury, NiCad, lead acid),
	    ▪ Glassware and soft goods contaminated with fuel (primarily MMH and solvents.”
	  ○ Liquids (“paints, solvents, electrolytes from batteries”) were disposed of in the landfill “in tens to hundreds of gal annually”	

Facilities Department (overseeing landfill operations) 1978-1994	• “Anything thrown away would have ended up in the landfill.” • Wastes were not shipped prior to having an Environmental Department (except for vehicle batteries). • Personnel attempted to ensure no hazardous wastes were added to the landfill. • The employee did not remember the details of what was disposed of in the landfill (recalled construction wastes and spill dry). • The employee recalled the WSTF recycling and waste reduction programs more clearly:	• Interviewed in 1993 as part of the landfill site assessment; also interviewed in August 2014 as part of the investigation for this HIS

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	○ wood was placed in a pile in the 100 Area for fire-fighting practice, ○ electrical equipment was shipped for recycling to Holloman (HAFB), ○ Vehicle batteries were shipped to HAFB for core trade-in, ○ Metal was accumulated in the 150 Yard and sold as scrap, ○ Most drums were also shipped to HAFB for recycling. • When interviewed in 1993: ○ The landfill opened in 1964 or 1965 ○ "In the early years there was no hazardous waste distinction; therefore, most probably we did [dispose of hazardous wastes in the landfill]". ○ Liquids were disposed of at the landfill "some, before I got here (1978)." ○ Liquids included: "off-specification paints from paint locker clean outs" and were "small quantities."	
WSTF Fire Department 1963-1996	• When interviewed in 1993: ○ The landfill opened in late 1964. ○ "Prior to the hazardous waste laws, the landfilled materials would surely have exhibited current hazardous waste characteristics." ○ Liquids were disposed of in the landfill: "Off-specification paints and epoxies. Residues from cleaning operations and drums that were landfilled."	• Interviewed in 1993 as part of the landfill site assessment; also interviewed in May 2014 as part of this HIS
WSTF Propulsion 1965-1971	• Large quantities of Freon (Freon 11 and Freon 113) were used • "Also Trich [TCE] was primarily used. Most evaporated." • "Landfilled most of waste" • "The landfill site north of the usage areas was used to dispose of drums of Freon waste." (700 Area landfill)	• Interviewed in 1990
WSTF 300 Area 1965-1968; "All Areas" 1975-1990	• There was "no limit on the type of stuff that went into the landfill."	• Interviewed in 1990

Appendix B
Well Information

WELL COMPLETION DIAGRAM

CONVENTIONAL MONITORING

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

Location ID: **700-A-253** | Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 NW 1/4 SE 1/4 Sec 26, T20S, R3E**
NM State Plane Coordinates (NAD 83): **170655.79N 467020.93E**
Elevation (Brass Cap): **1496.62 m AMSL**
Elevation (Top of Casing): **1497.35 m**
Drilling Contractor: **Larjon Drilling Company**
Driller: **T. Crawford**
Total Depth of Borehole (bgs): **287' (87.5 m)**
Borehole Diameter: **9 7/8" (reamed 16") 0-60'; 9 7/8" 60-155'; 9" 155-287'**
Depth to Bedrock (bgs): **149' (45.4 m); Andesite**
Depth to Groundwater: **183.71' (56 m) TOC (11/9/89)**
Total Depth Surface Casing (bgs): **60' (18.3 m)**
Diameter and Type Surface Casing: **Nominal 10" Steel**

Date(s) Well Installed: **11/6/89 - 11/8/89**
Date(s) Well Developed: **11/9-13/89 (bailing); 11/17-27/89 (pumping)**
Field Representative(s): **G. Contaldo**
Total Depth Well Casing (bgs): **268.7' (80.9 m)**
Type of Casing: **PVC and Stainless Steel**
Diameter Well Casing: **Nominal 4" (~4 1/2" OD; ~3 3/4" ID)**
Casing Schedule: **40 PVC to 161.8'; 5 Stainless Steel to 268.7'**
Screened Zone (bgs): **253.0' - 263.4' (77.1 - 80.3 m)**
Comments: **bgs = below ground surface**
TOC = Top of Casing
AMSL = Above Mean Sea Level

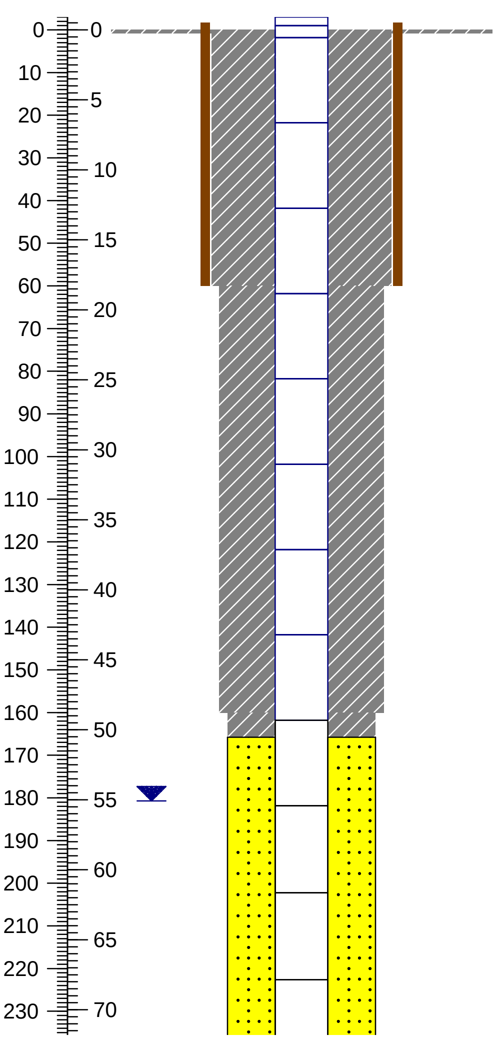
Casing Explanation:

- Surface Casing **Nominal 10" Steel**
- Conventional Casing **Nominal 4" PVC**
- Conventional Casing **Nominal 4" Stainless Steel**
- Conventional Screen **Nominal 4" Stainless Steel 0.020"-Slot (Regular Strength)**
- Conventional End Cap **Nominal 4" Stainless Steel**
- **Welded Stainless Steel Centralizers**
- Water Table

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 10/20 Sand/ Bentonite Mix
- Slough
- 8/20-16/40 Sand Mix
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Conventional Well Stick-Up = 2.4' (0.73 m); 3' (0.9 m) at installation. 2.0' stainless steel riser and locking cap top casing.

Surface Casing Stick-Up = ~1.7' (0.5 m)

Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface

Nominal 10" Steel Surface Casing Depth = 60' (18.3 m)

All Casing Above 161.8' (49.3 m) = Schedule 40 PVC

All Casing and Screen Below 161.8' (49.3 m) = Schedule 5 Stainless Steel

Water Table = 183.71' TOC (56 m); measured 11/9/89 during annular materials installation.

Annular/Borehole Descriptions
All depths listed are bgs

Top of Neat Cement (with 5% bentonite) = 0'

Santa Fe Group Alluvium from surface to 149' (45.4 m)

16" Borehole TD = 60' (18.3 m). Pilot hole: 12 1/4" (per Driller) or 9 7/8" (per Geologist).

Andesite (Orejon) Bedrock Depth = 149' (45.4 m)

9 7/8" Borehole TD = 155' (47.24 m) per Driller; 160' (48.8 m) per Geologist.

Top of 8/20 & 16/40 Silica Sand (~1:1 ratio) = 166' (50.6 m)

Micritic Limestone and Calcareous Siltstone (Panther Seep Formation) Bedrock Depth = 206' (62.8 m)

Top of Upper Bentonite Seal = 239.8' (73.1 m)

Top of Upper 16/40 Silica Sand = 243.2' (74.1 m)

Top of 8/20 Silica Sand = 249' (75.9 m)

Surface Casing
Nominal 10" Steel

Conventional Casing
Nominal 4" PVC

Conventional Casing
Nominal 4" Stainless Steel

Conventional Screen
Nominal 4" Stainless Steel
0.020"-Slot (Regular Strength)

Conventional End Cap
Nominal 4" Stainless Steel

Welded Stainless
Steel Centralizers

Water Table

Casing Explanation:

Cement

Bentonite (Grout Well DF)

Bentonite Seal

Slough

1/8 Gravel

8/20-16/40 Sand Mix

4/8 Sand

6/9 Sand

8/12 Sand

8/20 Sand

10/20 Sand

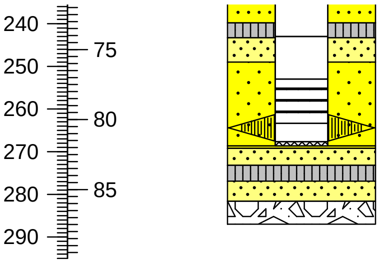
16/40 Sand

20/40 Sand

30/70 Sand

Annular Materials Explanation:

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Top of Screen (Regular Strength) = 253.0' (77.1 m)

Bottom Screen (Regular Strength) = 263.4' (80.3 m)

Four steel plates (centralizers) welded to casing at ~264' (80.5 m)

Sump consists of 5' blank riser and end cap

Nominal 4" Schedule 5 Stainless Steel Casing TD = 268.7' (81.9 m)

Annular/Borehole Descriptions
All depths listed are bgs

Top of Lower 16/40 Silica Sand = 269.2' (82.1m)

Top of Lower Bentonite Seal = 273.2' (83.3 m)

Top of 16/40 Silica Sand = 276.9' (84.4 m)

Top of Slough = 281.5' (85.8 m; Sounded 11/6/89)

9" Borehole TD = 287' (87.5 m)

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

Location ID: **700-B-510** | Site ID: **NASA-WSTF, Doña Ana County, NM**

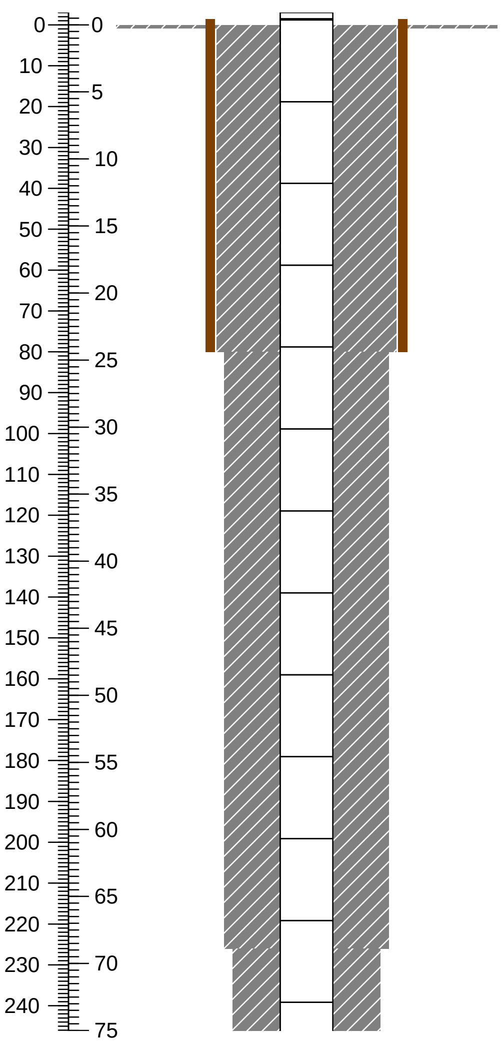
Township and Range: **NW 1/4 NW 1/4 SW 1/4 Sec 26, T20S, R3E**
NM State Plane Coordinates (NAD 83): **170874.82N 465851.50E**
Elevation (Brass Cap): **1465.39 m AMSL**
Elevation (Top of Casing): **1466.00 m AMSL**
Drilling Contractor: **Larjon Drilling Company**
Driller: **J. Gower**
Total Depth of Borehole (bgs): **550' (167.6 m)**
Borehole Diameter: **7 7/8" (reamed 16") (0-80'); 9 7/8" (80-226'); 9" (226-550')**
Depth to Bedrock (bgs): **285' (86.9 m); Andesite**
Depth to Groundwater: **468.65' (142.84 m) TOC (7/23/90)**
Total Depth Surface Casing (bgs): **80' (24.4 m)**
Diameter and Type Surface Casing: **Nominal 10" Steel**

Date(s) Well Installed: **7/23/90 - 7/25/90**
Date(s) Well Developed: **7/25/90-7/26/90 (bailing); 7/27/90-8/13/90 (pumping)**
Field Representative(s): **M. Canavan, J. Rogers, G. Contaldo**
Total Depth Well Casing (bgs): **536.3' (163.5 m)**
Type of Casing: **Stainless Steel**
Diameter Well Casing: **Nominal 4"**
Casing Schedule: **SCD 5 0-399.3'; SCD 10 399.3-536.3'**
Screened Zone (bgs): **510.0' - 530.8' (155.4 - 161.8 m)**
Comments: **AMSL = Above Mean Sea Level bgs = below ground surface**
TOC = Top of Casing

Casing Explanation:
- Surface Casing **Nominal 10" Steel**
- Conventional Casing **Nominal 4" Stainless Steel**
- Conventional Screen **Nominal 4" Stainless Steel 0.020"-Slot**
- Conventional End Cap **Nominal 4" Stainless Steel**
- **Welded Steel Centralizers**
- Water Table

Annular Materials Explanation:
- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 10/20 Sand/ Bentonite Mix
- Slough
- 8/20-16/40 Sand Mix
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Conventional Well Stick-Up = 2.0' (0.61 m) (3.2' (1.0 m) measured at installation)
Stick-up consists of a 1.73' riser and 0.27' adapter plus 1.2' well casing stick-up.

Surface Casing Stick-Up = ~1.4' (0.4 m)

Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface.

Well casing is schedule 5 stainless steel 0-399.3' (0-121.7 m).

Water not detected during drilling; however, after drilling to 550' (total depth), water was present the next day.

Annular/Borehole Descriptions
All depths listed are bgs

Top of Neat Cement (with 5% bentonite) = 0'

The formation is Santa Fe Group Alluvium from surface to 255' (77.7 m).

16" Borehole TD = 80' (24.4 m) (originally drilled 7 7/8" with tricone bit)

9 7/8" Borehole TD = 226' (68.9 m)

Surface Casing
Nominal 10" Steel

Conventional Casing
Nominal 4"
Stainless Steel

Conventional Screen
Nominal 4"
Stainless Steel 0.020"-Slot

Casing Explanation:

Conventional End Cap
Nominal 4"
Stainless Steel

Welded Steel Centralizers

Water Table

Cement

Bentonite (Grout Well DF)

Bentonite Seal

10/20 Sand/ Bentonite Mix

Slough

8/20-16/40 Sand Mix

4/8 Sand

6/9 Sand

8/12 Sand

8/20 Sand

Annular Materials Explanation:

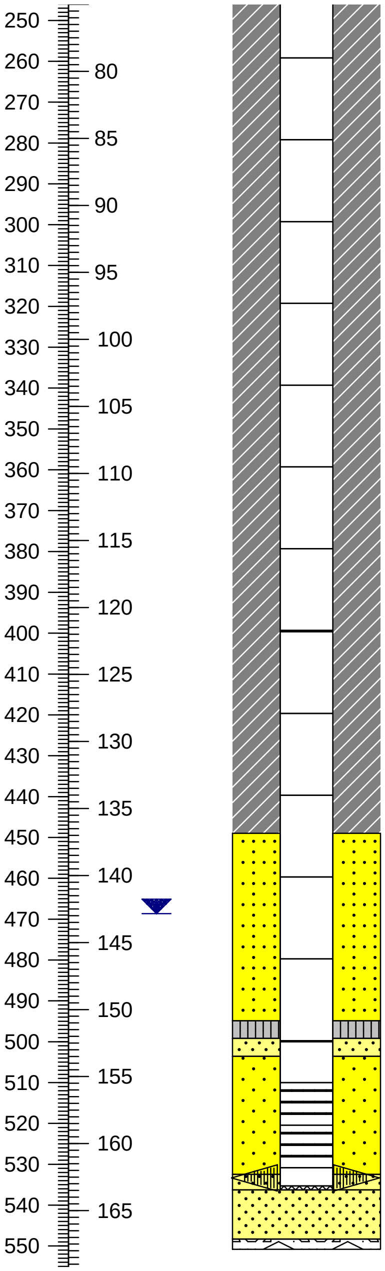
10/20 Sand

16/40 Sand

20/40 Sand

30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Well casing is schedule 10 stainless steel 399.3-536.3' (121.7-163.5 m)

Water Table = 468.65.92' (142.84 m) (measured 7/23/90 before well installation; TOC surface casing)

Adaptor at 499.7' (152.3 m)

Top of Screen (Extra Strength) = 510.0' (155.4 m)

Bottom of Screen (Extra Strength) = 530.8' (161.8 m)

Four steel plates (centralizers) welded to casing at ~533.3' (~162.5 m)

Sump consists of 5.0' blank riser and stainless steel end cap.

Nominal 4" Schedule 10 Stainless Steel Casing TD = 536.3' (163.5 m)

Annular/Borehole Descriptions
All depths listed are bgs

Volcanic Alluvium Depth = 255' (77.7 m)

Volcanic Andesite (Orejon) Bedrock Depth = 285' (86.9 m)

Top of 8/20 & 16/40 Silica Sand = 450' (137.2 m)

Top of Bentonite Seal = 495' (150.9 m)

Top of Upper 16/40 Silica Sand = 499' (152.1 m)

Top of 8/20 Silica Sand = 504' (153.6 m)

Top of Lower 16/40 Silica Sand = 533' (162.5 m)

Top of Slough = 548' (167.0 m) before casing installation (7/23/90)

9" Borehole TD = 550' (167.6 m)

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

Location ID: **700-D-186** | Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NW 1/4 SW 1/4 NE 1/4 Sec 26, T20S, R3E**
NM State Plane Coordinates (NAD 83): **170984.32N 466879.24E**
Elevation (Brass Cap): **1489.57 m AMSL**
Elevation (Top of Casing): **1490.20 m AMSL**
Drilling Contractor: **Larjon Drilling Company**
Driller: **T. Crawford**
Total Depth of Borehole (bgs): **205' (62.5 m)**
Borehole Diameter: **12 1/4" (reamed 16") 0-54'; 9 7/8" 54-194'; 9" 194-205'**
Depth to Bedrock (bgs): **180' (54.9 m); Limestone**
Depth to Groundwater: **175.' (53.55 m) TOC (11/20/89)**
Total Depth Surface Casing (bgs): **54' (16.5 m)**
Diameter and Type Surface Casing: **Nominal 10" Carbon Steel**

Date(s) Well Installed: **11/17/89 - 11/27/89**
Date(s) Well Developed: **11/28/89 - 12/21/89**
Field Representative(s):**R. Cooper**
Total Depth Well Casing (bgs): **201.6' (61.4 m)**
Type of Casing: **PVC and Stainless Steel**
Diameter Well Casing: **Nominal 4" (~4.5" OD; ~3.75" ID)**
Casing Schedule: **SCD 40 PVC 0-145.7'; SCD 5 Stainless Steel to 201.6'**
Screened Zone (bgs): **186.0' - 196.3' (56.7 - 59.8 m)**
Comments: **AMSL = Above Mean Sea level**
TOC = Top of Casing
SCD = Schedule
bgs = below ground surface

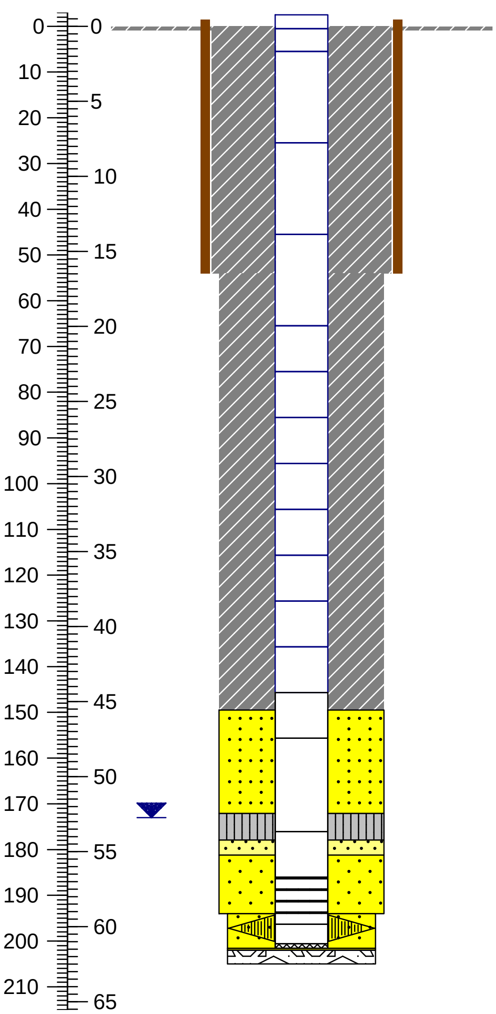
Casing Explanation:

- Surface Casing **Nominal 10" Carbon Steel**
- Conventional Casing **Nominal 4" PVC**
- Conventional Casing **Nominal 4" Stainless Steel**
- Conventional Screen **Nominal 4" Stainless Steel 0.020"-Slot (Regular Strength)**
- Conventional End Cap **Nominal 4" Stainless Steel**
- **Welded Stainless Steel Centralizers**
- Water Table

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 10/20 Sand/ Bentonite Mix
- Slough
- 8/20-16/40 Sand Mix
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Conventional Well Stick-Up = 2.1' (0.64 m) (2.5' (0.8 m) at installation) 3.0' (0.91 m) Stainless steel riser and locking cap tops casing.
Surface Casing Stick-Up = ~1.5' (0.5 m)
Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface.

Nominal 10" Carbon Steel Surface Casing Depth = 54' (16.5 m)

All casing 0.5-145.7' (44.4 m) bgs = SCD 40 PVC

All casing and screen below145.7' (44.4 m) = SCD 5 Stainless Steel

Water Table = 172.9' (52.7 m) bgs (11/16/89) in open borehole

Top of Screen (Regular Strength) = 186.0' (56.7 m)

Bottom of Screen (Regular Strength) = 196.3' (59.8 m)

Four steel plates (centralizers) welded to casing at ~197' (60.0 m)

Sump consists of 5' blank riser and end cap.

Nominal 4" SCD 5 Stainless Steel Casing TD = 201.6' (61.4 m)

Annular/Borehole Descriptions
All depths listed are bgs

Top of Neat Cement (with 5% bentonite) = 0'

Santa Fe Group Alluvium from surface to 180' (54.9 m)

16" Borehole TD = 54' (16.5 m) (12 1/4" pilot hole)

Top of 8/20 & 16/40 Silica Sand = 150' (45.7 m)

Top of Upper Bentonite Seal = 172' (52.4 m)

Top of Upper 16/40 Silica Sand = 178' (54.3 m)

Limestone (Hueco Formation) Bedrock Depth = 180' (54.9 m)

Top of 8/20 Silica Sand = 181' (55.2 m)

9 7/8" Borehole TD = 194' (59.1 m)

Top of Slough = 202' (61.6 m) (11/18/89) before casing installation

9" Borehole TD = 205' (62.5 m) (air hammer bit)

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

NASA JSC - White Sands Test Facility, Las Cruces, New Mexico, USA

Location ID: **700-E-458** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NW 1/4 SE 1/4 SW 1/4 Sec 27, T20S, R3E**
NM State Plane Coordinates (NAD 83): **170316.63N 464666.64E**
Elevation (Brass Cap): **1438.73 m AMSL**
Elevation (Top of Casing): **1439.36 m AMSL**
Drilling Contractor: **Larjon Drilling Company**
Driller: **J. Gower, M. Clanton**
Total Depth of Borehole (bgs): **515' (157.0 m)**
Borehole Diameter: **12 1/4" 0-65'; reamed 16" to 69'; 9 7/8" 69-515'**
Depth to Bedrock (bgs): **285' (86.9 m); Andesite**
Depth to Groundwater: **354.9' (108.16 m) TOC (3/15/90)**
Total Depth Surface Casing (bgs): **69' (21.0 m)**
Diameter and Type Surface Casing: **Nominal 10" Steel**

Date(s) Well Installed: **3/2/90 - 3/6/90**
Date(s) Well Developed: **3/7/90-3/15/90 (bailing); see comments**
Field Representative(s): **R. Cooper**
Total Depth Well Casing (bgs): **484.2' (147.6 m)**
Type of Casing: **Stainless Steel**
Diameter Well Casing: **Nominal 4"**
Casing Schedule: **Sch 5 +2.7-392.9'; Sch 10 392.9-484.2'**
Screened Zone (bgs): **458.1'-478.9' (139.6 - 146.0 m)**
Comments: **bgs = below ground surface**
TOC = Top of Casing
AMSL = Above Mean Sea Level
Lockheed techs completed development (no records).

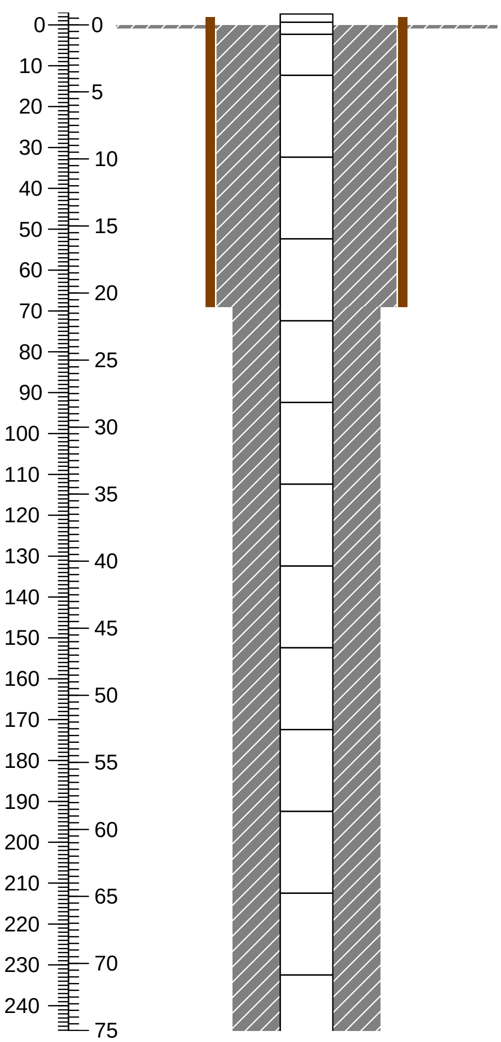
Casing Explanation:

- Surface Casing **Nominal 10" Steel**
- Conventional Casing **Nominal 4" Stainless Steel**
- Extra Strength Screen **Nominal 4" Stainless Steel 0.020" Slot**
- Conventional End Cap **Nominal 4" Stainless Steel**
- **Welded Steel Centralizers**
- Water Table

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 10/20 Sand/ Bentonite Mix
- Slough
- 8/20-16/40 Sand Mix
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs
Conventional Well Stick-Up = 2.1' (0.63 m) (2.7' (0.8 m) at installation) Surface Casing Stick-Up = ~1.9' (0.6 m) Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface. Well casing is schedule 5 stainless steel 0-392.9' (0-119.8 m)	Top of Neat Cement (with 5% bentonite) = 0' Santa Fe Group Alluvium from surface to 285' (86.9 m) 16" Borehole TD = 69' (21.0 m) (Originally Drilled 12 1/4" with Tricone Bit)

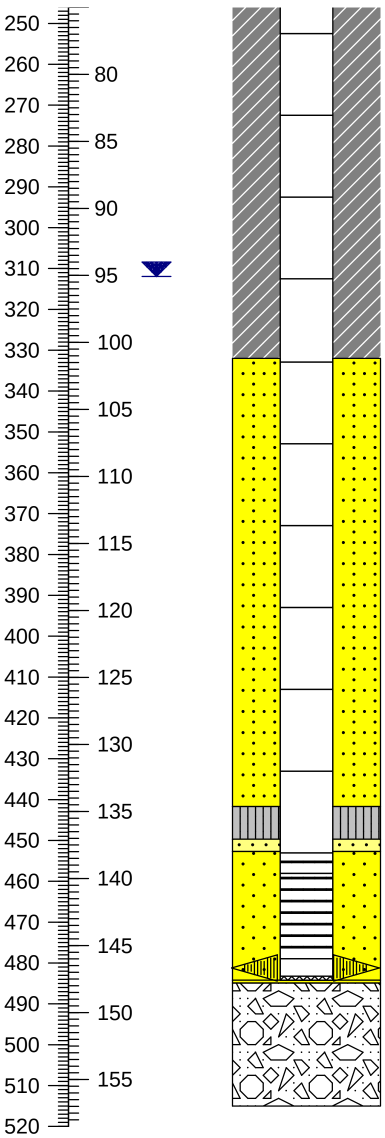
Casing Explanation:

- Surface Casing **Nominal 10" Steel**
- Conventional Casing **Nominal 4" Stainless Steel**
- Conventional Screen **Nominal 4" Stainless Steel 0.020" Slot**
- Conventional End Cap **Nominal 4" Stainless Steel**
- **Welded Steel Centralizers**
- Water Table

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 10/20 Sand/ Bentonite Mix
- Slough
- 8/20-16/40 Sand Mix
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Water Table = 354.9' (108.16 m) (measured 3/15/90 during development; TOC)

Well casing is schedule 10 stainless steel (blanks) 392.9-458' (119.8-139.6 m)

Top of Screen (Extra Strength) = 458.0' (109.1 m)

Bottom of Screen (Extra Strength) = 478.9' (146.0 m)

Four steel plates (centralizers) welded to casing at ~481.2' (~146.7 m)

Sump consists of 5.0' blank riser and stainless steel end cap

Nominal 4" Schedule 10 Stainless Steel Casing TD = 484.2' (147.6 m)

Annular/Borehole Descriptions
All depths listed are bgs

Volcanic Andesite (Orejon) Bedrock Depth = 285' (86.9 m)

Top of 8/20 & 16/40 Silica Sand = 332' (101.2 m)

Top of Upper Bentonite Seal = 442' (134.7 m)

Top of Upper 16/40 Silica Sand = 450' (137.2 m)

Top of 8/20 Silica Sand = 453' (138.1 m)

Top of Slough = 484.9' (147.8 m)(Measured 3/2/90 before casing installation)

9 7/8" Borehole TD = 515' (157.0 m) (Drilled with Tricone Bit)

WELL COMPLETION DIAGRAM

WESTBAY® MONITORING WELL

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

Location ID: **700-H** | Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 SE 1/4 NW 1/4 Sec. 26, T20S, R3E**
NM State Plane Coordinates (NAD 83 in meters): **170800.46N 466572.04E**
Elevation (Brass Cap): **1484.3 m AMSL**
Elevation (Top of Casing): **1484.58 m AMSL**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Total Depth of Borehole (bgs): **730' (222.5 m)**
Borehole Diameter: **7 5/8" 0-170'; 4 1/2" 170-730'**
Depth to Bedrock (bgs): **200' (61.0 m); Andesite**
Depth to Groundwater: **258.58' (78.81 m) TOSC (8/10/99; open borehole)**
Total Depth Surface Casing (bgs): **170' (51.8 m)**
Diameter and Type Surface Casing: **Nominal 5" Steel**
Date(s) Well Installed: **8/10/99 - 8/18/99**

Date(s) Well Developed: **BH = 6/20/99, 7/12-15/99; WB = Not Recorded**
Field Representative(s): **M. Canavan, G. Giles, M. McClure, (see comments)**
Total Depth Well Casing (bgs): **695' (211.8 m)**
Type of Casing: **Westbay® MP 38 PVC**
Diameter Well Casing: **1.5" ID; 1.9" OD**
WB Sampling Zone(s)(bgs): **350' (107.56 m); 535' (163.88 m); and 670' (204.93 m)**
WB Packer Zone(s)(bgs): **345-360' (106.04-110.60 m); 525-545' (160.83-166.93 m); and 660-680' (201.88-207.97 m)**
Comments: **Depths (meters) for WB components and zones are a calculated value based on piezometric levels at MPs. AMSL = Above Mean Sea Level TOSC = Top of Surface Casing Field Reps, cont'd: J. Pearson, L. Hunnicutt-Mack, M. Rivera**

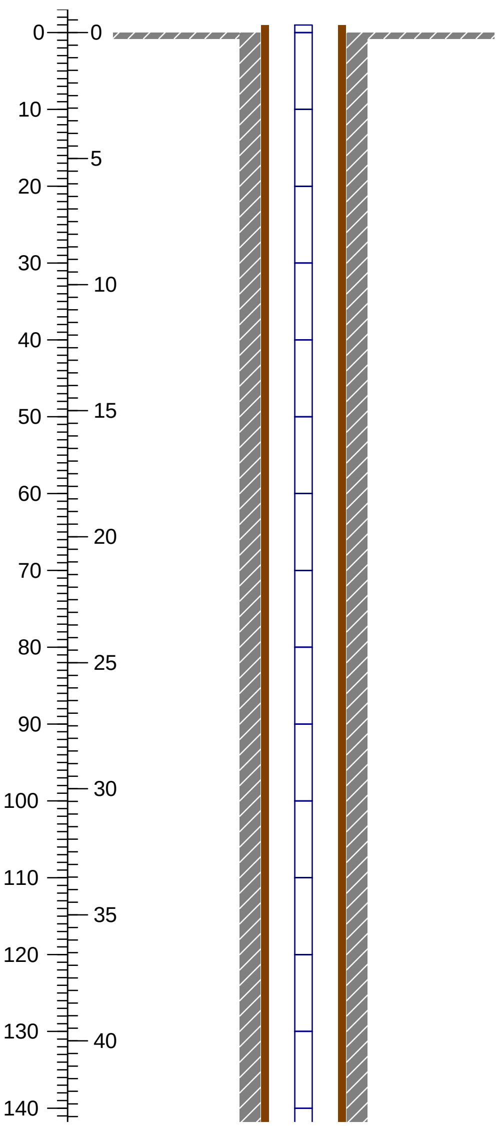
Surface Casing **Nominal 5" Steel**
1.5" ID Westbay® MP38 Casing

Casing Explanation:
1.5" ID Westbay® MP38 End Cap
Packer

Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)
Magnetic Collar
Water Table
Cement
Slough

Feet/Meters

Well Descriptions All depths listed are bgs (unless noted)	Annular/Borehole Descriptions All depths listed are bgs
Westbay® Well Stick-Up = 1.0' (0.298 m) Surface Casing Stick-Up = ~1.01' (0.3 m) Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface	



Surface Casing
Nominal 5" Steel
1.5" ID Westbay® MP38 Casing

Casing Explanation:
1.5" ID Westbay® MP38 End Cap
Packer

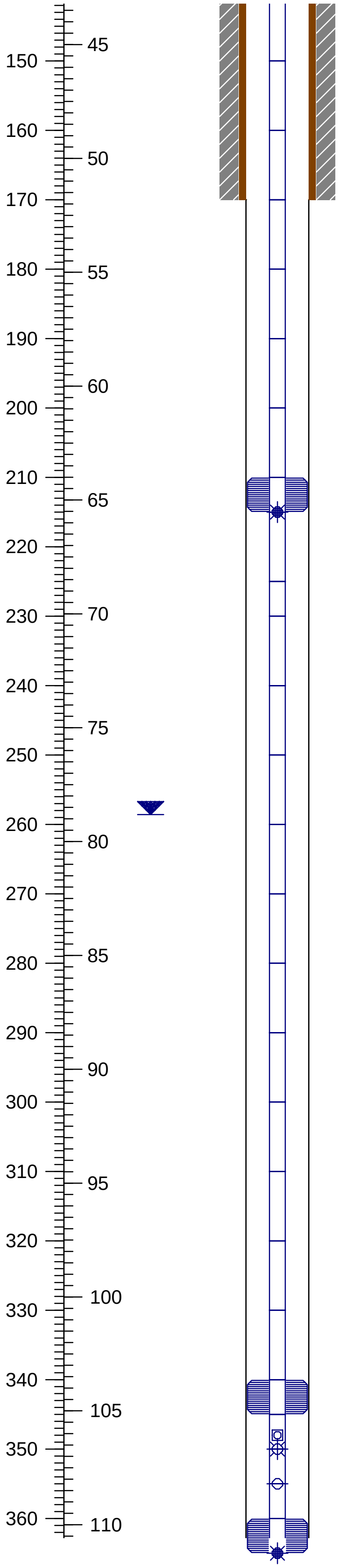
Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)

Magnetic Collar
Water Table

Cement
Slough

Feet/Meters

Well Descriptions All depths listed are bgs (unless noted)	Annular/Borehole Descriptions All depths listed are bgs



	Well Descriptions	Annular/Borehole Descriptions
170	Nominal 5" Steel Surface Casing Depth = 170' (51.8 m)	7 5/8" Borehole cemented to 170' (51.8 m)
200		Andesite (Orejon Andesite) Bedrock Depth = 200' (61.0 m)
210	Packer Depth = 210'-215' (64.01-65.53 m)	
215	MP Depth (with Filter Sock) = 215' (65.53 m)	
258.58	Depth to Water = 258.58' (78.81 m)(Borehole; measured 8/10/99 (Top of Surface Casing) just before Westbay® well casing installation)	
340	Packer Depth = 340'-345' (104.51-106.04 m)	
349	Magnetic Collar Depth = 349' (107.26 m)(Exact Location Not Recorded)	
350	Sampling MP Depth = 350' (107.56 m)	
355	PP Depth = 355' (109.08 m)	
360	Packer Depth = 360'-365' (110.60-112.12 m)	

Surface Casing
Nominal 5" Steel

1.5" ID Westbay® MP38 Casing

Casing Explanation:

1.5" ID Westbay® MP38 End Cap

Packer

Measurement Port (MP)

MP with Filter Sock

Mechanical Pumping Port (PP)

Magnetic Collar

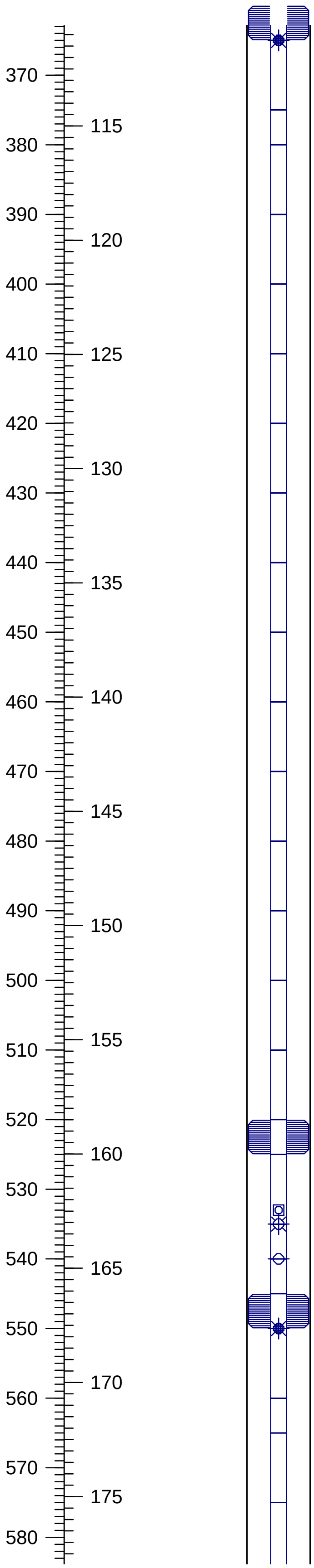
Water Table

Cement

Slough

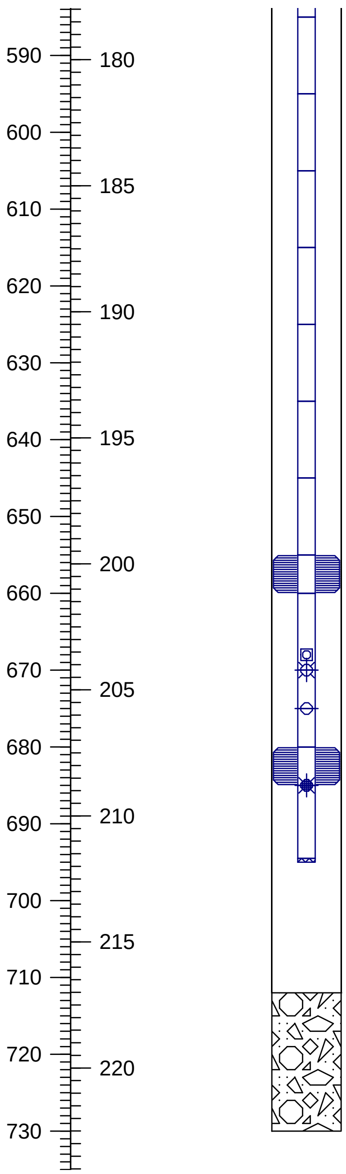
Feet/Meters

Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs
MP Depth (with Filter Sock) = 365' (112.12 m)	
Packer Depth = 520'-525' (159.31-160.83 m)	
Magnetic Collar Depth = 534' (163.58 m)(Exact Location Not Recorded)	
Sampling MP Depth = 535' (163.88 m)	
PP Depth = 540' (165.40 m)	
Packer Depth = 545'-550' (166.93-168.45 m)	
MP Depth (with Filter Sock) = 550' (168.45 m)	



Surface Casing **Nominal 5" Steel**	**Casing Explanation:** **1.5" ID Westbay® MP38 End Cap**	Measurement Port (MP)	Magnetic Collar
1.5" ID Westbay® MP38 Casing	Packer	MP with Filter Sock	Water Table
		Mechanical Pumping Port (PP)	
		Cement	Slough

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs
Packer Depth = 655'-660' (200.36-201.88 m)	
Magnetic Collar Depth = 669' (204.63 m)(Exact Location Not Recorded)	
Sampling MP Depth = 670' (204.93 m)	
PP Depth = 675' (206.45 m)	
Packer Depth = 680'-685' (207.97-209.49 m)	
MP Depth (with Filter Sock) = 685' (209.49 m)	
Westbay® MP 38 Casing TD = 695' (211.8 m)	
	Top of Slough = 712' (217.0 m). Borehole sloughed. Total depth was measured 8/10/99 prior to Westbay® casing installation.
4 1/2" Borehole TD = 730' (222.5 m)	

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

Location ID: **700-J-200** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 NE 1/4 SE 1/4 Sec 26, T20S, R3E**
NM State Plane Coordinates (NAD 83): **170653.39N 467353.49E**
Elevation (Brass Cap): **1508.74 m AMSL**
Elevation (Top of Casing): **1508.96 m AMSL**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Total Depth of Borehole (bgs): **240' (73.2 m)**
Borehole Diameter: **11 3/4" Drive Casing 0-70'; 9 7/8" Hammer Bit 70-240'**
Depth to Bedrock (bgs): **110' (33.5 m); Limestone**
Depth to Groundwater: **121.65' (37.08 m) TOC (2/25/00)**
Total Depth Surface Casing (bgs): **70' (removed)**
Diameter and Type Surface Casing: **11 3/4" Temporary Drive Casing**

Date(s) Well Installed: **6/6/99 - 6/7/99**
Date(s) Well Developed: **8/3/99 - 8/10/99 (Bennett pump)**
Field Representative(s): **M. Canavan, G. Giles, J. Pearson, (see comments)**
Total Depth Well Casing (bgs): **230' (70.1 m)**
Type of Casing: **304 Stainless Steel**
Diameter Well Casing: **4" ID; 4 1/2" OD**
Casing Schedule: **10**
Screened Zone (bgs): **199.6' - 219.7' (60.8 - 67.0 m)**
Comments: **bgs = below ground surface AMSL = Above Mean Sea Level**
TOC = Top of Casing
This well is upgradient of the 700 Area Landfill
Field Reps, cont'd: M. McClure, L. Hunnicutt-Mack, M. Rivera

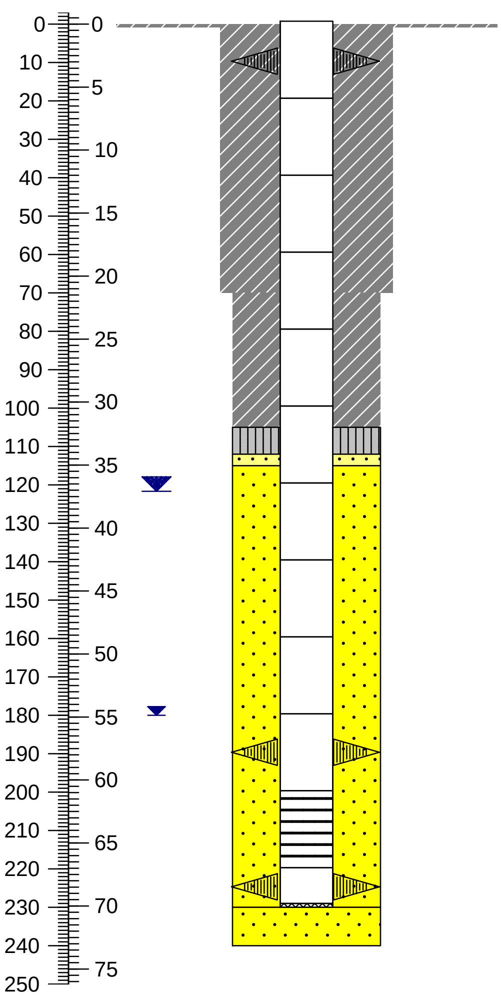
Surface Casing
11 3/4" Temporary Drive Casing
Conventional Casing
4" ID; 4 1/2" OD 304
Stainless Steel
Conventional Screen
4" ID; 4 1/2" OD 304
Stainless Steel 0.020"-Slot

Casing Explanation:
Conventional End Cap
4" ID; 4 1/2" OD 304
Stainless Steel
Welded Steel
Centralizers
Water Table

Cement
Bentonite (Grout Well DF)
Bentonite Seal
10/20 Sand/ Bentonite Mix
Slough
8/20-16/40 Sand Mix
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand

Annular Materials Explanation:
10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs
Conventional Well Stick-Up = 0.70' (0.21 m) (0.8' (0.2 m) at installation)	Top of Cement = 0'
Well completed with ~4' x ~4' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface	
NOTE: Number and locations of centralizers were not recorded at installation. Locations and depths were taken from camera log.	The formation is Santa Fe Group Alluvium from surface to 110' (33.5 m)
Three steel plates (centralizers) welded to casing at ~9.7' (~3.0 m)	11 3/4" Borehole TD = 70' (21.3 m) (Drilled with Drive Casing)
	Top of Upper Bentonite Seal = 105' (32.0 m)
	Limestone Bedrock Depth = 110' (33.5 m)
Water Table = 121.65' (37.08 m) (measured 2/25/00 post-development)	Top of Upper 16/40 Silica Sand = 112' (34.1 m)
	Top of 8/20 Silica Sand = 115' (35.1 m)
First Occurrence of Groundwater During Drilling = 180' (54.9 m)	
Three steel plates (centralizers) welded to casing at ~189.6' (~57.8 m)	
Top of Screen (Regular Strength) = 199.6' (60.8 m)	
Bottom of Screen (Regular Strength) = 219.7' (67.0 m)	
Three steel plates (centralizers) welded to casing at ~224.7' (~68.5 m)	
Sump consists of 10.0' blank riser and stainless steel end cap	9 7/8" Borehole TD = 240' (73.2 m) (Drilled with Hammer Bit)
4.5" OD (4" ID) Schedule 10 Stainless Steel Casing TD = 230' (70.1 m)	

QA 17 APR 0 3 1996

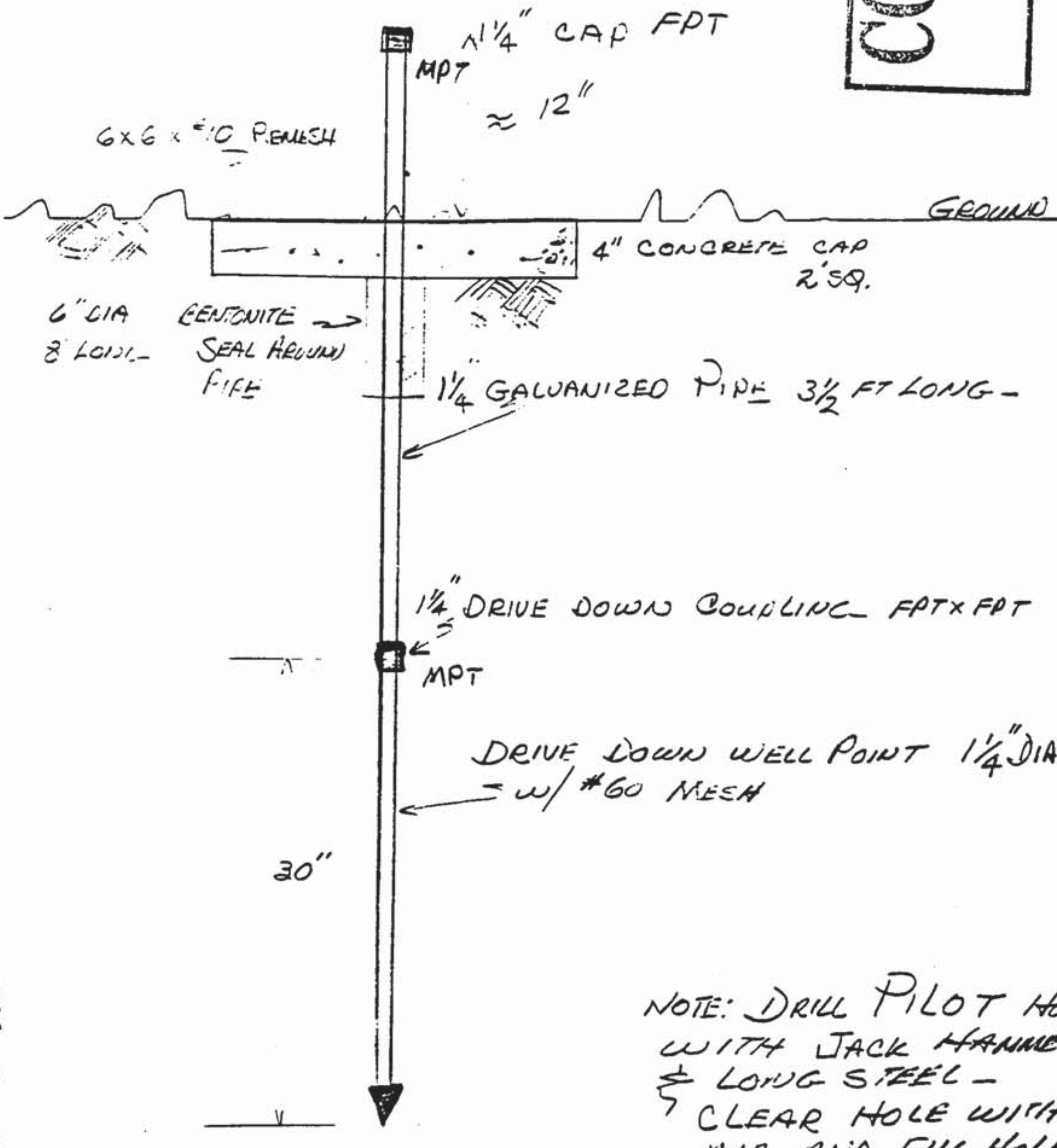
WSTF / SKETCH

TITLE: Methane Well Design

CONTRACTOR AUTH. SIGNATURES	NASA AUTH. SIGNATURES	TPS NO. 6-GHWM-960243	SKETCH NO. 2
[signature] 3/28/96	DA 4/3/96	PAGE 5 OF 5	SK -
[signature] 4-1-96		MOD. NO. DATE: 3-28-96	BY: G. Hackler
[signature] 04/03/96			DATE: 3-28-96

SK–

METHANE MONITERING WELL (TYP) 10EA



NOTE: DRILL PILOT HOLE WITH JACK HAMMER & LONG STEEL - CLEAR HOLE WITH AIR AND FILL HOLE w/ SAND

WSTF / 284

Appendix C
SDS

MATERIAL SAFETY DATA SHEET **CODE: M/L 1138**

This Material Safety Data Sheet complies with the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200

PRODUCT: LENOX GENERAL PURPOSE SOFT SOLDERING LIQUID FLUX (Inorganic Acid Soldering Flux)

NFPA/HMIS HAZARD CODES: HEALTH: 3 FIRE: 0 REACTIVITY: 0 SPECIAL: N/A

0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

SECTION I IDENTIFICATION

SUPPLIER NAME: LENOX
1690 Lowery Street
Winston-Salem, NC 27101

ISSUE DATE: May, 2007

INFORMATION PHONE: 336-777-8600

SECTION II COMPOSITION INFORMATION

INGREDIENT	CAS NO.	US OSHA PEL	%
Ammonium Chloride	12125-02-9	NA	4-15
Hydrochloric Acid	7647-01-0	5.0 PPM	3-15
Zinc Chloride	7646-85-7	1PPM	30-45

PEL = PERMISSABLE EXPOSURE LIMIT
Unlisted percentages are non-hazardous stabilizers, activators, and water.
None of the materials in this product are listed in NTP, IARC, or OSHA as carcinogens.

SECTION III HEALTH HAZARDS

EYES: Flush with water for 10 minutes. Obtain immediate medical attention.
SKIN: Wash thoroughly with water. If irritation develops, obtain medical attention.
ACUTE INHALATION: Remove to fresh air. Obtain immediate medical attention.
INGESTION: If patient is fully conscious, give two glasses of water and induce vomiting. Obtain immediate medical attention.
PRIMARY ROUTES OF ENTRY: Fume inhalation, ingestion, skin and eyes.
SYMPTOMS OF OVEREXPOSURE: Pulmonary edema, abdominal pain, vomiting, eye damage and skin burn.
MEDICAL CONDITIONS GENERALLY AGGRAVATED BY OVEREXPOSURE: None presently known.
CHEMICAL LISTED AS A CARCINOGEN OR POTENTIAL CARCINOGEN: None
OSHA Permissible Exposure Limit (PEL): 1 PPM
ACGIH Threshold Limit Value (TLV): 1 PPM

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: N/A
FLAMMABLE LIMITS: N/A
EXTINGUISHING MEDIA: Dry chemical, CO2 foam
AUTO IGNITION TEMPERATURE: None
SPECIAL FIRE FIGHTING PROCEDURES: Normal cautious when dealing with chemicals.
UNUSUAL FIRE & EXPLOSION HAZARDS: Will release small amounts of HC1 upon decomposition.

SECTION V ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IN CASE MATERIAL IS SPILLED: First neutralize with Soda Ash or Sodium Bicarbonate; dilute with water and dispose of in accordance with EPA Regulations.

SECTION VI HANDLING AND STORAGE

STORAGE REQUIREMENT:	Store in plastic containers in cool area, away from heat. Do not store in glass or porcelain container. Wash thoroughly after use.
HANDLING PRECAUTIONS:	Safe precautionary practices - avoid spills and exposure to skin and fumes.

SECTION VII CONTROL MEASURES

RESPIRATORY PROTECTION (TYPE):	NIOSH approved respirator
MECHANICAL (GENERAL):	Yes
EYE PROTECTION:	Safety glasses/goggles
PROTECTIVE GLOVES:	Recommended, NIOSH approved
OTHER PROTECTIVE CLOTHING OR EQUIPMENT:	Rubber apron, or equivalent
VENTILATION:	Yes
LOCAL EXHAUST:	Yes

SECTION VIII PHYSICAL AND CHEMICAL CHARACTERISTICS

BOILING POINT:	104°C/220°F	**SPECIFIC GRAVITY (WATER=1)**:	1.32
VAPOR PRESSURE (mm Hg):	N/A	**PERCENT VOLATILE BY VOLUME**:	64%
VAPOR DENSITY (AIR=1):	N/A	**EVAPORATION RATE (BUTYL ACETATE=1)**:	0.6
MELTING POINT:	0°C/32°F	**SOLUBILITY IN WATER**:	Unlimited
REACTIVITY IN WATER:	None	**APPEARANCE AND ODOR**:	Clear, odorless liquid

SECTION IX STABILITY AND REACTIVITY

STABILITY:	Product is stable
(CONDITIONS TO AVOID):	Metals
INCOMPATIBILITY:	Alkaline, Strong Oxidizing or Reducing Materials, Cyanides or Combustible Materials.
HAZARDOUS DECOMPOSITION PRODUCTS:	HC1, Zinc Chloride, Zinc Oxide, Ammonium
HAZARDOUS POLYMERIZATION:	Will not occur
(CONDITIONS TO AVOID):	Excessive heat or cold

SECTION X TRANSPORTATION AND DISPOSAL CONSIDERATIONS

D.O.T. PROPER SHIPPING NAME:	Corrosive Liquid, Acidic, Inorganic, N.O.S. Contains Zinc Chloride, Hydrochloric Acid
HAZARD CLASS:	8
IDENTIFICATION NUMBER:	UN3264
PACKING GROUP:	III
TYPE DOT LABEL REQUIRED INFO:	Corrosive
WASTE DISPOSAL METHOD:	Dispose of in accordance with EPA regulations

SECTION XI OTHER INFORMATION

VOC CONTENT: None

MATERIAL SAFETY DATA SHEET

Chemical Product and Company Identification

LABEL IDENTIFIER: DuPont® Krytox ® performance lubricants, 240 AC

PRODUCT IDENTIFIER: P/N 601593 Lubricant, Fluorinated Grease, “Krytox”, 2 oz. Tube

COMPANY IDENTIFICATION: MINE SAFETY APPLIANCES COMPANY
1100 Cranberry Woods Drive
Cranberry Township, PA 16066
CUSTOMER SERVICE: 1-800-MSA-2222 (8:30 a.m. – 5:00 p.m., USA local time)
EMERGENCY: 1-800-255-3924 (CHEM-TEL, INC.)

Vendor Information

A Material Safety Data Sheet as furnished by DuPont for “Krytox” 240 Series Fluorinated Grease is attached (6 Pages).

DuPont Chemicals MSDS REVISION DATE: 5/5/95

Other Information

WARNING: This is a hazardous chemical product. By following the directions and warnings provided with this product, the hazards associated with the use of this product can be greatly reduced but never entirely eliminated. Mine Safety Appliances Company makes no warranties, expressed or implied, with respect to this product and EXPRESSLY DISCLAIMS THE WARRANTY OF MERCHANTABILITY AND ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. Users assume all risks in handling, using or storing this product.

DuPont Chemicals

3886PP

Revised 5-MAY-1995 Printed 15-DEC-1998

"KRYTOX" 240 Series Fluorinated Grease

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

"KRYTOX" is a registered trademark of DuPont.

Corporate MSDS Number	DU008138
Grade	AA,AB,AC,AD, & AZ

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont
1007 Market Street
Wilmington, DE 19898

PHONE NUMBERS

Product Information	1-800-441-7515
Transport Emergency	CHEMTREC 1-800-424-9300
Medical Emergency	1-800-441-3637

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
PERFLUOROALKYLETHER	60164-51-4	73-82
PTFE	9002-84-0	18-27

HAZARDS IDENTIFICATION

Potential Health Effects

Skin contact may cause skin irritation with discomfort or rash. Prolonged skin contact may cause redness and inflammation of the hair follicles without skin sensitization.

Eye contact may cause eye irritation with discomfort, tearing or blurring of vision.

(Continued)

HAZARDS IDENTIFICATION(Continued)

Inhalation of fluorine compounds released as decomposition products above 290 degC (554 degF) may cause lung irritation and pulmonary edema which require medical treatment. Inhalation of fumes or smoke from overheated or burning grease may cause polymer fume fever, a temporary flu-like illness accompanied by fever, chills, and sometimes cough, of approximately 24 hours duration. Repeated episodes of polymer fume fever may cause lung damage.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

Flush skin with water after contact. Wash contaminated clothing before reuse.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, do not induce vomiting. Immediately give 2 glasses of water. Never give anything by mouth to an unconscious person. Call a physician.

Notes to Physicians

Activated charcoal mixture may be administered. To prepare activated charcoal mixture, suspend 50 grams activated charcoal in 400 mL water and mix thoroughly. Administer 5 mL/kg, or 350 mL for an average adult.

(Continued)

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point	Does not ignite
Method	PMCC

Non-combustible.

Extinguishing Media
As appropriate for combustibles in area

Fire Fighting Instructions
Wear self-contained breathing apparatus. Wear full protective equipment.

Decomposition at flame temperatures may form toxic fluorine compounds. Avoid breathing decomposition products.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)
NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures
Place in container for disposal. Remove source of heat and flame.

HANDLING AND STORAGE

Handling (Personnel)
Avoid contact with eyes. Avoid contact with skin. Wash thoroughly after handling. Do not store or consume food, drink or tobacco in areas where they may become contaminated with this material.

Storage
Keep container tightly closed. Do not store or consume food, drink or tobacco in areas where they may become contaminated with this material.

Keep away from heat and flames to avoid decomposition product.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls
Keep container tightly closed.

Keep away from heat and flames.

(Continued)

EXPOSURE CONTROLS/PERSONAL PROTECTION(Continued)

Personal Protective Equipment

EYE/FACE PROTECTION

Wear safety glasses or coverall chemical splash goggles.

RESPIRATOR

Where the potential exists for exposure to decomposition products due to heating or elevated temperatures, wear NIOSH/MSHA approved respiratory protection as appropriate.

PROTECTIVE CLOTHING

Where there is potential for skin contact have available and wear as appropriate, impervious gloves, apron, pants, and jacket.

Exposure Guidelines

Applicable Exposure Limits

PTFE

PEL (OSHA)	None Established
TLV (ACGIH)	None Established
AEL * (DuPont)	10 mg/m3, 8 Hr. TWA, total dust 5 mg/m3, 8 Hr. TWA, respirable dust

* AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Melting Point	320 C (608 F)
Solubility in Water	Negligible WT%
pH	Neutral
Odor	Odorless
Form	Solid, waxy grease
Color	White
Specific Gravity	1.89-1.93 @ 24 deg C (75 deg F)

STABILITY AND REACTIVITY

Chemical Stability

Stable.

Incompatibility with Other Materials

None reasonably foreseeable.

Polymerization

Polymerization will not occur.

Other Hazards

Decomposition: Heating above 260-290 deg C (500-554 deg F) may form potentially toxic fluorine compounds.
Depolymerization may occur in the presence of some metal oxides at temperatures above 288 deg C (550 deg F).
Decomposition occurs at increasing rates as temperature is raised above 355 deg C (670 deg F).

(Continued)

TOXICOLOGICAL INFORMATION

Animal Data

Perfluoroalkylether:

Inhalation 4 hour ALC:	19.54 mg/l in rats
Skin absorption ALD:	>17,000 mg/kg in rats
Oral ALD:	>25,000 mg/kg in rats

The product contains a mild eye irritant. A single inhalation exposure to perfluoroalkylether caused nonspecific effects such as respiratory irritation. Toxic effects described in animals exposed to decomposition products of perfluoroalkylether formed above 260 degC (500 degF) include lung irritation, irregular respiration, tremors and increased liver weight. Pulmonary edema and death occurred in rats exposed to the decomposition products of perfluoroalkylether formed at around 290 degC (554 degF).

A single inhalation exposure to PTFE caused irritation of the lungs. A repeated ingestion exposure caused no significant toxicological effects. Long-term ingestion exposure caused altered white blood cell count.

DISPOSAL CONSIDERATIONS

Waste Disposal

Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations. Do not flush to surface water or sanitary sewer system.

TRANSPORTATION INFORMATION

Shipping Information

DOT

Proper Shipping Name Not Regulated.

Shipping Containers:
2, 8 oz. polyethylene tubes
1 lb. double wall jars (polypropylene inner; polystyrene outer)
5-15 lb. polyethylene pails
50-75 lb. white high density polyethylene pails

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status Reported/Included.

TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

Acute	: Yes
Chronic	: No
Fire	: No
Reactivity	: No
Pressure	: No

(Continued)

OTHER INFORMATION

NFPA, NPCA-HMIS

NPCA-HMIS Rating

Health	1
Flammability	0
Reactivity	0

Personal Protection rating to be supplied by user depending on use conditions.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS	MSDS Coordinator
Address	DuPont Chemicals Wilmington, DE 19898
Telephone	800-441-7515

End of MSDS

MATERIAL SAFETY DATA SHEET

Share Corporation
P.O. Box 245013
Milwaukee, WI 53224

GENERAL INFORMATION NUMBER: (414) 355-4000
EMERGENCY TELEPHONE NUMBER: (800) 776-7192
CHEMTREC: (800) 424-9300

REVISION DATE: September 4, 2002
DATE OF ISSUE: September 10, 2002

I - Product Identification

Diazinon 4E

PRODUCT CODE: 1501
CHEMICAL FORMULATION: Solvent based residual insecticide.
NFPA HAZARD IDENTIFICATION SYSTEM: **HEALTH:** 2 **FLAMMABILITY:** 2 **REACTIVITY**: 0
HAZARD RATING: 4 - Extreme; 3 - High; 2 - Moderate; 1 - Slight; 0 - Insignificant

II - Hazardous Ingredients

Values reported as TWA unless noted.

SUBSTANCE	APPROX %	OSHA PEL	ACGIH TLV	EPA 40 CFR: 302	355	372	CAS #
Diazinon	48.0	N/E	.1 mg/m^3 (skin)	N	N	N	333-41-5
Aromatic Hydrocarbon	< 35.0	N/E	435 mg/m^3 (skin)	N	N	N	64742-95-6
Xylene	< 2.00	100 ppm	100 ppm				1330-20-7
Cumene	< 1.00	50 ppm	50 ppm				98-82-8
Pseudocumene (1,2, 4-Trimethylbenzene)	10.0-20.0	25 ppm	25 ppm				95-63-6

Key: **PEL**: Permissible Exposure Limit **TLV:** Threshold Limit Value **C**: Ceiling level **STEL**: Short Term Exposure Limit
N/A: Not Applicable **N/D**: Not Determined **N/E**: Not Established **Y**: Yes **N**: No
302: CERCLA List of Hazardous Substances and Reportable Quantities (40 CFR 302.4).
355: SARA TITLE III / List of Extremely Hazardous Substances for Emergency Planning and Notification (40 CFR 355).
372: SARA TITLE III / List of Toxic Chemicals subject to Release Reporting (Community Right to Know) (40 CFR 372).

III - Physical Data

BOILING POINT (°F): > 200
SPECIFIC GRAVITY (WATER = 1): 1.00
VAPOR PRESSURE (mm Hg): 31.0 @ 100^{o}F
VOC CONTENT (% by weight): N/D
VAPOR DENSITY (AIR = 1): < 1.0
EVAPORATION RATE (WATER = 1): N/D
SOLUBILITY IN WATER: Emulsifiable
pH: N/A
APPEARANCE AND ODOR: Clear, yellow liquid; aromatic solvent odor..

IV - Fire and Explosion Hazard Data

FLASH POINT (°F): 145 **(TEST METHOD):** TCC
FLAMMABLE LIMITS IN AIR (VOLUME %) **UPPER:** N/D **LOWER:** N/D
EXTINGUISHING MEDIA: Carbon dioxide, dry chemical.
SPECIAL FIRE FIGHTING PROCEDURES: Cool fire exposed containers with water fog. Firefighters should be equipped with full protective gear including self-contained breathing apparatus.
UNUSUAL FIRE AND EXPLOSION HAZARD: Combustible liquid. Do not use, pour, spill or store near heat or open flame.

V - Reactivity Data

STABILITY: Stable.
INCOMPATIBILITY: Strong oxidizers
CONDITIONS TO AVOID: Excess heat and open flame.
HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition may produce oxides of carbon.
HAZARDOUS POLYMERIZATION: Will not occur.
CONDITIONS TO AVOID: None

VI - Health Hazard Data

ROUTES OF ENTRY **INHALATION:** X **EYE CONTACT:** X **SKIN CONTACT:** X **INGESTION:** X
INGREDIENTS THAT ARE CONSIDERED BY OSHA, NTP, IARC TO BE SUSPECTED HUMAN CARCINOGENS: None
EFFECTS OF OVEREXPOSURE
IF IN EYES: Causes moderate eye irritation.
IF ON SKIN: May be absorbed through skin. Avoid contact with skin and clothing.
IF SWALLOWED: Nausea, cramps, diarrhea.
IF INHALED: Irritation to upper respiratory tract. May be an aspiration hazard.
EMERGENCY AND FIRST AID PROCEDURES
IF IN EYES: Flush eyes and under eyelids with plenty of cool water for at least 15 minutes. If irritation persists, obtain medical attention.
IF ON SKIN: Wash with soap and water. Remove contaminated clothing and launder separately before reuse. If irritation persists, obtain medical attention.
IF SWALLOWED: Contact physician or poison control center immediately. Give affected person 1 to 2 glasses of water. Do not induce vomiting. Never give anything to an unconscious person.
IF INHALED: Remove person to fresh air.
NOTE TO PHYSICIAN: Gastric lavage may be indicated if product was taken internally. Diazinon is an organophosphate insecticide. If symptoms of cholinesterase inhibition are present, atropine sulfate by injection is antidotal. 2-PAM is also antidotal and may be administered, but only in conjunction with atropine.

VII - Spill or Leak Protection

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Ventilate area and remove all sources of ignition. Contain spill. Soak up spilled material with inert absorbent material and place in a properly marked closed container for proper disposal.
WASTE DISPOSAL METHOD: Consult local environmental authorities.

VIII - Special Protection Information

RESPIRATORY PROTECTION: Use with adequate ventilation. Do not breathe vapors or mists. If recommended Exposure Limits are exceeded wear a NIOSH approved respirator, following manufacturer's recommendations.
VENTILATION **LOCAL:** Recommended **MECHANICAL:** Not required
PROTECTIVE GLOVES: Chemical resistant.
EYE PROTECTION: None normally required otherwise protective goggles.
OTHER PROTECTIVE EQUIPMENT: Protective clothing.
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Store in a cool, dry place away from heat or open flame. Keep container tightly closed when not in use. Keep away from food and feed. Do not permit children or pets on sprayed grass until sprayed grass has completely dried. Do not contaminate ornamental fish ponds. Do not use on humans, household pets or livestock.
OTHER PRECAUTIONS: Keep out of reach of children.

IX - Transportation Information (ground transportation only)

DOT PROPER SHIPPING NAME: Consumer Commodity
DOT CLASS: ORM-D **DOT ID NUMBER:** N/A **DOT PACKING GROUP**: N/A

The shipping information listed above applies only to non-bulk (< 119 gallons) containers of this product. This product may have more than one proper shipping name depending on packaging, product properties, & mode of shipment. If any alteration of packaging, product, or mode of transportation is further intended, different shipping names and labeling may apply.

REVISION DATE: September 4, 2002 Prepared by: PMR DATE OF ISSUE: September 10, 2002

"DuPont" "HYVAR" X-L
M0000506 Revised 11-OCT-2008

Substance ID :130000023989

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

"HYVAR" is a registered trademark of DuPont.

"DuPont" is a trademark of DuPont.

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont
1007 Market Street
Wilmington, DE 19898

PHONE NUMBERS
Product Information : 1-800-441-7515 (outside the U.S. 302-774-1000)
Transport Emergency : CHEMTREC 1-800-424-9300(outside U.S. 703-527-3887)
Medical Emergency : 1-800-441-3637 (outside the U.S. 302-774-1000)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
*BROMACIL (LITHIUM SALT OF 5-BROMO-3-SEC-BUTYL-6-METHYLURACIL)	314-40-9	21.9
INERT INGREDIENTS (INCLUDES PERCENTAGES OF THE FOLLOWING:)		78.1
* ETHYLENE GLYCOL	107-21-1	30-35
ETHANOL	64-17-5	<10
* METHANOL	67-56-1	<5

* Disclosure as a toxic chemical is required under Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

HAZARDS IDENTIFICATION

Emergency Overview

CAUTION! Harmful if swallowed or absorbed through skin.

Causes moderate eye irritation. Avoid contact with eyes, skin or clothing.

Potential Health Effects

Based on animal studies, eye contact with "Hyvar" X-L may cause moderate corneal opacity.

Based on animal studies, skin contact with "Hyvar" X-L may cause skin irritation or rash.

Carcinogenicity Information

The following components are listed by IARC, NTP, OSHA or ACGIH as carcinogens.

Material	IARC	NTP	OSHA	ACGIH
BROMACIL				A3

FIRST AID MEASURES

First Aid

IF IN EYES: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

IF SWALLOWED: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

IF ON SKIN OR CLOTHING: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

IF INHALED: No specific intervention is indicated as the product is not likely to be hazardous by inhalation. Consult a physician if necessary.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-441-3637 for emergency medical emergencies involving this product.

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point : 44 C (111 F)
Method : Setaflash
Autoignition : 410 C (770 F)

Combustible. Heating can release vapors which can be ignited.

Do not store near heat or open flame.

Extinguishing Media

Water Spray, Foam, Dry Chemical, CO2.

Fire Fighting Instructions

Wear self-contained breathing apparatus. Wear full protective equipment. Use water spray. Cool tank/container with water spray. Runoff from fire control may be a pollution hazard.

If area is heavily exposed to fire and if conditions permit, let fire burn itself out since water may increase the area contaminated.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Initial Containment

Dike spill. Prevent material from entering sewers, waterways, or low areas.

Spill Clean Up

Soak up with sawdust, sand, oil dry or other absorbent material.

Accidental Release Measures

If spill area is on ground near valuable plants or trees, remove top 2 inches of soil after initial cleanup.

HANDLING AND STORAGE

Handling (Personnel)

USERS SHOULD: Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.

Users should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Handling (Physical Aspects)

Keep away from heat, sparks and flames.

Storage

Store product in original container only. Do not contaminate water, other pesticides, fertilizer, food or feed in storage Keep container closed when not in use.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use only with adequate ventilation. Keep container tightly closed.

When handlers use closed systems, enclosed cabs or aircraft in a manner that meets the requirements listed in the Workers Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4-6)]. The handler PPE requirements may be reduced or modified as specified in the WPS.

Personal Protective Equipment

Some materials that are chemical resistant to this product are listed below. If you want more options follow the instructions for Category C on the EPA chemical resistance category selection chart.

Applicators and other handlers must wear:
- Long-sleeved shirt and long pants.
- Shoes plus socks.
- Chemical Resistant Gloves, Category C (such as butyl rubber, neoprene rubber, or nitrile rubber) equal to or greater than 14 mils.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product’s concentrate. Do not reuse them.

Follow manufacturer’s instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Exposure Guidelines

Applicable Exposure Limits

BROMACIL

PEL (OSHA)	: None Established
TLV (ACGIH)	: 10 mg/m3, 8 Hr. TWA, A3
AEL * (DuPont)	: 10 mg/m3, 8 & 12 Hr. TWA

ETHYLENE GLYCOL

PEL (OSHA)	: None Established
TLV (ACGIH)	: Ceiling: 39.4 ppm, 100 mg/m3, aerosol,A4
AEL * (DuPont)	: 50 ppm, 8 & 12 Hr. TWA, vapor 10 mg/m3, 8 & 12 Hr. TWA, particulate Aerosol

ETHANOL

PEL (OSHA)	: 1,000 ppm, 1,900 mg/m3, 8 Hr. TWA
TLV (ACGIH)	: 1,000 ppm, 1,880 mg/m3, 8 Hr. TWA, A4 Notice of Intended Changes (2008) STEL 1000 ppm, A3
AEL * (DuPont)	: 1000 ppm, 8 & 12 Hr. TWA

METHANOL

PEL (OSHA)	: 200 ppm, 260 mg/m3, 8 Hr. TWA
TLV (ACGIH)	: 200 ppm, 8 Hr. TWA, Skin STEL 250 ppm
AEL * (DuPont)	: 200 ppm, 8 & 12 Hr. TWA, Skin

* AEL is DuPont’s Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Solubility in Water	: Soluble
pH	: 11.2 - 12.2
Odor	: Alcoholic
Form	: Liquid
Color	: Amber
Density	: 1.12 g/cc

Physical Hazards

Combustible. Do not use or store near heat or open flame. Keep container tightly closed when not in use.

STABILITY AND REACTIVITY

Chemical Stability

Stable at normal temperatures and storage conditions.

Incompatibility with Other Materials

Incompatible with acids and amines, especially primary amines.

Decomposition

Decomposes with heat.

Polymerization

Polymerization will not occur.

TOXICOLOGICAL INFORMATION

Animal Data

Oral LD50	:	3927 mg/kg (male rats)
		1414 mg/kg (female rats)
Dermal LD50	:	>5000 mg/kg (rabbits)
Inhalation 4-hr LC50	:	>or= 4.3 mg/L (rats)

Based on animal testing, Hyvar X-L is an eye and skin irritant, but is not a skin sensitizer.

BROMACIL
Repeated exposure to Bromacil by ingestion resulted in incoordination, salivation, vomiting, weakness, tearing and dilated pupils. Repeated exposure caused liver changes, increased liver, adrenal, and heart weights, decreased kidney and spleen weights, and thyroid changes. Long-term exposure caused reduced weight gain, slight thyroid effects, and liver effects.

Repeated exposure to Bromacil by inhalation caused slightly increased platelet counts, lower serum cholesterol, and slightly increased liver weights. All remaining animals were normal after a 14-day recovery period.

Dogs fed Bromacil for one year had decreased body weight gain in the high dose group. Rats fed Bromacil for two years had reduced body weight gain, increased incidence of thyroid cysts, and enlargement of thymus at the high dose, and a dose-related increase in thyroid tumors. Mice fed Bromacil for 18-months had liver lesions in all male groups and an increase in liver tumors in the high dose males.

Animal testing indicates Bromacil does not have reproductive

effects. Bromacil is not considered to be a developmental toxicant. Any developmental effects occurred at maternally toxic doses. The weight of evidence suggests that Bromacil does not produce genetic damage in mammalian or bacterial cells cultures or animal studies.

METHANOL
Toxic effects that may result from excessive exposure to methanol include visual disturbances or blindness, narcosis and other CNS effects, liver effects, and acidosis.

Indivdiuals with preexisting diseases of the retina or liver may have increased susceptibility to methanol toxicity.

ETHYLENE GLYCOL
Immediate effects of overexposure to ethylene glycol by ingestion or inhalation may include non-specific effects such as headache, nausea and weakness. Gross overexposure may cause central nervous system depression with dizziness, confusion, incoordination, drowsiness or unconsciousness; altered kidney function which may be accompanied by abnormal urine volume, low back pain, discomfort or edema; kidney stones; liver abnormalities; high blood pressure; irregular heart beat with a strange sensation in the chest, "heart thumping"; apprehension; lightheadedness, feeling of fainting, dizziness, weakness, sometimes progressing to loss of consciousness; retention of acid in the blood, making oxygen less available in the blood stream and leading to symptoms of increased breathing rate, nausea, vomiting, confusion and weakness which may progress to loss of consciousness. Gross overexposure could lead to death. Skin permeation can occur in amounts capable of producing the effects of systemic toxicity. There are no reports of human sensitization. Individuals with preexisting diseases of the kidneys may have increased susceptibility to the toxicity of excessive exposures.

ETHANOL
Toxic effects described in animals include effects on the liver, reproductive system, and cardiovascular system along with CNS depression.

ECOLOGICAL INFORMATION

Ecotoxicological Information

AQUATIC TOXICITY
For the active ingredient Bromacil:

96 hr LC50 Rainbow trout	:	36 mg/L
96 hr LC50 Bluegill sunfish	:	127 mg/L
96 hr LC50 Fathead minnows	:	182 mg/L

AVIAN TOXICITY

For the active ingredient Bromacil:

Acute Oral LD50 Bobwhite quail	:	2250 mg/kg
Subacute Dietary LC50 Mallard duck	:	>10,000 ppm
Subacute Dietary LC50 Bobwhite quail	:	>10,000 ppm

DISPOSAL CONSIDERATIONS

Waste Disposal

Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations. Do not flush to surface water or sanitary sewer system.

Do not contaminate water, food, or feed by disposal. Waste resulting from the use of this product may be disposed of on the site or at an approved waste disposal facility.

ENVIRONMENTAL HAZARDS:
Do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

Container Disposal

Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

TRANSPORTATION INFORMATION

Shipping Information

DOT
Proper Shipping Name: Not regulated for domestic non-bulk shipments*

IMO/IATA
Proper Shipping Name: Flammable liquid, n.o.s., (Ethanol, Methanol)
Hazard Class : 3
UN No. : UN 1993
Special Information : Flashpoint 44 DEG C (for ocean transport only)
Packing Group : III

*For Domestic Bulk Shipments:
Proper shipping name: Combustible liquid, n.o.s., (Ethanol, Methanol)
NA No. : NA 1993
Packing Group : III

REGULATORY INFORMATION

U.S. Federal Regulations

TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

Acute : Yes
Chronic : Yes
Fire : Yes
Reactivity : No
Pressure : No

In the United States this product is regulated by the US Environmental Protection Agency under the Federal Insecticide, Fungicide and Rodenticide Act. It is a violation of federal law to use this product in a manner inconsistent with its labeling.

EPA Reg. No. 352-346

ADDITIONAL REGULATORY INFORMATION

SARA/CERCLA Reportable Quantity:
Methyl alcohol (5,000 lb)

******ATTENTION******

CALIFORNIA PROPOSITION 65

THIS PRODUCT CONTAINS LITHIUM SALT OF BROMACIL
WHICH IS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE
DEVELOPMENTAL EFFECTS AND MALE REPRODUCTION EFFECTS.

OTHER INFORMATION

NFPA, NPCA-HMIS

NFPA Rating
Health : 1
Flammability : 2
Reactivity : 0

NPCA-HMIS Rating
Health : 1
Flammability : 2
Reactivity : 0

(Continued)

Personal Protection rating to be supplied by user depending on use conditions.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : DuPont Crop Protection
Address : Wilmington, Delaware 19898
Telephone : 1-888-638-7668

# Indicates updated section.

MATERIAL SAFETY DATA SHEET

Douglas Products and Packaging Co.
1550 E. Old 210 Highway
Liberty, Mo. 64068
Phone :(816)-781-4250
Fax: (816)-781-1043

Manufacturer's Name:
Douglas Products and Packaging Co.
1550 E. Old 210 Highway
Liberty, MO. 64068

Emergency Telephone No.
1-800-424-9300 (Chemtrec)
Day Telephone: 1-816-781-4250
Night Telephone: 1-816-781-4650

SECTION I- GENERAL INFORMATION

Trade Name: Pyrethrin 5
EPA Registration No: 1015-67

The Chem Trec number is used only in the event of chemical emergencies involving a spill, leak. Fire, exposure, or accident involving chemicals.

SECTION II-INGREDIENTS

Labels

Material or Component	Cas#	%	Osha Pel	TLV	Hazard Data
Petroleum Distillate	647-42-95-6	96.83	-/-	100 ppm	-
*Piperonyl Butoxide, Technical	00051-03-6	01.00	-/-	-	-
Pyrethrins	08003-34-7	00.50	-/-	5 mg/m3	-

*Equivalent to 1.11% (Butylcarbityl) (6-Propylpiperonyl) Ether and 0.28% related compound.

HMIS: Health-2 Flammability-2 Reactivity-1 Personal Protection-B

SECTION III-PHYSICAL DATA

Physical properties	Liquid
Appearance	Straw Colored
Odor	N/A
Boiling Point	403 degrees F. to 509 degrees F.
Specific gravity	.8127
Vapor density	N/A
Melting point	N/A
Vapor pressure	N/A
Evaporation rate	1/430
Soluble in water	Negligible

SECTION IV- FIRE DATA

Flashpoint: 150 Degrees F
Flammable Limits: LOWER-N/A UPPER N/A
Extinguishing Media: NFPA Class B extinguisher CO2, Dry Chemical or Foam (For liquid fires)
Fire Fighting Techniques: None

Unusual fire and explosion hazards: Product will burn at elevated temperatures, keep away from heat and open flame.

SECTION V-REACTIVITY DATA

Heat and open flames are conditions that contribute to instability. Strong oxidizers such as permanganate are incompatible with product. Will produce carbon monoxide from burning. Conditions contributing to hazardous polymerization: N/A

SECTION VI-HEALTH HAZARD DATA

Principal Routes of Entry are inhalation and contact with skin.

Inhalation:	Acute toxicity LC (50) = 8.53 mg/L in air for 4 hours.
Skin:	N/A
Eye:	N/A
Ingestion:	Acute toxicity LD (50) = g/kg for rats
Effects of Exposure:	Irritation to skin, eyes, mucosa, hyperexcitability, uncoordination, chronic, convulsions and diarrhea.

SECTION VII- EMERGENCY PROCEDURES

Eye contact:	Flush with water thoroughly
Skin contact:	Wash with soap and water
Inhalation:	Remove patient to fresh air
Indigestion:	Call physician immediately. Do not induce vomiting, Antidote for cholinesterase inhibition antrophine

CARCINOGINICITY: **NPT: NO** **IARC: NO** **OSHA: NO**

SECTION VIII-SPILL OR LEAK PROCEDURES

Remove all sources of ignition, ventilate area, and soak up spillage with absorbent materials such as sawdust.

To dispose incinerate and dispose of empty containers according to local regulations. Do not incinerate in closed containers, avoid breathing vapors, do not bury waste close to water sources.

SECTION IX-SPECIAL PROTECTION INFORMATION

Eye Protection:	Safety glasses recommended
Ventilation Requirements:	Local exhaust is preferable, can use mechanical
Respiratory Protection:	None required if adequate ventilation
Skin Protection:	Solvent resistant gloves
Other:	None

SECTION X-SPECIAL PRECAUTIONS

Special Precautions/Storage

*Wash thoroughly after handling and before eating and smoking.

*****Do not store above 120 degrees F., Combustible, keep away from heat and open flame, do not store **i**n open or unlabeled containers.

The information presented herein for consideration, while not guaranteed, is true and accurate to the best of our knowledge. No warranty, or guaranty is expressed or implied regarding the accuracy or reliability of such information and we shall not be liable for any loss or consequential damages arising out of the use thereof.

Revised 5-31-07

MATERIAL SAFETY DATA SHEET

Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

Effective Date: 11/15/99
Product Code: 75068
MSDS: 006667

SPIKE* 80 DF HERBICIDE

1. PRODUCT AND COMPANY IDENTIFICATION:

PRODUCT: Spike* 80 DF Herbicide

COMPANY IDENTIFICATION:
Dow AgroSciences
9330 Zionsville Road
Indianapolis, IN 46268-1189

2. COMPOSITION/INFORMATION ON INGREDIENTS:

Tebuthiuron: N-(5-(1,1-Dimethylethyl)-1,3,4-thiadiazol-2-yl)-N,N'-dimethylurea	CAS # 034014-18-1	80%
Other Ingredients, Total		20%

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

3. HAZARDOUS IDENTIFICATIONS:

EMERGENCY OVERVIEW
Hazardous Chemical. Tan solid granule with a mild odor. May cause eye irritation with corneal injury. LD_{50} for skin absorption in rabbits is >2000 mg/kg. Oral LD_{50} for rats is 488 mg/kg. Inhalation LC_{50} for rats is >4.84 mg/L for 4 hours (particulate aerosol).
EMERGENCY PHONE NUMBER: 800-992-5994

POTENTIAL HEALTH EFFECTS: This section includes possible adverse effects, which could occur if this material is not handled in the recommended manner.

EYE: May cause moderate eye irritation with corneal injury.

SKIN: Essentially non-irritating to skin. A single prolonged exposure is not likely to result in the material being absorbed through skin in harmful amounts. The LD_{50} for skin absorption in rabbits is >2000 mg/kg. Did not cause allergic skin reactions when tested in guinea pigs.

INGESTION:. Single dose oral toxicity is moderate. Small amounts swallowed incidental to normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause serious injury, even death. The oral LD_{50} for rats is 488 mg/kg.

INHALATION: Single exposure to dust is not likely to be hazardous. The LC_{50} for rats is 4.84 mg/l for 4 hours (particulate aerosol).

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: Effects have been reported in the following organs: blood, kidney, and pancreas.

CANCER INFORMATION: Tebuthiuron did not cause cancer in laboratory animals.

TERATOLOGY (BIRTH DEFECTS): Birth defects are unlikely. Exposures having no adverse effects on the mother should have no effect on the fetus.

REPRODUCTIVE EFFECTS: Tebuthiuron did not interfere with reproduction in animal studies.

4. FIRST AID:

EYES: Irrigate with flowing water immediately and continuously for 15 minutes. Consult medical personnel.

SKIN: Wash off in flowing water or shower.

INGESTION: If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Consult medical personnel.

INHALATION: Remove to fresh air if effects occur. Consult a physician.

NOTE TO PHYSICIAN: No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

5. FIRE FIGHTING MEASURES:

FLASH POINT: Not applicable
METHOD USED: Not applicable

FLAMMABLE LIMITS
LFL: Not applicable
UFL: Not applicable

EXTINGUISHING MEDIA: Use water fog, foam, or CO_2 if product is involved in a fire.

FIRE AND EXPLOSION HAZARDS: Will emit toxic fumes when heated to decomposition.

FIRE-FIGHTING EQUIPMENT: Wear positive-pressure, self-contained breathing apparatus and full protective clothing.

6. ACCIDENTAL RELEASE MEASURES:

ACTION TO TAKE FOR SPILLS: Contain and sweep up material of small spills and dispose of waste. Report large spills to Dow AgroSciences at 800-992-5994. Prevent runoff.

7. HANDLING AND STORAGE:

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Keep out of reach of children. May be fatal if swallowed. Causes eye irritation. Harmful if absorbed through the skin. Avoid breathing dust or spray mist and contact with skin, eyes or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco. Wash exposed clothing before reuse. Store in original container in a dry area.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION:

These precautions are suggested for conditions where a potential for exposure exists. Emergency conditions may require additional precautions.

EXPOSURE GUIDELINES: None established.

ENGINEERING CONTROLS: Good general ventilation should be sufficient for most conditions. Local exhaust ventilation may be necessary for some operations.

RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS.

RESPIRATORY PROTECTION: In dusty atmospheres, use a NIOSH approved respirator for dust.

SKIN PROTECTION: No precautions other than clean body-covering clothing should be needed.

EYE/FACE PROTECTION: Use chemical goggles.

APPLICATORS AND ALL OTHER HANDLERS: Please refer to the product label for personal protective clothing and equipment.

9. PHYSICAL AND CHEMICAL PROPERTIES:

BOILING POINT: Not Determined
VAPOR PRESSURE: Not Determined
BULK DENSITY: 25-45 lb/cu. ft.
SOLUBILITY IN WATER: Not Determined
SPECIFIC GRAVITY: Not Determined
APPEARANCE: Tan solid granule
ODOR: Mild
pH: 5 - 8.5 (1% Aqueous)

10. STABILITY AND REACTIVITY:

STABILITY: (CONDITIONS TO AVOID) Stable under normal storage conditions.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) None known.

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of nitrogen and sulfur may be formed if product is involved in fire.

HAZARDOUS POLYMERIZATION: Not known to occur.

11. TOXICOLOGICAL INFORMATION:

MUTAGENICITY: For tebuthiuron, in-vitro mutagenicity studies were negative in some cases and positive in other cases. Animal mutagenicity studies were negative.

*Trademark of Dow AgroSciences

MATERIAL SAFETY DATA SHEET

Dow AgroSciences

Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

Effective Date: 11/15/99
Product Code: 75068
MSDS: 006667

SPIKE* 80 DF HERBICIDE

12. ECOLOGICAL INFORMATION:

ENVIRONMENTAL FATE:

MOVEMENT & PARTITIONING: Based largely or completely on information for tebuthiuron. Bioconcentration potential is low (BCF <100 or Log Pow <3).

DEGRADATION & PERSISTENCE: No relevant information found.

ECOTOXICOLOGY: Based largely or completely on information for tebuthiuron. Maximum acceptable toxicant concentration (MATC) in water flea (Daphnia magna) is 31.4 mg/L. Maximum acceptable toxicant concentration (MATC) in fathead minnow (Pimephales promelas) is 12.94 mg/L.

13. DISPOSAL CONSIDERATIONS:

DISPOSAL METHOD: Do not contaminate water, food or feed by storage or disposal. Open dumping is prohibited. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility in accordance with all Federal, State, and local regulations.

14. TRANSPORT INFORMATION:

For DOT regulatory information, if required, consult transportation regulations, product shipping papers, or consult your Dow AgroSciences representative.

15. REGULATORY INFORMATION:

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.

U.S. REGULATIONS

SARA 313 INFORMATION: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

CHEMICAL NAME	CAS NUMBER	CONCENTRATION
TEBUTHIURON	034014-18-1	80%

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An immediate health hazard
A delayed health hazard

TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

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MATERIAL SAFETY DATA SHEET

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SPIKE* 80 DF HERBICIDE

STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in the composition section of the MSDS.

CHEMICAL NAME	CAS NUMBER	LIST
Proprietary Ingredient	Proprietary	PA1
Tebuthiuron	034014-18-1	NJ2

NJ2=New Jersey Environmental Hazardous Substance (present at greater than or equal to 1.0%).
PA1=Pennsylvania Hazardous Substance (present at greater than or equal to 1.0%).

OSHA HAZARD COMMUNICATION STANDARD: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

16. OTHER INFORMATION:

MSDS STATUS: New
Reference: DR-0362-8806
Document Code: D03-094-001

The Information Herein Is Given In Good Faith, But No Warranty, Express Or Implied, Is Made. Consult Dow AgroSciences For Further Information.

*Trademark of Dow AgroSciences

1801 Morgan Street
Rockford, IL 61102
Phone: (815) 968-9661
Fax: (815) 968-9731
www.gcelectronics.com

MSDS Number: 112
Revision Date: 4/20/2012
Supersedes Date: 05/04/2009

MATERIAL SAFETY DATA SHEET

Complies with OSHA Hazard Communication Standard 29 CFR 1910.1200

Product Name: LIQUID SOLDER FLUX

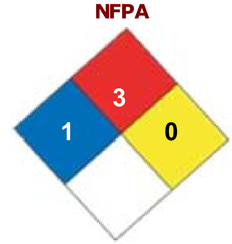
SECTION 1- PRODUCT AND COMPANY IDENTIFICATION

Product Type: Solder Flux
Product Name: **LIQUID SOLDER FLUX**
Part Number(s): 10-4202
10-4216

Emergency Contact: Chemtrec
Phone: (800) 424-9300

Common Name: Liquid Solder Flux
Chemical Name: Rosin Solder Flux
Family Usage: Soldering Flux for Electrical or Electronic Applications
Description: Mixture of the substances listed below with non-hazardous additions.
GHS Class: Highly Flammable liquid and vapour

NFPA



This product has to be labeled due to the calculation procedure of international guidelines. Has a narcotizing effect. Highly flammable. Irritating to eyes. May cause sensitization by skin contact. Vapors may cause drowsiness and dizziness.

Least	0
Slight	1
Moderate	2
High	3
Extreme	4
Gloves, Safety Glasses	B

HMIS

Health Hazard	1
Fire Hazard	3
Reactivity	0
Personal Protection	x

* Chronic Health Effects

Information pertaining to particular dangers for man and environment:

Personal Protective Equipment


Chemical Splash Goggles


Safety Glasses


Protective Gloves

WHMIS Pictograms


Flammable


D2B Toxic

GHS Pictograms


Highly flammable liquid and vapour

DOT Pictograms

Flammable Liquid

MATERIAL SAFETY DATA SHEET

Product Name: LIQUID SOLDER FLUX

SECTION 2 - COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Ingredient Percent	EC Num.
Gum rosin	8050-09-7	30 - 60 by weight	
Isopropyl alcohol	67-63-0	30 - 60 by weight	

SECTION 3 - HAZARDS IDENTIFICATION

Emergency Overview:	DANGER! Flammable. Potential Sensitizer Flux fumes during soldering may cause irritation and damage of mucous membranes and respiratory system.
Route of Exposure:	Eyes. Skin. Inhalation. Ingestion.
Eye:	Eye contact with product or vapors may result in irritation, redness, and blurred vision. Smoke during soldering can cause eye irritation.
Skin:	May cause irritation. May cause skin sensitization, an allergic reaction, which becomes evident on reexposure to this material.
Inhalation:	Inhalation of vapors, fumes or mists of the product may be irritating to the respiratory system. May cause respiratory sensitization with asthma-like symptoms in susceptible individuals.
Ingestion:	May be harmful if swallowed. May cause vomiting.
Chronic Health Effects:	Prolonged or repeated contact may cause skin irritation. Repeated or prolonged inhalation may cause toxic effects.
Signs/Symptoms:	Overexposure may cause headaches and dizziness.
Target Organs:	Eyes. Skin. Respiratory system. Digestive system.
Aggravation of Pre-Existing Conditions:	None generally recognized.

SECTION 4 - FIRST AID MEASURES

Eye Contact:	Immediately flush eyes with plenty of water for 15 to 20 minutes. Get medical attention, if irritation or symptoms of overexposure persists.
Skin Contact:	Immediately wash skin with soap and plenty of water. Get medical attention if irritation develops or persists.
Inhalation:	If inhaled, remove to fresh air. If not breathing, give artificial respiration or give oxygen by trained personnel. Seek immediate medical attention.
Ingestion:	If swallowed, do NOT induce vomiting. Call a physician or poison control center immediately. Never give anything by mouth to an unconscious person.

1801 Morgan Street
Rockford, IL 61102
Phone: (815) 968-9661
Fax: (815) 968-9731
www.gcelectronics.com

MATERIAL SAFETY DATA SHEET

Product Name: LIQUID SOLDER FLUX

SECTION 5 - FIRE FIGHTING MEASURES

Flash Point:	18 °C (64 °F)
Auto Ignition Temperature:	425.0 °C (797 °F)
Lower Flammable/Explosive Limit:	2.0 % by volume
Upper Flammable/Explosive Limit:	12.0 % by volume
Extinguishing Media:	Use alcohol resistant foam, carbon dioxide, dry chemical, or water fog or spray when fighting fires involving this material.
Unsuitable Media:	Do not use a solid water stream as it may scatter and spread fire.
Protective Equipment:	As in any fire, wear Self-Contained Breathing Apparatus (SCBA), MSHA/NIOSH (approved or equivalent) and full protective gear.
Hazardous Combustion Byproducts:	Oxides of carbon, oxides of nitrogen, aliphatic aldehydes, and other organic substances may be formed during combustion..

NFPA Ratings:

NFPA Health:	1
NFPA Flammability:	3
NFPA Reactivity:	0

SECTION 6 - ACCIDENTAL RELEASE MEASURES

Personnel Precautions:	Evacuate area and keep unnecessary and unprotected personnel from entering the spill area. Avoid breathing vapor, aerosol or mist. Avoid contact with skin, eyes and clothing.
Environmental Precautions:	Avoid runoff into storm sewers, ditches, and waterways.
Methods for containment:	Contain spills with an inert absorbent material such as soil, sand or oil dry.
Methods for cleanup:	Remove all sources of ignition. Absorb spill with inert material (e.g., dry sand or earth), then place in a chemical waste container. Provide ventilation. Collect spill with a non-sparking tool. Place into a suitable container for disposal.

1801 Morgan Street
Rockford, IL 61102
Phone: (815) 968-9661
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MATERIAL SAFETY DATA SHEET

Product Name: LIQUID SOLDER FLUX

SECTION 7 - HANDLING and STORAGE

Handling:	Use with adequate ventilation. Avoid breathing vapor and fumes. Use only in accordance with directions. To reduce potential for static discharge, bond and ground containers when transferring material.
Storage:	Store in a cool, dry, well ventilated area away from sources of heat, combustible materials, direct sunlight, and incompatible substances. Keep container tightly closed when not in use.
Special Handling Procedures:	DANGER! Rags, steel wool and waste soaked with this product may spontaneously catch fire if improperly discarded or stored. To avoid a spontaneous combustion fire, immediately after use, place rags, steel wool or waste in a sealed, water-filled, metal container.
Hygiene Practices:	Wash thoroughly after handling. Avoid inhaling vapors, mists, or fumes.

SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION - EXPOSURE GUIDELINES

Engineering Controls:	Use appropriate engineering control such as process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Where such systems are not effective wear suitable personal protective equipment, which performs satisfactorily and meets OSHA or other recognized standards. Consult with local procedures for selection, training, inspection and maintenance of the personal protective equipment.
Eye/Face Protection:	Tightly fitting safety goggles. Wear a face shield also when splash hazards exist
Hand Protection Description:	Wear appropriate protective gloves. Consult glove manufacturer's data for permeability data. Nitrile rubber or natural rubber gloves are recommended.
Respiratory Protection:	A NIOSH approved air-purifying respirator with an organic vapor cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air purifying respirators is limited. Use a positive pressure air supplied respirator if there is any potential for an uncontrolled release, exposure levels are not known, or any other circumstances where air purifying respirators may not provide adequate protection.
Other Protective:	Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower.

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MATERIAL SAFETY DATA SHEET

Product Name: LIQUID SOLDER FLUX

SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION - EXPOSURE GUIDELINES (CONTINUED)

Gum rosin :

Guideline ACGIH:	Sensitizer.: Sen

Isopropyl alcohol :

Guideline ACGIH:	TLV-STEL: 400 ppm TLV-STEL: 400 ppm
Guideline OSHA:	PEL-TWA: 400 ppm

SECTION 9 - PHYSICAL and CHEMICAL PROPERTIES

Physical State Appearance:	Liquid.
Color:	Amber
Odor:	Alcohol-like
Boiling Point:	82 °C (180 °F)
Melting Point:	Not determined.
Density:	0.880 g/cm³ @ 20°C (68°F)
Vapor Pressure:	33 mmHg @ 20°C (68°F)
Flash Point:	18 °C (64 °F)
Auto Ignition Temperature:	425.0 °C (797 °F)

SECTION 10 - STABILITY and REACTIVITY

Chemical Stability:	Stable under normal temperatures and pressures.
Hazardous Polymerization:	Not reported.
Conditions to Avoid:	Keep away from heat, ignition sources and incompatible materials.
Incompatible Materials:	Oxidizing agents. Strong acids and alkalis.
Special Decomposition Products:	When heated to soldering temperatures, the solvents are evaporated and rosin may be thermally degraded to liberate aliphatic aldehydes and acids.

SECTION 11 - TOXICOLOGICAL INFORMATION

Gum rosin :

RTECS Number:	VL0480000
Inhalation:	Inhalation. - Rat LC50: 110 mg/m3 [Behavioral - somnolence (general depressed activity) Cardiac - pulse rate Lungs, Thorax, or Respiration - respiratory depression] (RTECS)
Ingestion:	Oral - Mouse LD50: 2.2 mg/kg [Behavioral - somnolence (general depressed activity) Cardiac - pulse rate Lungs, Thorax, or Respiration - respiratory depression] Oral - Rat LD50: 3.0 mg/kg [Brain and Coverings - other degenerative changes Liver - other changes Biochemical - Metabolism (Intermediary) - other] (RTECS)

Isopropyl alcohol :

RTECS Number:	NT8050000
Eye:	Eye - Rabbit Standard Draize test: 100 mg Eye - Rabbit Standard Draize test: 10 mg Eye - Rabbit Standard Draize test: 100 mg/24H (RTECS)
Skin:	Administration onto the skin - Rabbit Standard Draize test: 500 mg Administration onto the skin - Rabbit LD50: 12800 mg/kg [Details of toxic effects not reported other than lethal dose value.] (RTECS)
Inhalation:	Inhalation. - Rat LC50: 16000 ppm/8H [Details of toxic effects not reported other than lethal dose value.] Inhalation. - Mouse LC50: 53000 mg/m3 [Behavioral - general anesthetic Lungs, Thorax, or Respiration - other changes] Inhalation. - Rat LC50: 72600 mg/m3 [Behavioral - general anesthetic Lungs, Thorax, or Respiration - other changes] (RTECS)
Ingestion:	Oral - Rat LD50: 5045 mg/kg [Behavioral - altered sleep time (including change in righting reflex) Behavioral - somnolence (general depressed activity)] Oral - Mouse LD50: 3600 mg/kg [Behavioral - altered sleep time (including change in righting reflex) Behavioral - somnolence (general depressed activity)] Oral - Mouse LD50: 3600 mg/kg [Behavioral - general anesthetic] Oral - Rat LD50: 5000 mg/kg [Behavioral - general anesthetic] (RTECS)

SECTION 12 - ECOLOGICAL INFORMATION

Ecotoxicity:	No ecotoxicity data was found for the product.
Environmental Fate:	No environmental information found for this product.

SECTION 13 - DISPOSAL CONSIDERATIONS

Waste Disposal:	Consult with the US EPA Guidelines listed in 40 CFR Part 261.3 for the classifications of hazardous waste prior to disposal. Furthermore, consult with your state and local waste requirements or guidelines, if applicable, to ensure compliance. Arrange disposal in accordance to the EPA and/or state and local guidelines.

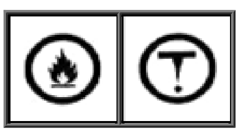
SECTION 14 - TRANSPORT INFORMATION

DOT Shipping Name:	Isopropanol, mixture
DOT UN Number:	UN1219
DOT Hazard Class:	3
DOT Packing Group:	II
Label:	3 Flammable Liquids
Description:	Soldering Flux
IATA Shipping Name:	Isopropanol, mixture
IATA UN Number:	UN1219
IATA Hazard Class:	3
IATA Packing Group:	II
IMDG UN NUmber :	UN1219
IMDG Shipping Name :	Isopropanol, mixture
IMDG Hazard Class :	3
IMDG Packing Group :	II
RID UN Number :	UN1219
RID Shipping Name :	Isopropanol, mixture
RID Hazard Class :	3
RID Packing Group :	II

SECTION 15 - REGULATORY INFORMATION

Canada Reg. Status:	This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by the Controlled Products Regulations.
Canada WHMIS:	Controlled - Class: B2 Flammable Liquid Controlled - Class: D2B Toxic
Gum rosin :	
TSCA Inventory Status:	Listed
Canada DSL:	Listed
Isopropyl alcohol :	
TSCA Inventory Status:	Listed
Canada DSL:	Listed

WHMIS Pictograms



SECTION 16 - ADDITIONAL INFORMATION

GC Electronics believes that the information contained herein is accurate and reliable as of the date of this material safety data sheet, but no representation guarantee or warranty, express or implied, is made as to the accuracy, reliability or completeness of the information. Persons receiving information are encouraged to make their own determination as to the information's suitability and completeness for their particular application.
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Product Name: Liquid Solder Flux
MSDS Number: 112
Revision Date: 5/04/09
Supersedes Date: 8/16/06

MATERIAL SAFETY DATA SHEET

Complies with OSHA Hazard Communication Standard 29 CFR 1910.1200

Product Type:	Solder Flux		
Product Name:	**Liquid Solder Flux**		
Part Number(s):	**10-4202**	**Emergency Contact:**	**Chemtrec**
	10-4216	**Phone:**	**(800) 424-9300**

Section 1 – Identification of Product

Common Name: Liquid Solder Flux
Chemical Name: Rosin Solder Flux
Family Usage: Soldering Flux for Electrical or Electronic Applications
Description: Mixture of the substances listed below with non-hazardous additions.

HMIS RATINGS		NFPA RATINGS			
				Least	0
				Slight	1
Health	1	Health	1	Moderate	2
Flammability	3	Flammability	3	High	3
Reactivity	0	Reactivity	0	Extreme	4
Personal Protection	5			Gloves, Safety Glasses	B

Information pertaining to particular dangers
for man and environment:


This product has to be labeled due to the calculation procedure of international guidelines. Has a narcotizing effect. Highly flammable. Irritating to eyes. May cause sensitization by skin contact. Vapors may cause drowsiness and dizziness.

Section 2 – Hazardous Ingredients/SARA III Information

Hazardous Ingredients 1% or greater Carcinogens 0.1% or greater	C.A.S. NUMBER	WEIGHT PERCENT	OSHA PEL	SHORT TERM REL	LONG TERM REL	ACGIH TLV SHORT TERM	ACGIH TLV LONG TERM
Propan-2-ol*	67-63-0	50-100	980 mg/m3 400 ppm	1225 mg/m3 500 ppm	980 mg/m3 400 ppm	1230 mg/m3 500 ppm	983 mg/m3 400 ppm
Rosin (Colophony)	8050-09-7	25-50	NE	NE	NE		

Notes: *Chemical subject to the reporting requirements of Section 313 of Title III of the U.S.A. Superfund Amendment and Reauthorization Act (SARA) of 1986 and 40 CFR Part 372.

Section 3 – Physical Data

Physical State at 20°C:	Liquid
Density at 20°C (68°F):	0.880 g/cm^3
Boiling Point (760 mm Hg):	180°F 82°C
Melting Point:	Undetermined
Vapor Pressure (mm Hg at 20°C):	33
Solubility in /Miscibility w/Water :	Partly miscible
Flash Point:	64°F (18°C)
Ignition Temperature:	797°F (425/0°C
Odor Threshold:	200 ppm for 2-propanol
Appearance and Odor:	Amber, liquid with alcohol odor

Section 4 – Fire and Explosion Hazards

Flammability:	Yes
Conditions to Avoid:	Sparks, open flames
Flash Point (T.O.C.):	65°F 18°C
Auto-Ignition Temperature:	750°F 399°C
Flammability Limits Percent by Volume in Air:	LEL: 2.0 UEL: 12.0
Extinguishing Means:	CO2, sand, extinguishing powder. Do not use water.
Hazardous Combustion Products:	Carbon monoxide, carbon dioxide, aliphatic aldehydes.
Danger of Explosion:	Product is not explosive. However, formation of explosive air/vapor mixtures are possible.
Explosion Limits:	
Lower:	2.0 Vol %
Upper:	12.0 Vol %
Unusual Fire and Explosion Hazards:	A moderate explosion hazard exists when exposed to heat or flames.
For safety reasons unsuitable extinguishing Agents:	Water with full jet
In case of fire, the following can be Released:	Carbon monoxide (CO), carbon dioxide (CO2), aliphatic aldehydes
Protective equipment:	Wear self-contained respiratory protective device.

Section 5– Health Hazard Data

Emergency Overview:

Fumes during soldering are irritating to eyes and may cause headache and respiratory system irritation or damage. Prolonged or repeated exposure to rosin flux fumes during soldering may result in allergic reaction in a sensitive person, resulting in asthma symptoms. Harmful if swallowed. May cause allergic skin reaction. Flammable liquid and vapor.

ECC (Europe) Dangerous Substance Hazard Designation:	R-Phrases (Risks to Humans and the Environment): R11-Highly flammable. F=Easily Flammable R20/22-Harmful by inhalation and if swallowed. R42/43-May cause sensitization by inhalation and skin contact.
Exposure Limits:	Not determined for the product. See Section 2 for ingredients.
Primary Exposure:	Fumes during soldering will contain evaporated solvent and droplets of rosin and/or organic decomposition products.
Primary Routes of Entry:	__ Skin X Eyes X Inhalation X Ingestion
Target Organs:	Eyes, skin, mucous membranes and respiratory system.

Effects of Acute (severe short-term) Exposure:

Inhalation:	Flux fumes during soldering may cause irritation and damage of mucous membranes and respiratory system. High concentrations can cause headache, dizziness, narcosis and nausea.
Skin Contact:	Possible local irritation by contact with flux or fumes.
Skin Absorption:	None
Eye Contact:	Irritation from contact with liquid and smoke from soldering.
Ingestion:	May exhibit burning sensation in the digestive tract.

Effects of Chronic (prolonged) Exposure

Inhalation:	Vapors can cause headache, dizziness, narcosis and irritation of the mucous membranes. Smoke during soldering will contain resin which is an allergen that can cause eye irritation and respiratory system irritation and damage.
Skin Contact:	Prolonged or repeated contact with skin can cause a rash.
Medical Conditions Generally Aggravated by Exposure:	Chemical hypersensitivity, asthma and other respiratory conditions, existing eye and skin disorders. Continued breathing of high concentrations of solvent vapors can affect the liver and central nervous system.

First Aid Measures

Seek medical assistance for further treatment, observation and support if needed.

Eye Contact:	Rinse opened eye for several minutes under running water. If symptoms persist, consult a doctor..
Skin Contact:	Immediately wash with water and soap and rinse thoroughly.
Inhalation:	Remove person from exposure to fumes. Supply fresh air. Consult a doctor in case of complaints.
Ingestion:	Induce vomiting if person is conscious. Seek medical help.

Section 6–Reactivity Data

Chemical Stability:	X Stable __ Unstable
Conditions to Avoid:	
Thermal Decomposition:	No decomposition if used according to specifications.
Incompatibility (materials to avoid):	Strong oxidizing materials. Strong acids.
Hazardous Decomposition Products:	When heated to soldering temperatures, the solvents are evaporated and rosin may be thermally degraded to liberate aliphatic aldehydes and acids.
Hazardous Polymerization:	__ May Occur X Will Not Occur
Dangerous Reactions:	No dangerous reactions known.
Dangerous Products of Decomposition:	When heated to soldering temperatures, the solvents are evaporated and rosin may be thermally degraded to liberate alphatic aldehydes and acids.

Section 7-Spill or Leak Procedures

Procedures for Material Control

Steps to be Taken if Material is Spilled or Released:	Ensure adequate ventilation. Keep away from ignition sources. Use caution to avoid breathing fumes.
Measures for environmental Protection	Do not allow product to reach sewage system or any water course.:Prevent runoff into storm sewers and natural waterways.
Measures for cleaning/ collecting:	Absorb with clay, diatomaceous earth, dry sand or other inert material. Do not use combustible materials such as sawdust. Place in a chemical waste container. Keep out of waterways. Harmful to fish and other water organisms. Biodegradation is expected in a waste treatment plant. Emissions are photochemically reactive.
Waste Disposal Methods:	According to local regulations, usually by incineration. EPA Hazardous Waste Number is D001. Hazard Class is Ignitable Waste.
Caution:	Empty containers may contain product residue. Observe all label precautions
Ecological Information:	
General Notes:	Do not allow product to reach ground water, water course or sewage system.
Product Recommendation:	Must not be disposed of together with household garbage. Do not allow product to reach sewage system.
Uncleaned Packagings:	
Recommendation:	Disposal must be made according to official regulations.

Section 8 – Special Protection Information

Personal Protective Equipment General Protective & Hygienic Measures:	Keep away from foodstuffs, beverages and feed. Immediately remove all soiled and contaminated clothing. Wash hands before breaks and at the end of work. Avoid contact with the eyes and skin.
Ventilation to be used:	Provide adequate exhaust ventilation (general and/or local) if necessary to meet exposure requirements. Local exhaust ventilation is preferred to minimize dispersion of smoke and fumes into the work area.
Respiratory Protection:	When ventilation is not sufficient to remove fumes from the breathing zone, a NIOSH approved respirator or self-contained breathing apparatus should be worn.
Protective Gloves:	Nitrile or natural rubber gloves where necessary to avoid skin contact. The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.
Eye Protection:	Safety glasses or tightly sealed goggles should be used.
Other Protective Clothing and Equipment:	Impermeable apron is advised to avoid contact through clothing.
Hygienic Work Practices:	Wash hands thoroughly after handling chemicals or solder containing lead before eating or smoking.
Exposure Limits:	Not determined for the product. See section 2 for ingredients. Rosin is an allergen. Prolonged or repeated exposure to fumes during soldering may result in allergic reaction In a sensitive person, resulting in eye and skin irritation and asthma symptoms.

Section 9 – Special Precautions

Waste Disposal Methods:	According to local regulations, usually by incineration. EPA Hazardous Waste Number is D001. Hazard Class is Ignitable Waste.
Caution:	Empty containers may contain product residue. Observe all label precautions
Precautions to be taken in handling and storage:	Store in cool, dry conditions in well sealed receptacles. Store in a cool location. Store away from oxidizing agents. Store away from sources of ignition. Keep containers sealed when not in use. Open containers cautiously to allow venting of any internal pressure. Use grounding and bonding connection when transferring material to prevent static discharge, fire or explosion. Do not use a cutting torch or containers (even empty) as residual may explode.
Personal Precautions:	Avoid breathing smoke/fumes generated during soldering. Avoid contact with eyes and skin. Ensure good ventilation/exhaustion at the workplace.
Information about Protection Against Explosions and Fire:	Keep ignition sources away. Do not smoke. Protect against electrostatic charges.

Recommendation:	Must not be disposed of together with household garbage. Do not allow product to reach sewage system.

Section 10 – Regulatory Information

DOT Classification:	Isopropanol, mixture
Hazard Class:	3
UN #:	UN1219
Packing Group:	II
Label:	3
Description:	Soldering Flux

Land Transport ADR/RID (cross border):

ADR/RID Class:	3 Flammable Liquids
Danger Code (Kemler):	33
UN-Number:	1219
Packaging Group:	II
Description of Goods:	1219 Isopropanol, Mixture

Maritime Transport IMDG:

IMDG Class:	3
UN Number:	1219
Label:	3
Packaging Group:	II
EMS Number:	F-E,S-D
Marine Pollutant:	No
Proper Shipping Name:	Isopropanol, Mixture

Air Transport ICAO-TI and IATA-DGR:

ICAO/IATA Class:	3
UN/ID Number:	1219
Label:	3
Packaging Group:	II
Proper Shipping Name:	Isopropanol, Mixture

Toxicological Information:

Acute Toxicity:	Oral	LD50	5045 mg/kg (rat)
	Dermal	LD50	12800 mg/kg (rabbit)
	Inhalative	LC50/4 h	30 mg/l (rat)

Primary Irritant Effect:

Skin:	Possible local irritation by contact with flux or fumes.
Eye:	Smoke during soldering can cause eye irritation.

Inhalation:	Fumes during use may irritate mucous membranes and respiratory system. High concentrations can cause headache, dizziness, narcosis, and nausea. Flux fumes during soldering may cause irritation and damage of mucuous membranes and respiratory system.
Ingestion:	May cause gastrointestinal irritation.
Sensitization:	Sensitization possible through skin contact.
Additional Toxicological Information:	The product shows the following dangers according to internally approved calculation methods for preparations: Irritant
U.S.A.	All chemical substances in this product are listed in the EPA (Environmental Protection Agency) TSCA (Toxic Substances Control Act) Inventory.
California Proposition 65:	None
Carcinogenicity:	
67-63-0 Propanol-2-ol	
NTP	None
OSHA	None
IARC	None
TLV	None
NIOSH-Ca	None
Canada:	
WHMIS (Workplace Hazardous Materials Information System)	
Classification:	B2 D2B
Components on Ingredient List for WHMIS:	Rosin, Propan-2-ol

This product has been classified in accordance with the hazard criteria of the Canadian Controlled Product Regulations (CPR) and the MSDS contains all the information required by the CPR.

NA = Not Applicable NE = Not Established UN = Unknown

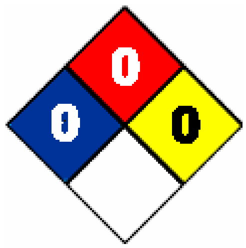
Hazard communication regulations, U.S.A. Occupational Safety and Health Act (OSHA) and Canada Workplace Hazardous Materials Information Systems (WHMIS), require that employees must be trained how to use a Material Safety Data Sheet as a source for Hazard information.

European Union:	The following information relates to product regulation specific to the directives of the European Union.
Europe: Dangerous Substance Hazard Classification:	European Council Directive 67/548/EEC F=Highly Flammable Xn=Harmful
R-Phrases (Risks to Humans or the Environment):	R11=Highly flammable. Irritating to eyes. R20/22=Harmful by inhalation and if swallowed. R42/43=May cause sensitization by skin contact. Vapors may cause drowsiness and dizziness.
S-Phrases (Safety pre-cautions for storing, handling and using the product):	Wear suitable gloves S2=Keep out of reach of children Avoid contact with skin and eyes. S7=Keep containers tightly closed. S16=Keep away from sources of ignition-No Smoking. S23=Do not breathe the fumes. S29=Do not empty into drains. Dispose of this material and its containers at hazardous or special waste collection points.

If swallowed, seek medical advise immediately and show this container or label.

Disclaimer

MATERIAL SAFETY DATA SHEET

Protective Clothing	NFPA Rating (USA)	EC Classification	WHMIS (Canada)	Transportation
Not required for normal use		Not Dangerous	Not Controlled	Not Regulated

Section 1: Product and Company Information

Product Name: Regular Soldering Flux Paste

Product Use: Soldering flux for copper, brass, galvanized iron, lead, zinc, tin, silver, nickel, mild steel, terne plate and malleable iron.

Manufacturer: LA-CO Industries, Inc.
1201 Pratt Boulevard
Elk Grove Village, IL.
60007-5746

Phone Number: (847) 956-7600

Fax: (847) 956-9885

24-hour Emergency: **CHEMTREC: (800) 424-9300**

Section 2: Composition and Ingredient Information

Hazardous/Dangerous Ingredients:

Chemical Name	CAS No.	Wt.%	EINECS / ELINCS	Symbol	Risk Phrases
Hydrochloric acid	7647-01-0	10 – 20	231-595-7	C, Xi	R34, R37
2-aminoethanol	141-43-5	7 – 13	205-483-3	Xn, C	R20/21/22; R34
Ammonium Chloride	12125-02-9	7 – 13	235-186-4	Xn, Xi	R22, R36
Stearic Acid	57-11-4	1 – 5	200-313-4	None	None

Note: See Section 8 of this MSDS for exposure limit data for these ingredients.
See Section 16 for the full text of the R-phrases above.

MATERIAL SAFETY DATA SHEET

Section 3: Hazards Identification

Preparation Hazards and Classification:

Normal use of this product is not expected to cause any harm or irritation to the user.

USA: This product is not a hazardous material as defined by 29 CFR1910.1200, OSHA Hazard Communication Evaluation.

Canada: This is not a controlled product under WHMIS.

European Communities (EC): This preparation is not classified as dangerous according to Directive 1999/45/EC and its amendments.

Appearance, Color and Odor: White colored paste

Primary Route(s) of Exposure: Inhalation, Ingestion

Potential Health Effects: **ACUTE (short term): see Section 8 for exposure controls**

Inhalation: Inhalation of vapors is not expected with normal use. Over exposure to high vapor concentrations may cause nasal and respiratory irritation, sore throat, coughing and difficulty breathing. High concentrations may also cause dizziness, headache, nausea, vomiting or in extreme cases, unconsciousness or asphyxiation.

Ingestion: Not an expected route of occupational exposure. Low oral toxicity. Ingestion of large quantities may cause abdominal and chest pain, nausea, vomiting, diarrhea or dizziness. Aspiration into the lungs may occur during ingestion of large quantities or vomiting, resulting in lung injury.

Skin: This product has been tested and found to be non-irritating to skin.

Eye: This product has been tested and found to be non-irritating to eyes. May be irritating as a foreign object in the eye.

CHRONIC (long term): see Section 11 for additional toxicological data

Chronic effects are not expected with normal use. Prolonged or repeated over exposure to high vapor concentrations may cause damage to the respiratory tract or lungs.

Medical Conditions Aggravated by Exposure: Not available

Section 4: First Aid Measures

Inhalation: No health effects expected. If symptoms are experienced remove source of contamination or move victim to fresh air and obtain medical advice.

Eye Contact: No health effects expected. If material becomes lodged in the eye, do not allow victim to rub eye(s). Let the eye(s) water naturally for a few minutes. Have victim look right and left, then up and down. If particle does not dislodge, flush with lukewarm, gently flowing water for 5 minutes or until removed, while holding eyelid(s) open. If irritation occurs, obtain medical attention. DO NOT attempt to manually remove anything stuck to the eye.

Skin Contact: No health effects expected. If irritation does occur, flush with lukewarm, gently flowing water for 5 minutes or until chemical is removed.

Ingestion: No health effects expected. If irritation or discomfort occurs, obtain medical advice.

MATERIAL SAFETY DATA SHEET

Section 5: Fire Fighting Measures

Extinguishing Media:	Use water spray, carbon dioxide, dry chemical powder or foam.
Unusual Fire and Explosion Hazards:	Sensitivity to mechanical impact: Not sensitive Sensitivity to static discharge: Not sensitive
Fire Fighting Instructions:	Self-contained breathing apparatus and protective clothing should be worn.
Hazardous Combustion Products:	Carbon dioxide, carbon monoxide, ammonia, hydrochloric acid fumes, smoke and irritating and toxic fumes may be formed.

Section 6: Accidental Release Measures

Personal Precautions:	Wear protective equipment. Keep unauthorized personnel away.
Environmental Precautions:	Do not allow product to reach sewage systems or ground water.
Methods for Containment:	Stop the spill if it is safe to do so. Contain spilled flux with earth, sand, or absorbent material which does not react with spilled material.
Methods for Clean-up:	Scrape or scoop up the spilled material. Put material in suitable, labeled container. Flush area with water.

Section 7: Handling and Storage

Handling	Avoid breathing fumes. Do not ingest. Keep away from children. Use this material with adequate ventilation. Keep container closed when not in use.
Storage:	Store in a cool, dry area. Keep containers tightly closed when not in use. Store away from incompatible materials

MATERIAL SAFETY DATA SHEET

Section 8: Exposure Controls and Personal Protection

Exposure Limits

Ingredient	ACGIH TLV (8-hr. TWA)	U.S. OSHA PEL (8-hr. TWA)	Ontario (Canada) TWAEV	UK OEL (8-hr. TWA)
Hydrochloric acid	2 ppm CEL	5 ppm (7 mg/m^3) CEL	2 ppm CEV	1 ppm (2 mg/m^3); 5 ppm (8 mg/m^3) STEL
2-aminoethanol	3 ppm 6 ppm STEL	3 ppm (6 mg/m^3)	3 ppm (7.5 mg/m^3); 6 ppm (15 mg/m^3) STEV	1 ppm (2.5 mg/m^3); 3 ppm (7.6 mg/m^3) STEL
Ammonium Chloride	10 mg/m^3 (fume); 20 mg/m^3 STEL	Not established	10 mg/m^3; 20 mg/m^3 STEV	10 mg/m^3 (fume); 20 mg/m^3 STEL
Stearic Acid	Not established	Not established	Not established	Not established

CEL = Ceiling Exposure Limit
CEV = Ceiling Exposure Value
STEV = Short Term Exposure Value
STEL = Short Term Exposure Limit

Exposure Controls

Engineering Controls: Provide adequate ventilation/local exhaust to keep vapor concentrations below the exposure limits listed above.

A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 or Canadian Standards Association (CSA) Standard Z94.4-93 must be followed whenever workplace conditions warrant a respirator's use.

Personal Protection:

Respiratory Protection: Not required for normal use.

Skin Protection: Not required for normal use. Wear appropriate protective gloves and clean, body-covering clothing, when workplace conditions warrant their use.

Eye Protection: Not required for normal use. Wear appropriate safety goggles, when workplace conditions warrant their use.

Other Protective Equipment: If used during welding, wear appropriate equipment required for welding operations.

Hygiene Measures: Avoid breathing fumes. Keep container tightly closed when not in use. Wash hands thoroughly after handling this material. Maintain good housekeeping.

MATERIAL SAFETY DATA SHEET

Section 9: Physical and Chemical Properties

Physical State:	Paste	**Vapor Pressure: (mm Hg @ 25°C)**	Not available
Appearance:	White	**Vapor Density: (Air = 1)**	Not available
pH:	6.5 – 7	**Solubility in Water:**	Water soluble Fat insoluble
Relative Density: (water = 1)	1.1	**Water / Oil distribution coefficient:**	Not available
Boiling Point:	Not available	**Odor Type:**	Low odor
Freezing Point:	Not available	**Odor Threshold:**	Not available
Viscosity:	Not available	**Evaporation Rate: (n-Butyl Acetate = 1)**	Not available
Oxidizing Properties:	Not available	**Auto Ignition Temperature (°C):**	Not available
Flash Point and Method:	>204°C (400°F) TOC	**Flammability Limits (%):**	Not available

Section 10: Stability and Reactivity

Stability: Stable at normal temperature

Conditions to Avoid: No known conditions to avoid.

Incompatible Materials: Incompatible with strong oxidizing agents, strong acids, bases, amines, carbonates, aldehydes, acid chlorides and anhydrides, aluminum, cellulose nitrate, cyanides, sulfides, and potassium chlorate.

Hazardous Decomposition Products: Products of incomplete combustion may include ammonia, carbon dioxide and dense smoke. Heat can cause evolution of gaseous hydrogen chloride.

Possibility of Hazardous Reactions: Not available

Other Reactivity Concerns: Not available

MATERIAL SAFETY DATA SHEET

Section 11: Toxicological Information

Acute Toxicity Data

Ingredient	LD_{50} Oral (mg/kg)	LD_{50} Dermal (mg/kg)	LC_{50} Inhalation (4 hrs.)
Hydrochloric acid	238 - 277 (female rat) 700 (rat)	> 5 010 (rabbit)	544 ppm (mouse) 1 562 ppm (rat)
2-aminoethanol	1 720 (rat)	1 000 (rabbit)	1 210 mg/m^3 (mouse)
Ammonium Chloride	1 300 (mouse) 1 650 (rat)	Not available	Not available
Stearic Acid	> 5 000 (rat)	> 5 000 (rabbit)	Not available

Chronic Toxicity Data

Carcinogenicity: The table below indicates whether each agency has listed any ingredient as a carcinogen.

Ingredient	ACGIH	IARC	NTP
Hydrochloric acid	A4	Group 3	Not listed
2-aminoethanol	Not listed	Not listed	Not listed
Ammonium Chloride	Not listed	Not listed	Not listed
Stearic Acid	Not listed	Not listed	Not listed

ACGIH: (American Conference of Governmental Industrial Hygienists)
A4 – Not Classifiable as a Human Carcinogen.
IARC: (International Agency for Research on Cancer)
Group 3 – The agent is not classifiable as to its carcinogenicity in humans.
NTP: (National Toxicology Program)

Other Toxicity Data: Regular Soldering Flux Paste Toxicity Data: LD_{50} Oral: > 5 gm/kg (rat)
(Tested by Rosner-Hixson Laboratories; August 30, 1962)

Irritation: The product is essentially non-irritating to the eyes and skin. Application of the product to areas of intact and abraded rabbit skin produced no signs of skin irritation (Rosner-Hixson Laboratories; Aug 30, 1962).

Sensitization: Not applicable

Neurological Effects: Not applicable for normal use.

Teratogenicity: Not applicable

Reproductive Toxicity: Not applicable

Mutagenicity (Genetic Effects): Not applicable

Toxicologically Synergistic Materials: Not applicable

MATERIAL SAFETY DATA SHEET

Section 12: Ecological Information

Ecotoxicity:	Not available
Mobility:	Not available
Persistence and degradability:	Not available
Bioaccumulative potential:	Not available
Other adverse effects:	Not available

Section 13: Disposal Considerations

Waste Disposal Method:	Do NOT dump into any sewers, on the ground or into any body of water. Store material for disposal as indicated in Section 7 Handling and Storage.
USA:	Dispose of in accordance with local, state and federal laws and regulations.
Canada:	Dispose of in accordance with local, provincial and federal laws and regulations.
EC:	Waste must be disposed of in accordance with relevant EC Directives and national, regional and local environmental control regulations. For disposal within the EC, the appropriate code according to the European Waste Catalogue (EWC) should be used.

Section 14: Transport Information:

U.S. Hazardous Materials Regulation (DOT 49CFR)	Not regulated
Canadian Transportation of Dangerous Goods (TDG)	Not regulated
ADR/RID:	Not regulated
IMDG:	Not regulated
Marine Pollutants:	Not applicable
ICAO/IATA :	Not regulated

MATERIAL SAFETY DATA SHEET

Section 15: Regulatory Information

NFPA Hazard Rating

Category	NFPA
Acute Health	0
Flammability	0
Instability	0

USA

TSCA Status: All ingredients in the product are listed on the TSCA inventory.

SARA Title III:
Sec. 302/304: None
Sec: 311/312: None
Sec. 313: None
CERCLA RQ Hydrochloric acid 5 000 lbs (2 270 kg); Ammonium Chloride 5 000 lbs (2 270 kg)

California Prop 65 : This product does not contain chemicals known to the State of California to cause cancer or reproductive toxicity.

State Right-to-Know Lists : Hydrochloric acid, 2-aminoethanol and Ammonium chloride can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

Canada This product has been classified in accordance with the hazard criteria of the *Controlled Products Regulations* and the MSDS contains all the information required by the *Controlled Products Regulations*.

WHMIS Classification: Not Controlled

NSNR Status (New Substance Notification Regulations): All ingredients in the product are listed, as required, on Canada's Domestic Substances List (DSL).

NPRI Substances (National Pollutant Release Inventory): Hydrochloric acid is an NPRI reportable substance.

EC Classification for the Substance/Preparation:

Symbol: Not Dangerous

Risk Phrases: None

Safety Phrases: S1/2: Keep locked up and out of the reach of children.

MATERIAL SAFETY DATA SHEET

Section 16: Other Information

Full Text of R-phrases appearing in Section 2:

R20/21/22: Harmful by inhalation, in contact with skin, and if swallowed
R22: Harmful if swallowed
R34: Causes burns
R36: Irritating to eyes
R37: Irritating to respiratory system

Preparation Information:

Preparation Date: August 11, 2005

Revision Date: March 4, 2008

Revision Summary:
August 11, 2005: Preparation Date
March 4, 2008: Updated Exposure Limits (Section 8) and Toxicological Information (Section 11).

Prepared by:
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Disclaimer: While LEHDER Environmental Services Limited believes that the data set forth herein is accurate, as of the date hereof, LEHDER makes no warranty with respect thereto and expressly disclaims all liability for reliance thereon. Such data is offered solely for your consideration, investigation and verification.

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MATERIAL SAFETY DATA SHEET

Revised: March 8, 2013

Section 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name: DuPont™ Teflon® Multi-Use Lubricant - Aerosol

Product Use: Lubricant.

Manufacturer/Supplier: Finish Line Technologies
50 Wireless Blvd
Hauppauge, NY
11788

Phone Number: 631-666-7300

Emergency Phone: PROSAR: 1-800-217-5157
CHEMTREC: 1-800-424-9300

Date of Preparation: August 17, 2011

Section 2: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

DANGER

EXTREMELY FLAMMABLE. HARMFUL BY INHALATION. MAY CAUSE EYE IRRITATION. MAY CAUSE SKIN IRRITATION. CONTENTS UNDER PRESSURE. CONTAINER MAY EXPLODE IF HEATED. HARMFUL: MAY CAUSE LUNG DAMAGE IF SWALLOWED.

Potential Health Effects: See Section 11 for more information.

Likely Routes of Exposure: Skin contact, eye contact, inhalation, and ingestion.

Eye: May cause eye irritation.

Skin: May cause skin irritation.

Ingestion: Not a normal route of exposure. Harmful: may cause lung damage if swallowed.

Inhalation: Harmful by inhalation. May cause respiratory tract irritation. Intentional misuse by deliberately concentrating and inhaling the contents may be harmful or fatal. This product may be aspirated into the lungs and cause chemical pneumonitis.

Chronic Effects: Prolonged or repeated contact may dry skin and cause irritation.

Signs and Symptoms: Symptoms may include discomfort or pain, excess blinking and tear production, with marked redness and swelling of the conjunctiva. Symptoms may include redness, edema, drying, defatting and cracking of the skin. Headache. Sore throat. Cough. Laboured breathing. CNS depression. Vapours may cause drowsiness and dizziness.

Medical Conditions Aggravated By Exposure: Because of its irritating properties, product may aggravate preexisting skin, eye, and respiratory conditions.

Target Organs: Skin, eyes, gastrointestinal tract, respiratory system.

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Potential Environmental Effects: May cause long-term adverse effects in the aquatic environment. See Section 12 for more information.

Section 3: COMPOSITION / INFORMATION ON INGREDIENTS

Ingredient	CAS #	Wt. %
Distillates (petroleum), hydrotreated light	64742-47-8	15 - 40
Heptane, branched, cyclic and linear	426260-76-6	10 - 30
Heptane	142-82-5	10 - 30
Butane	106-97-8	5 - 10
Propane	74-98-6	5 - 10
Distillates (petroleum), hydrotreated light paraffinic	64742-55-8	3 - 7

Section 4: FIRST AID MEASURES

Eye Contact: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If easy to do, remove contact lenses, if worn. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of soap and water. Remove contaminated clothing and shoes. Wash clothing before reuse. Call a physician if irritation develops and persists.

Inhalation: If breathed in, move person into fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion: DO NOT induce vomiting. If victim is conscious and alert, give 2 cupfuls of water. Never give anything by mouth to an unconscious person. Seek medical attention or call poison control.

General Advice: In case of accident or if you feel unwell, seek medical advice immediately (show the label or MSDS where possible).

Note to Physicians: Symptoms may not appear immediately.

Section 5: FIRE FIGHTING MEASURES

Flammability: Extremely flammable by WHMIS/OSHA criteria.

Means of Extinction:

Suitable Extinguishing Media: Powder, water spray, foam, carbon dioxide.

Unsuitable Extinguishing Media: Not available.

Products of Combustion: May include, and are not limited to: oxides of carbon, noxious fumes.

Explosion Data:

Sensitivity to Mechanical Impact: Not available.

Sensitivity to Static Discharge: Not available.

Protection of Firefighters: Containers may explode when heated. Keep upwind of fire. Wear full fire fighting turn-out gear (full Bunker gear) and respiratory protection (SCBA).

Section 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions: Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected personnel. Eliminate sources of ignition. Ruptured cylinders may rocket.

Environmental Precautions: Many gases are heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks). Keep out of drains, sewers, ditches, and waterways. Minimize use of water to prevent environmental contamination.

Methods for Containment: Contain and/or absorb spill with inert material (e.g. sand, vermiculite), then place in a suitable container. Do not flush to sewer or allow to enter waterways. Use appropriate Personal Protective Equipment (PPE).

Methods for Clean-Up: Scoop up material and place in a disposal container. Provide ventilation.

Other Information: Not available.

Section 7: HANDLING AND STORAGE

Handling:
Keep away from sources of ignition. No smoking. Avoid contact with skin and eyes. Do not swallow. Do not breathe gas/fumes/vapor/spray. Use only in well-ventilated areas. Launder contaminated clothing before reuse. When using do not eat or drink. Wash hands before eating, drinking, or smoking.

Storage:
Keep out of the reach of children. Keep container in a well-ventilated place. Do not store at temperatures above 49 °C / 120 °F. Store away from light.

Section 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Guidelines

	Exposure Limits	
Ingredient	**OSHA-PEL**	**ACGIH-TLV**
Distillates (petroleum), hydrotreated light	5 mg/m^3	5 mg/m^3
Heptane, branched, cyclic and linear	400 ppm	400 ppm
Heptane	400 ppm	400 ppm
Butane	Not available.	800 ppm
Propane	1000 ppm	1000 ppm
Distillates (petroleum), hydrotreated light paraffinic	Not available.	Not available.

Engineering Controls: Use ventilation adequate to keep exposures (airborne levels of dust, fume, vapor, etc.) below recommended exposure limits.

Personal Protective Equipment:

Eye/Face Protection: Wear eye/face protection.

Hand Protection: Wear suitable gloves.

Skin and Body Protection: Impervious protective clothing recommended.

Respiratory Protection: In case of insufficient ventilation, wear suitable respiratory equipment.

General Hygiene Considerations: Handle according to established industrial hygiene and safety practices.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Translucent.
Color:	White.
Odour:	Light petroleum odor.
Odour Threshold:	Not applicable.
Physical State:	Liquid.
pH:	Not applicable.

Viscosity:	< 10 cSt @ 40 °C (104 °F)
Freezing Point:	Not available.
Boiling Point:	Not available.
Flash Point:	Not available.
Evaporation Rate:	Not applicable.
Lower Flammability Limit:	Not applicable.
Upper Flammability Limit:	Not applicable.
Vapor Pressure:	Not applicable.
Vapor Density:	Not applicable.
Specific Gravity:	Not available.
Solubility in Water:	Insoluble.
Coefficient of Water/Oil Distribution:	Not available.
Auto-ignition Temperature:	Not available.
Percent Volatile, wt. %:	49
VOC content, wt. %:	49

Section 10: STABILITY AND REACTIVITY

Stability: Stable under normal storage conditions. Contents under pressure. Container may explode if heated. Do not puncture. Do not burn. Keep in a cool place.

Conditions of Reactivity: Heat. Incompatible materials.

Incompatible Materials: None known.

Hazardous Decomposition Products: May include, and are not limited to: oxides of carbon, noxious fumes.

Possibility of Hazardous Reactions: No dangerous reaction known under conditions of normal use.

Section 11: TOXICOLOGY INFORMATION

EFFECTS OF ACUTE EXPOSURE

Component Analysis

Ingredient	LD_{50} (oral)	LC_{50}
Distillates (petroleum), hydrotreated light	> 5000 mg/kg, rat	> 5.2 mg/L 4hr, rat
Heptane, branched, cyclic and linear	Not available.	103 g/m³ 4hr, rat
Heptane	5000 mg/kg, mouse	103 g/m³ 4hr, rat
Butane	Not available.	658 mg/L 4hr, rat
Propane	Not available.	658 mg/L 4hr, rat
Distillates (petroleum), hydrotreated light paraffinic	>5000 mg/kg, rat	3900 mg/m³ 4hr, rat

Eye: May cause eye irritation. Symptoms may include discomfort or pain, excess blinking and tear production, with marked redness and swelling of the conjunctiva.

Skin: May cause skin irritation. Symptoms may include redness, edema, drying, defatting and cracking of the skin.

Ingestion: Not a normal route of exposure. Harmful: may cause lung damage if swallowed.

Inhalation: Harmful by inhalation. May cause respiratory tract irritation. This product may be aspirated into the lungs and cause chemical pneumonitis. Vapours may cause drowsiness and dizziness.

EFFECTS OF CHRONIC EXPOSURE

Target Organs: Not available.

Chronic Effects: Not hazardous by WHMIS/OSHA criteria.

Carcinogenicity: Not hazardous by WHMIS/OSHA criteria.

Ingredient	Chemical Listed as Carcinogen or Potential Carcinogen *
Distillates (petroleum), hydrotreated light	I -3, G-A3
Heptane, branched, cyclic and linear	Not listed.
Heptane	Not listed.
Butane	Not listed.
Propane	Not listed.
Distillates (petroleum), hydrotreated light paraffinic	Not listed.

* See Section 15 for more information.

Mutagenicity: Not hazardous by WHMIS/OSHA criteria.

Reproductive Effects: Not hazardous by WHMIS/OSHA criteria.

Developmental Effects:

Teratogenicity: Not hazardous by WHMIS/OSHA criteria.

Embryotoxicity: Not hazardous by WHMIS/OSHA criteria.

Respiratory Sensitization: Not hazardous by WHMIS/OSHA criteria.

Skin Sensitization: Not hazardous by WHMIS/OSHA criteria.

Toxicologically Synergistic Materials: Not available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity: Not available.

Persistence / Degradability: Not available.

Bioaccumulation / Accumulation: Not available.

Mobility in Environment: Not available.

Section 13: DISPOSAL CONSIDERATIONS

Disposal Instructions:
This material must be disposed of in accordance with all local, state, provincial, and federal regulations.

Section 14: TRANSPORTATION INFORMATION

DOT Classification
UN1950; AEROSOLS, Flammable; Class 2.1
ORM-D (≤ 1L)

TDG Classification
UN1950; AEROSOLS, Flammable; Class 2.1
Limited Quantity (≤ 1L)

Section 15: REGULATORY INFORMATION

Federal Regulations

Canadian: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

US: MSDS prepared pursuant to the Hazard Communication Standard (CFR29 1910.1200).

SARA Title III

Ingredient	Section 302 (EHS) TPQ (lbs.)	Section 304 EHS RQ (lbs.)	CERCLA RQ (lbs.)	Section 313
Distillates (petroleum), hydrotreated light	Not listed.	Not listed.	Not listed.	Not listed.
Heptane, branched, cyclic and linear	Not listed.	Not listed.	Not listed.	Not listed.
Heptane	Not listed.	Not listed.	Not listed.	Not listed.
Butane	Not listed.	Not listed.	Not listed.	Not listed.
Propane	Not listed.	Not listed.	Not listed.	Not listed.
Distillates (petroleum), hydrotreated light paraffinic	Not listed.	Not listed.	Not listed.	Not listed.

State Regulations

California Proposition 65:
This product does not contain a chemical known to the State of California to cause cancer, birth defects or other reproductive harm.

Global Inventories

Ingredient	Canada DSL/NDSL	USA TSCA
Distillates (petroleum), hydrotreated light	DSL	Yes.
Heptane, branched, cyclic and linear	DSL	Yes.
Heptane	DSL	Yes.
Butane	DSL	Yes.
Propane	DSL	Yes.
Distillates (petroleum), hydrotreated light paraffinic	DSL	Yes.

HMIS - Hazardous Materials Identification System

Health - 1 **Flammability -** 3 **Physical Hazard -** 0 **PPE –** B

NFPA - National Fire Protection Association:

Health - 1 **Fire -** 3 **Reactivity -** 0

Hazard Rating: 0 = minimal, 1 = slight, 2 = moderate, 3 = severe, 4 = extreme

WHMIS Classification(s):
Class A - Compressed Gas
Class B5 - Flammable Aerosol
Class D2B - Skin/Eye Irritant

WHMIS Hazard Symbols:

SOURCE AGENCY CARCINOGEN CLASSIFICATIONS:

OSHA (O) Occupational Safety and Health Administration.

ACGIH (G) American Conference of Governmental Industrial Hygienists.
A1 - Confirmed human carcinogen.
A2 - Suspected human carcinogen.
A3 - Animal carcinogen.
A4 - Not classifiable as a human carcinogen.
A5 - Not suspected as a human carcinogen.

IARC (I) International Agency for Research on Cancer.
1 - The agent (mixture) is carcinogenic to humans.
2A - The agent (mixture) is probably carcinogenic to humans; there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals.
2B - The agent (mixture) is possibly carcinogenic to humans; there is limited evidence of carcinogenicity in humans in the absence of sufficient evidence of carcinogenicity in experimental animals.
3 - The agent (mixture, exposure circumstance) is not classifiable as to its carcinogenicity to humans.
4 - The agent (mixture, exposure circumstance) is probably not carcinogenic to humans.

NTP (N) National Toxicology Program.
1 - Known to be carcinogens.
2 - Reasonably anticipated to be carcinogens.

Section 16: OTHER INFORMATION

Disclaimer:
The information contained in this document applies to this specific material as supplied. It may not be valid for this material if it is used in combination with any other materials. It is the user's responsibility to satisfy oneself as to the suitability and completeness of this information for the user's own particular use.

Expiry Date: August 17, 2014

Version #: 1.0

Prepared by: Nexreg Compliance Inc.
Phone: (519) 488-5126
www.nexreg.com

Appendix D
Spill Reports

SPL001

THIS SICK

SPILL SUN 4/3/88

7 GAL OF TRANSMISSION FLUID
AT THE FIRE DEPT.

SPILL SOAKED UP W/SPILL DRY

AND DISPOSED OF IN DUMPSTER

PER RECOMMENDATION OF

J. HENDERSON

SPILL REPORT

Date: April 13, 1988 Time: 10:30am

The southern transformer in the Bldg. 201/203 substation developed a leak (1 qt.) at the sample port. The transformers had been sampled April 7, 1988, by an outside contractor. It appears that the valve was not properly sealed after the sampling event. The leak was corrected and the spill cleaned up with paper towels and spill dry. The transformer (Serial #6436916) did not contain PCB's. Therefore, the disposal method is the WSTF landfill.

WIWPS # 20-99-08

ITEM	QTY	LOCATION	KVA	PHASE	PRIMARY VOLTAGE	SECONDARY VOLTAGE	POLE #	MFG	S/N	CONTENT (GALS)	PCB CONTENT	TEST DATE	COMMENTS
13													
14													
15													
16	1	BLDG 200 SUBSTATION	1000	3	24900	480/277	PAD	ESCO	12336127	685	NONE	TCI 10/85	1970
17	1	BLDG 201/203 SUBSTATION	1500	3	24900	480/277	PAD	ESCO	6436916	620	NONE	TCI 10/85	1970
18	1 1 1	250 AREA	167	1 1 1	24.9/14.4	480/277	POLE	ESCO	87IN52934 87IN52935 87IN52933	114 114 114			NEW 1987 NON-PCB
19	1	200 AREA PARKING LOT		1									
20	1	BLDG 201/203 SUBSTATION	300	3	24900	208/120	PAD	ESCO	9437388	295	NONE	TCI 10/85	1970
21	1	BLDG 201/203 SUBSTATION	300	3	24900	208/120	PAD	ESCO	2740114	304	2 PPM	TCI 10/85	1970
22													
23													
24	1	BLDG 300 SUBSTATION	1500	3	24900	480/277	PAD	GE	E-690843	520	20 PPM	TCI 8/85	1970

SPILL SUMMARY

On June 1, 1987, a stained area of soil was noted under building 253 (chemical storage building) in the 200 Area. Further investigation revealed that a 5 gallon oil container, which had been stored in the building since 1984, had developed a leak and lost its contents through the floor and into the soil beneath the building. The container still had its original seals on the top of the pail. The oil is a water soluble cutting oil from Texaco which is used in the Met. Lab. There was no MSDS for this chemical. Environmental Problem Report # 11, and DR 2-HWM-037, were issued in response to this release. An MSDS has been obtained by the Environmental Group.

SPILL SUMMARY

On June 24, 1987 at approximately 8:00 am a spill of paint occurred at the 100 Area main warehouse. Five 1-gallon cans of paint were dropped from the loading dock onto the asphalt during a transfer from the dock to a truck. Several of the cans came open and a spill of about one gallon occurred. This material was destined for the HELSTF facility. The first response taken was to wash off the paint which had splashed onto the truck. This practice of washing down a spill prior to determining the hazards involved with the spilled material is not a correct action. There is, however, no written procedure(s) readily available which outlines what is to be done in response to a spill. The warehouse was aware, because of other recent spills, that the Environmental Group should be notified and did provide prompt notification to the Environmental Group. The Environmental Group arrived on the scene to find about one gallon of paint had been spilled and that the limited washdown had not resulted in any soil contamination, and the washwater was still on the asphalt. The next step in the cleanup was to identify the paint and the hazardous constituents, if any. There was not an MSDS at the warehouse or in the Safety office for this product. The information on the label indicated that the paint was water-based. The label also provided the manufacturers name. A call was placed to the manufacturer to determine the hazardous nature of the paint. The paint was determined to be non-hazardous and was picked up with the use of spill pillows and sand which were disposed of in a dumpster. The remaining material was washed down with water.

INSIGHTS FROM THIS SPILL

<u>PROBLEM</u>
This paint was traced back to a specific MR (attached) which specified that an MSDS was not required for this product. The lack of an MSDS can result in resource overkill, eg., the use of self contained breathing apparatus and fully encapsulating suits for the cleanup of a chemical that is later determined to be non-hazardous.

<u>PROBLEM</u>
Spill pillows are a restricted item and the Environmental Group is not on the list of people authorized to sign for them.

<u>PROBLEM</u>
If this spilled material had been a hazardous material the response would have been delayed until paperwork could be written, signed, logged, and scheduled to work. There are also special training requirements for workers involved in the clean up of hazardous waste spills.

<u>PROBLEM</u>
There are no site wide, readily available, procedures to follow in the event of a spill.

SPILL REPORT

DATE: November 18, 1988 TIME: 9:30 a.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: David Barrera, Warehouse

WHAT WAS SPILLED: Given Black Enamel Paint

QUANTITY: 1 gallon LOCATION: Inside Bldg. 120

WHO WAS NOTIFIED (WSTF): I.D. Smith, 100 Area Emergency Coord.

R. Mitchell, WSTF Environmental Emergency Coordinator

DESCRIPTION: A can of paint was dropped and spilled on the floor of the warehouse. The Safety Department was contacted for an MSDS, but was not able to find one for the spilled material. Based on information previously obtained by the Environmental Section, the paint was assumed to be a mineral spirit based paint with no heavy metal content. The flash point was assumed to be less that 140°F. Based on this information TPS 6-HWM-056 was implemented as a work authorizing document for spill response. A Facilities Service Section hazardous waste handler was used for the clean-up. Using rags, spill pillows, and mineral spirits the spill was collected and the floor cleaned. The collected liquids were placed in paint drum #3A in the Drum Storage Facility. The rags and spill pillows were allowed to dry and were placed into the landfill.

RESPONSE COST

ITEM	COST $	CHARGE
Spill Pillows	$ 20.00	JBL
Rags, Drum Liner, etc.	30.00	JBL
1 Hour M & C Tech.	28.00	JBL
2 Hours ES Engineer	56.00	JAA
	$ 134.00	

Lockheed Engineering and Management Services Company, Inc.

INTERDEPARTMENTAL COMMUNICATION

ES88-208

DATE 12/15/88

TO Bob Mitchell DEPT./ORGN. NASA BLDG. ZONE 100 PLANT/FAC. WSTF

FROM Peter H. Pache DEPT./ORGN. 40-01 BLDG. ZONE 100 PLANT/FAC. WSTF EXT. 5464

SUBJECT: Isopropyl Alcohol Spill - 400 Area

The Propulsion Test Department was performing maintenance on their 10,000-gallon isopropyl alcohol (IPA) storage tank on Monday, December 5, 1988. In order to completely empty the tank of all liquids, approximately 1,500 gallons of IPA was placed in two galvanized metal storage tanks (cattle tanks). When work was begun Tuesday, December 6, it was noticed that the soil under one tank was damp. The IPA was pumped into a second tank which also began to leak once the liquid reached a 3-foot level. After this, the liquid was placed back into the IPA storage tank. The soil contaminated with IPA was collected, placed in a cattle tank, and covered.

Isopropyl alcohol is not a reportable quantity material, therefore reporting to outside regulatory authorities was not required. The contaminated soil is awaiting disposition. There is approximately 1,100 gallons (147 cu. ft.) of contaminated soil. Our Section recommends that the soil be sampled and analyzed for flash point. If the flash point of the soil is less than 140°F, the soil is regulated as an ignitable hazardous waste and the recommended disposal would be off-site incineration. If the flash point is greater than 140°F (which is highly likely), the soil would not be a regulated waste and could be disposed of on site.

The cattle tanks which leaked were marked "leaks" and set aside. It is suspected that the lower surface tension of IPA compared to water could explain why the IPA leaked. Prior to using these particular tanks elsewhere, they will be leak tested with water. If this leak test fails, the tanks will be replaced.

Please inform either myself or Joe Hossley on the sampling, analysis, and disposal steps to be taken for the collected contaminated soil.

Peter H. Pache
Supervisor, Environmental Section
LESC/WSTF Operations

kjs

cc:
NASA:
R. Tillett
W. Waldrip
I.D. Smith
LESC:
J. Schentrup
R. Wingfield
B. Silver

NASA WHITE SANDS TEST FACILITY

SAMPLE IPA SPILL RESIDUE

CHEMICAL ANALYSIS REPORT

March 22, 1989

TPS-4-HWM-044

Source:	NASA WHITE SANDS, New Mexico
Site Description:	Dirt stored in stock tank adjacent to 400 Area IPA storage tank.
Sample Type:	Dirt
Parameter:	Flash Point (Ignitability)

QUALITY ASSURANCE FLAGS AND PARAMETERS

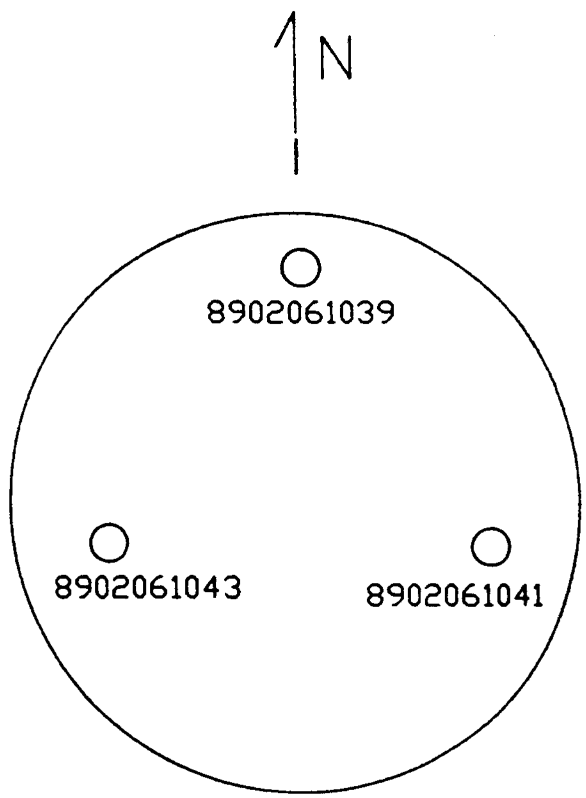
Notes: Results are flagged with a designated Quality Assurance parameter only when a problem is found.

- A indicates the analyst's check standard was outside standard limits.
- RB indicates the analyte was detected in the laboratory reagent blank.
- TB indicates the analyte was detected in the trip blank.
- EB indicates the analyte was detected in the equipment blank.
- FB indicates the analyte was detected in the field blank.
- Q indicates the result for the analyte in a blind control was outside standard limits.
- QD means the precision for duplicate analysis was outside the standard limits.
- T indicates the sample was analyzed outside the specified holding time.
- J indicates an estimated value outside the range of calibration.
- G indicates a value was greater than the indicated calibration limit.
- NC indicates not calculated.
- NA means not analyzed/not applicable.
- ND means not detected at the reporting limit.
- NS value not supported by certified standards.

"Reporting limit" indicates the minimum concentration for which calibration has been established.

SAMPLING PROCEDURE

The soil contained in a 1000-gallon stock tank located near the 400 area was sampled. Samples were taken with a stainless steel scoop, six inches below the surface, at three distinct locations within the stock tank. During sampling, a slight alcohol odor was detected by the sampling team. The diagram below illustrates the sample locations and the sample identification numbers.



STOCK TANK

CHEMICAL ANALYSIS DATA

General Inorganics
Location: 400-Area Stock Tank
Sample # 8902061039
Date Sampled: 02/06/89
Time Sampled: 10:39

Laboratory: RMAL
Date Received: 02/08/89
Date Analyzed: 02/15/89

Method	Parameter	Units	Result	Reporting Limit	QA Flag
1010/1020	Flash Point	°C	69	NA	

CHEMICAL ANALYSIS DATA

General Inorganics
Location: 400-Area Stock Tank
Sample # 8902061041
Date Sampled: 02/06/89
Time Sampled: 10:41

Laboratory: RMAL
Date Received: 02/08/89
Date Analyzed: 02/15/89

Method	Parameter	Units	Result	Reporting Limit	QA Flag
1010/1020	Flash Point	°C	69	NA	

CHEMICAL ANALYSIS DATA

General Inorganics
Location: 400-Area Stock Tank
Sample # 8902061043
Date Sampled: 02/06/89
Time Sampled: 10:43

Laboratory: RMAL
Date Received: 02/08/89
Date Analyzed: 02/15/89

Method	Parameter	Units	Result	Reporting Limit	QA Flag
1010/1020	Flash Point	°C	ND	NA	

COMMENTS AND QUALITY ASSURANCE PROCEDURES

1. IPA means 2-propanol or isopropyl alcohol.
2. No QA/QC data were provided by the analyst.
3. All specified sampling and chain of custody procedures were followed.
4. No blind controls were provided.

Prepared By: Jan Kilduff
Jan Kilduff
Scientist
Lockheed-ESC

Prepared By: Ben Greene
Ben Greene
Scientist
Lockheed-ESC

Prepared By: Keith Burke
Keith E. Burke
Laboratory Quality Assurance
Lockheed-ESC

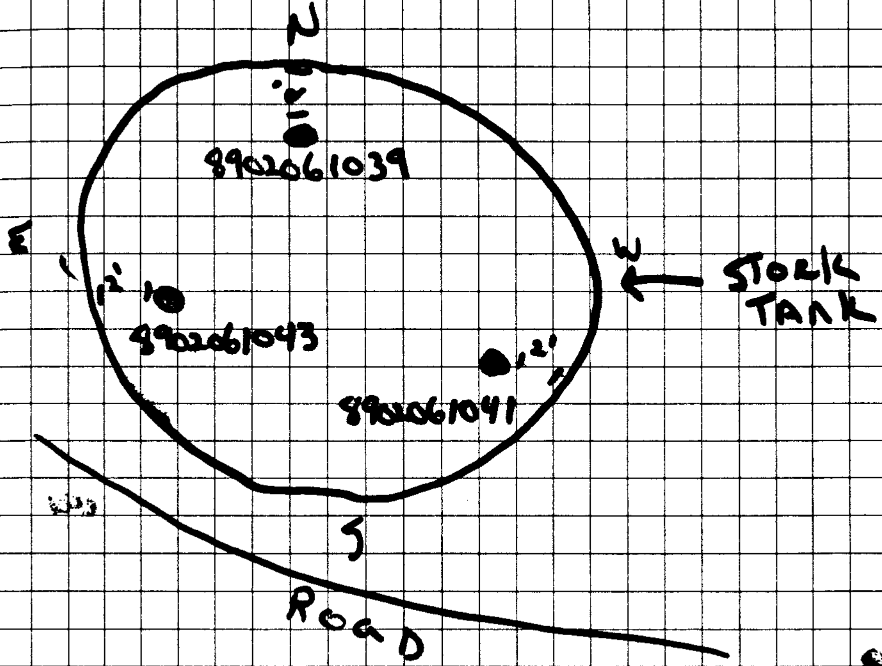
Approved By: R. P. Johnson
Robert Johnson
Chemistry Laboratory Supervisor
Lockheed-ESC

Approved By: Harry J. Johnson
Harry Johnson
Laboratory Manager
NASA Laboratories Office

Arrive @ 400 Area IPA Stock Tank at 1038, C. Warner + P. Matthews Present.

Soil samples were taken with S.S. Scoop 6" below surface of soil in Stock Tank

IPA Odor was observed



SAMPLE	Parameter	Lab
8902061039	Flash Point	
-1041	"	
-1043	"	

Secured area at 1050

Continued on Page ______

Signed: [signature] Date: 2-6-87

Read and Understood By

Signed ______ Date ______

Bottle
500 ml P
1l Glass
1l Glass
Plastic 500 ml
1l glass
40 ml glass
1l glass
500 ml P
1l glass
250 ml P

…ued on Page

Date

LABORATORY WORK ORDER

REQUESTED BY	NEED DATE	PRIORITY	W.O. NUMBER	T & D RECEIVED
J Henderson				

ORGANIZATION	PHONE	PROMISED DATE	TASK NUMBER	T & D COMPLETED
LSSC			033JBL00	

SUPERVISOR	WORK CONTACT	PHONE	LABORATORY FILE NUMBER	DOCUMENTATION (1)
P Parke			661191	

DELIVERED TO	LAB (1)	HOURS	LAB (3)	HOURS	DOCUMENTATION (2)

DATE DELIVERED	LAB (2)	HOURS	LAB (4)	HOURS	DOCUMENTATION (3)

BRIEF DESCRIPTION (MFR - MODEL - SER. NO.) (IDENTIFY IF CHEMICAL/METALLIC ETC.)

COMMENTS

SERVICES REQUESTED

Sample + analyze per TPS

CHEM & MET. LABS ONLY

APPLICABLE SPECS	SAMPLE TAKEN FROM	TPS NO.
	Dist 4 [illegible] IPA [illegible]	4-HWV-044

ADDITIONAL COMMENTS

SAMPLE RECEIVED BY	DATE	TIME

ITEM	LABORATORY OPERATION OR COMMENTS	TECH	QA	OTHER
	See attached report			
	[illegible] 03/29/89			

REMARKS

(TECH APPROVED FOR WORK)

WSTF-122

SPILL REPORT

DATE: December 19, 1988 **TIME:** 1:15 p.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: Gary Charles, Warehouse

WHAT WAS SPILLED: Hydrofluoric Acid (HF)

QUANTITY: 2 ounces **LOCATION:** Inside Bldg. 120

WHO WAS NOTIFIED (WSTF): Dale Ready, Emergency Center

DESCRIPTION: Eight gallons of 52% hydrofluoric acid (HF) were received by the warehouse from VWR Scientific. The HF was packed in 1-gallon containers, four per box. The boxes appeared wet on the bottom, so Gary Charles called me to investigate. The moisture was determined to be HF by using pH paper. It appeared that the bottles had leaked from the top, perhaps from being stored on their sides during transit. A warehouse technician, Lawrence Gloria, who had handled the boxes, was sent to the dispensary as a safety measure. Donna Simon, a warehouse technician who went through the hazardous waste handlers training last week, repackaged the boxes in a drum liner (a large heavy trash bag). The Emergency Center (Dale Ready) was notified of the spill and asked to relay the information on the spill to I.D. Smith and R. Mitchell. The Emergency Center contacted I.D. Smith and R. Mitchell. This spill did not involve a reportable quantity. On December 22, 1988, with assistance from Laboratory Services Section, the HF was transported to the clean room pad and decontaminated. The boxes and other decontaminated items were placed in the trash and the HF was placed into stock (Bldg. T-253) for future use by the Laboratory Services Section.

SPILL REPORT SPL023

DATE: January 10, 1989 TIME: 3:20 p.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: Gary Charles, Warehouse

WHAT WAS SPILLED: Plastic Polish, Novus No. 1

QUANTITY: 8 ounce LOCATION: Inside Bldg. 120

WHO WAS NOTIFIED (WSTF): Robert Mitchell, I. D. Smith

DESCRIPTION: One 8-ounce bottle of plastic polish (a stock item) was spilled. The material was wiped up with rags and the rags were bagged. No MSDS was found on site for the product. The manufacturer was contacted January 11, 1989, and an MSDS was requested. Information obtained from the phone call indicates that the polish contains isopropyl alcohol as the only hazardous ingredient. The flash point of the product is 200°F. The residue is non-hazardous and will be placed in the WSTF landfill.

SPILL REPORT

SPL024

DATE: February 2, 1989 **TIME:** 2:15 p.m.

NAME OF PERSON COMPLETING FORM: Joseph B. Hossley, Environmental Section

NAME OF PERSON REPORTING SPILL: Irene Portillo, x5167

WHAT WAS SPILLED: Gasoline (unleaded)

QUANTITY: 5-10 gallons **LOCATION:** 113 Yard @ gas pumps

WHO WAS NOTIFIED (WSTF): Robert Mitchell, I. D. Smith

DESCRIPTION: Approximately 5-10 gallons of gasoline spilled when the gas pump didn't shut off and a vehicle's gas tank was over-filled. Vermiculite (Floor-Dri) was spread on the spill. After sitting overnight, the vermiculite will be collected and placed in a drum. The waste will be disposed of in the WSTF landfill after airing out.

SPILL REPORT

SPL025

DATE: February 15, 1989 TIME: 7:30 a.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: Irene Portillo, x5167

WHAT WAS SPILLED: Gasoline

QUANTITY: 2-3 gallons LOCATION: Bldg. 113, gas pumps

WHO WAS NOTIFIED (WSTF): Robert Mitchell, NASA

DESCRIPTION: The automatic shut-off on the unleaded gas pump failed resulting in a spill. Spill dry was used to absorb the spilled gas. The spill dry will be swept up and placed in a drum. The waste will be disposed of in the WSTF landfill after airing out.

Lockheed Engineering and Management Services Company, Inc.

INTERDEPARTMENTAL COMMUNICATION

ES89-047

DATE 02/15/89

TO	R. E. Wingfield	**DEPT./ ORGN.**	40-20	**BLDG./ ZONE**	100	**PLANT/ FAC.**	WSTF		
FROM	Peter H. Pache	**DEPT./ ORGN.**	40-01	**BLDG./ ZONE**	101	**PLANT/ FAC.**	WSTF	**EXT.**	5464

SUBJECT: Gasoline Spill

On February 2 and 15, 1989, spills of gasoline have occurred from the unleaded gas pump. The attached spill reports provide details of the spills and cleanups.

Peter H. Pache, Supervisor
Environmental Section
LESC/WSTF Operations

kjs

Attachments: a/s

cc: J. Schentrup
C. Coburn

FORM LEMSCO 426-1

SPILL REPORT

SPL026

DATE: February 21, 1989 **TIME:** 1:18 p.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: Byron Moore, x5744

WHAT WAS SPILLED: Hydraulic Fluid

QUANTITY: 2 liters **LOCATION:** Bldg. 800, Rm. 119

WHO WAS NOTIFIED (WSTF): Harry Johnson, NASA

DESCRIPTION: A bottle of hydraulic fluid was dropped inside on the floor. The oil was soaked up using rags and the rags placed in the dumpster.

SPILL REPORT

SP031

DATE: March 16, 1989 **TIME:** 1000 hours

NAME OF PERSON COMPLETING FORM: Ray Spencer & Joe Hossley, Environmetal Sect.

NAME OF PERSON REPORTING SPILL: Ron Pridmore, Warehouse

WHAT WAS SPILLED: Sulfuric Acid (Electrolyte Battery Fluid)

QUANTITY: < 1 ounce **LOCATION:** Bldg. 120 Dock

WHO WAS NOTIFIED (WSTF): Sam Carr, WSTF Emergency Center

DESCRIPTION: Electrolyte Battery Fluid (Sulfuric Acid) delivered by NAPA was accepted by the warehouse. Inspection following acceptance showed that six containers (5 gallons each) out of the 40 in the shipment had apparently leaked in transit. The outer cardboard boxes on these containers were wet and discolored, but it appeared that no liquid had leaked past the box. Two of the warehouse hazardous waste spill responders (Donna Simon and Charlie Davis) separated out the damaged containers, packaged them, and loaded them onto the Environmental Section's truck. The containers were then transported to Contamination Control. The acid, diluted 50% with water, will be drained into the 200 Evaporation Tank System by Contamination Control. The empty containers will be rinsed (with the rinsate also going to the 200 Area Evaporation Tank System) and then discarded in the WSTF landfill (via dumpster).

Joseph B Hossley
3-16-89

SPL033

SPILL REPORT

DATE: April 17, 1989 **TIME:** 1305 hrs

NAME OF PERSON COMPLETING FORM: J. B. Hossley

NAME OF PERSON REPORTING SPILL: Save Santner (x5125)

WHAT WAS SPILLED: Oil (Non-contaminated)

QUANTITY: ~2 quarts

LOCATION: Test Stand 401

WHO WAS NOTIFIED (WSTF): WSTF Emergency Center

DESCRIPTION: Oil leaking out at water pumps in front of Test Stand 401. Oil is not contaminated with fuel or oxidizer. Oily dirt will be collected, placed on plastic, allowed to dry, and disposed of at WSTF landfill. Oil leak will be investigated and repaired.

SPL034

SPILL REPORT

DATE: April 18, 1989 TIME: 0855 hrs

NAME OF PERSON COMPLETING FORM: James Henderson

NAME OF PERSON REPORTING SPILL: Gary Charles, Warehouse

WHAT WAS SPILLED: Kodak 1st Dev. Rep. Proc. R3

QUANTITY: <1 gallon

LOCATION: 120 warehouse

WHO WAS NOTIFIED (WSTF): R. Mitchell, NASA

DESCRIPTION: A case (6 - 1 quart bottles) of replenisher was received which had some leakage onto the box. The individual containers were rinsed with water and placed into a new box. The wash water was drained to the sewage lagoon and the box was placed in the dumpster. The replenisher will be placed into stock and issued as needed.

MATERIAL SAFETY DATA SHEET

EASTMAN KODAK COMPANY
343 State Street
Rochester, New York 14650

For Emergency Health, Safety, and Environmental Information, call 716 722-5151
For other purposes, call the Marketing and Distribution Center in your area.

Date of Preparation: 6/02/86 Kodak Accession Number: 427739

SECTION I. IDENTIFICATION

- Product Name: KODAK First Developer Replenisher, Process R-3, MX 1238
- Formula: Aqueous Mixture
- Kodak Photographic Chemicals Catalog Number(s): CAT 824 4931 - To Make 5 Litres
- Solution Number: 4816
- Kodak's Internal Hazard Rating Codes: R 1 S: 2 F: 0 C: 0

SECTION II. PRODUCT AND COMPONENT HAZARD DATA

A. PRINCIPAL COMPONENT(S):

PRINCIPAL COMPONENT(S):	Weight Percent	ACGIH TLV(R)	Kodak Accession No.	CAS Reg. No.
Water	60-70	---	035290	7732-18-5
Potassium sulfite	10-15	---	907064	10117-38-1
Potassium/Sodium carbonate mixture	10-15	---	---	---
*Potassium hydroquinone monosulfonate	5-10	---	911867	21799-87-1

*Principal Hazardous Component(s)

B. PRECAUTIONARY LABEL STATEMENT(S):

CONTAINS: potassium hydroquinone monosulfonate
WARNING!
CAN CAUSE ALLERGIC SKIN REACTION
Avoid prolonged or repeated contact with skin.
First Aid: In case of skin contact, immediately wash with soap and plenty of water. Get medical attention.

Skin: Flush skin with plenty of water and wash with a non-alkaline (acid) type of skin cleanser. If skin irritation or an allergic skin reaction develops, get medical attention.

===

SECTION VII. VENTILATION AND PERSONAL PROTECTION

A. VENTILATION: Good general ventilation should be sufficient.

B. SKIN AND EYE PROTECTION:

Safety glasses are recommended.
Impervious gloves should be worn.
The routine use of a non-alkaline (acid) type of skin cleanser and regular cleaning of working surfaces, gloves, etc, will help minimize the possibility of allergic skin reaction.

===

SECTION VIII. SPECIAL STORAGE AND HANDLING PRECAUTIONS

Keep container tightly closed and away from strong acids.

===

SECTION IX. SPILL, LEAK, AND DISPOSAL PROCEDURES

Flush material to an acid-free sewer with large amounts of water. Discharge, treatment, or disposal may be subject to federal, state, or local laws.

===

SECTION X. ENVIRONMENTAL EFFECTS DATA

This chemical formulation has not been tested for environmental effects. Some laboratory test data and published data are available for the major components of this chemical formulation, and these data have been used to provide the following estimate of environmental impact:1-4

This chemical formulation has a low biological oxygen demand, and it is expected to cause little oxygen depletion in aquatic systems. It is expected to have a moderate potential to affect the germination of some plants. It is expected to have a low potential to affect aquatic organisms, secondary waste treatment microorganisms, and the growth of some plants. The components of this chemical formulation are biodegradable and are not likely to bioconcentrate. The direct instantaneous discharge to a receiving body of water of an amount of this chemical formulation which will rapidly produce, by dilution, a final concentration of 100 mg/L or less is not expected to cause an adverse environmental effect. After dilution with a large amount of water, followed by secondary waste treatment, the chemicals in this formulation are not expected to have any adverse environmental impact.

===

SPL035

SPILL REPORT

DATE: April 28, 1989 TIME: 1:50 pm

NAME OF PERSON COMPLETING FORM: J. Henderson JH

NAME OF PERSON REPORTING SPILL: John Bernal

WHAT WAS SPILLED: Tetraethylene Pentamine

QUANTITY: < 1 ounce

LOCATION: 120 Warehouse

WHO WAS NOTIFIED (WSTF): R. Mitchell, NASA
I. D. Smith, NASA

DESCRIPTION: A 1-gallon container was received by the warehouse. When the box was opened to check the contents, some leakage was noted around the cap. The residue was wiped up with paper towels and placed in a box. The box containing vermiculite and paper towels was determined to be non-hazardous and placed in the dumpster.

MORTON THIOKOL, INC.
Morton Chemical Division

Material Safety Data Sheet

SECTION I: PRODUCT IDENTIFICATION

PRODUCT NAME:	EM-308
CHEMICAL NAME:	Amide Reaction Product of Tall Oil and Tetraethylene pentamine
COMMON NAME:	Amide Reaction Product of Tall Oil and Tetraethylene pentamine
CAS NUMBER:	None
PRODUCT USE:	Epoxy Flexibilizer and Hardener
EMERGENCY PHONE:	815-338-1800 (24 hours/day)
OTHER EMERGENCY PHONE:	312-807-3142
EFFECTIVE DATE:	October 1987
SUPERSEDES:	January 1987

SECTION II: HAZARDOUS INGREDIENTS

CHEMICAL NAME/COMMON NAME	%	CAS NO.	OSHA PEL	ACGIH/TLV TWA	STEL
Tetraethylene pentamine/TEPA	1-10	112-57-2	Not established		
Other alkylethylene amines	1-5	------	Not established		

SECTION III: PHYSICAL DATA

BOILING POINT (760 mm Hg):	318 degrees C (for tetraethylene pentamine)
SPECIFIC GRAVITY (Water = 1):	0.950
VAPOR PRESSURE (mm Hg):	< 0.001mm @ 20 degrees C
VAPOR DENSITY (Air=1):	> 1
% NONVOLATILE:	100% (at 120 degrees C)
pH:	9.8
EVAPORATION RATE (Ether=1):	<< 1
SOLUBILITY IN WATER:	Complete
APPEARANCE:	Clear amber liquid
ODOR:	Slight Amine odor

SECTION IV: FIRE AND EXPLOSION DATA

FLASH POINT: > 200 degrees F (> 93 degrees C)
METHOD USED: SETAFLASH

FLAMMABLE LIMITS Lel: Not Applicable
Uel: Not Applicable

EXTINGUISHING MEDIA: Water, carbon dioxide, dry chemical, foam.

SPECIAL FIRE FIGHTING PRACTICES: Fire fighters should wear NIOSH-MSHA approved self-contained positive pressure breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None as far as known.

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon monoxide, carbon dioxide, oxides of nitrogen, ammonia, and possibly some aldehydes and inorganic acids.

SECTION V: HEALTH HAZARD DATA

ORAL TOXICITY: Rats: LD50: 3.23g/Kg

DERMAL TOXICITY: A skin irritant.

EYE TOXICITY: Corrosive to the eye.

INHALATION TOXICITY: Not established for the product.

SENSITIZATION: TEPA: Consider a skin and pulmonary sensitizer.

CHRONIC TOXICITY:
- Carcinogen: Unknown.
- Teratogen: Unknown.
- Mutagen: Unknown.

EFFECTS OF OVEREXPOSURE:

INGESTION:	May cause gastrointestinal irritation, nausea, and vomiting.
SKIN CONTACT:	Will cause irritation. Repeated or prolonged contact may cause dermatitis, sensitization.
EYE CONTACT:	Will cause severe eye irritation and corneal edema. Corrosive to eye tissue.
INHALATION:	Unknown for product. May cause irritation and pulmonary sensitization and asthmatic-type reaction.
ACUTE SYSTEMIC:	Unknown.
CHRONIC SYSTEMIC:	Unknown.

NOTES: Persons with preexisting skin disorders may be more susceptible to dermal contact.

SECTION VI: EMERGENCY HEALTH AND FIRST AID PROCEDURES

INGESTION: Seek medical attention, if unavailable contact nearest Poison Control Center.

SKIN CONTACT: Promptly remove all contaminated clothing; shower if necessary. Wash with soap and water. If irritation is present after washing, get medical attention immediately.

EYE CONTACT: Flush with large amounts of fresh water for 15 minutes lifting upper and lower eyelids frequently. Get medical attention immediately.

INHALATION: Remove to fresh air. If breathing has stopped, perform artificial respiration. Keep affected person warm and at rest. Get medical attention immediately.

NOTE TO PHYSICIAN: Supportive therapy is recommended. No known antidote.

SECTION VII: REACTIVITY DATA

STABILITY: Stable under ordinary storage conditions.

HAZARDOUS CONDITIONS TO AVOID: Long storage at temperatures above 110 degrees F (43 degrees C).

INCOMPATIBILITY: (MATERIALS TO AVOID) None known.

CAN HAZARDOUS POLYMERIZATION OCCUR: No.

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of nitrogen, carbon monoxide, carbon dioxide, ammonia, and possibly some aldehydes and inorganic acids.

SECTION VIII: SPILL OR LEAK PROCEDURES

RESPONSE TO SPILLS: Stop discharge and contain spill or contaminated material using dike, barrier or other means. Recover with pumping equipment, vacuum truck, sorbent, vermiculite or other means. Place contaminated material in suitable container(s) for further handling.

HAZARDS TO BE AVOIDED: Do not flush to stream, other bodies of water or sewer. Avoid contact with skin or clothing. Other hazard information see Section Nos. IV (FIRE AND EXPLOSION DATA), V (HEALTH HAZARD DATA) and IX (CONTROL MEASURES).

SPILL NOTIFICATION: Check Federal and State reporting regulations.

DISPOSAL METHODS:
1 Recycle if feasible.
2 Incinerate at authorized facility.
3 Treatment at Industrial or Liquid Waste treatment facility.
4 Landfill after solidification in a facility authorized to receive waste.

NOTE: IF DISCARDING THIS MATERIAL, DISPOSE OF IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REGULATIONS.

SECTION IX: CONTROL MEASURES

RESPIRATORY PROTECTION: Not typically required. NIOSH-MSHA approved chemical cartridge respirator with organic vapor cartridges as necessary. Comply with OSHA 1910.134 (CFR), respiratory protection. Contaminant levels will vary dependent on the operation. Industrial hygiene consultation is recommended to assist in respirator selection, use and training.

FOR HANDS, BODY: Chemical resistant gloves recommended for hand protection, chemical resistant work clothing for general body protection.

FOR EYES: Wear safety glasses, chemical goggles or face shield (eight inch minimum).

VENTILATION: Provide adequate ventilation to minimize inhalation.

SECTION X: SPECIAL PRECAUTIONS

RECOMMENDED STORAGE PRACTICE AND CONDITIONS: Store between 50 and 110 degrees F (10 and 43 degrees C). EM-308 is hygroscopic and it is therefore recommended that it be stored in a tightly closed container in a cool dry place.

OTHER PRECAUTIONS: Eye wash and shower should be available. Use only under well ventilated conditions. For personal hygiene protection, personnel should wash thoroughly after handling product. Always wash up before eating, smoking or using washroom facilities. Do not breathe vapor. Do not contact eyes, skin and or clothing.

SECTION XI: LABELING INFORMATION

DOT SHIPPING NAME:	Corrosive Liquid, N.O.S.
DOT IDENTIFICATION NO.:	UN 1760
DOT LABEL:	Corrosive
MORTON PRECAUTIONARY LABEL:	L132

SECTION XII: USER'S RESPONSIBILITY

A bulletin such as this cannot be expected to cover all possible situations. As the user has the responsibility to provide a safe workplace, all aspects of an individual operation should be examined to determine if, or where, precautions in addition to those described herein, are required. Any health hazard and safety information contained herein should be passed on to your customers or employees, as the case may be. Morton Thiokol, Inc. must rely on the user to utilize the information we have supplied to develop work practice guidelines and employee instructional programs for the individual operation.

DISCLAIMER OF LIABILITY

The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control we make no guarantee of results, and assume no liability for damages incurred by use of this material. All chemicals may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS. It is the responsibility of the user to comply with all applicable federal, state, and local laws and regulations.

Nothing contained herein is to be construed as a recommendation for use in violation of any patents or of applicable laws or regulations.

Morton Thiokol, Inc.
Morton Chemical Division
333 West Wacker Drive
Chicago, Illinois 60606-1292
(312) 807-2000

SPL036

SPILL REPORT

DATE: May 4, 1989 TIME: 15:00 hrs

NAME OF PERSON COMPLETING FORM: Joseph B. Hossley

NAME OF PERSON REPORTING SPILL: David Santner

WHAT WAS SPILLED: Diesel

QUANTITY: ~ 2 gallons

LOCATION: Diesel Pad - 400 Area

WHO WAS NOTIFIED (WSTF): Joseph B. Hossley, LESC Environmental Sect.

DESCRIPTION: The return line from diesel engines leaked below ground level. Leak was discovered and discolored soil surrounding leaking pipe was removed. Discolored soil was placed on plastic to allow volatiles to evaporate. Pipe leak will be repaired. Soil, after exposure for five days, will be placed in the WSTF landfill. Trench will be filled with fresh sand.

SPL037

SPILL REPORT

DATE: May 8, 1988 TIME: 09:00 hrs

NAME OF PERSON COMPLETING FORM: Joseph B. Hossley

NAME OF PERSON REPORTING SPILL: John Bernal

WHAT WAS SPILLED: Bioact DG-1 (MSDS attached)

QUANTITY: < 1 pint

LOCATION: Warehouse Receiving

WHO WAS NOTIFIED (NASA): R. Mitchell

DESCRIPTION: Bioact DG-1 (petroleum derivative, MSDS attached) was received by warehouse. Shipment, five 1-gallon cans, had leaked out lids and contaminated shipping papers. Papers were placed in plastic, copied, and then discarded. Cans were wiped dry and then issued to Contamination Control, the requestor.

Material Safety Data Sheet [illegible]
May be used to comply with
OSHA's Hazard Communication Stan[illegible]
29 CFR 1910.1200. Standard must b[illegible]
consulted for specific requirements.

[illegible]S. Department of Labor
[illegible]ccupational Safety and Health Administration
[illegible]n-Mandatory Form)
[illegible]m Approved
[illegible]B No. 1218-0072

IDENTITY *(As Used on Label and List)*
BIOACT®* DG-1

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name PETROFERM INC.	Emergency Telephone Number 1-904-261-8286
Address *(Number, Street, City, State, and Zi[illegible])* 5400 First Coast Highw[illegible] Fernandina Beach, FL 3203[illegible]	Telephone Number for Information 1-904-261-8286
	Date Prepared 7/18/88
	Signature of Preparer *(optional)*

Section II — Ha[illegible]ormation

Hazardous Components [illegible] Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Terpene Hydrocarbons CAS # 138-86-3	Not Est.	Not Est.	Not Est.	65 - 95

All ingredients are listed [illegible] on the GRAS or as an approved substance for use either as an indirect [illegible] ditive or for use in the manufacture of metal food containers [illegible] he code of Federal Regulations, Title 21, Part 178, Secti[illegible]ion 3910.

None of the ingredients contained in the product are listed in the Threshold Limit Values and Biological Exposure Indices compiled by the American Conference of Governmental Industrial Hygienists.

Section III — Physical/Chemical Characteristics

Boiling Point	[illegible]40 - [illegible]72°F	Specific Gravity (H_2O = 1)	0.85
Vapor Pressure (mm Hg.) at 70°F	[illegible]	Melting Point	< 0°F
Vapor Density (AIR = 1)	[illegible]	Evaporation Rate (Butyl Acetate = 1)	< 1

Solubility in Water
Emulsifiable

Appearance and Odor
Clear free flowing [illegible] Citrus odor.

Section IV — Fire and Explosion Hazard[illegible]

Flash Point (Method Used)	Flammable Limits	LEL	UEL
145°F COC / 120°[illegible]	at 302°F	0.7%	6%

Extinguishing Media
Dry chemical, Foam, CO_2 [illegible]

Special Fire Fighting Procedures
Precautions use[illegible] fires.

Use self-contained breathing apparatus.

Unusual Fire and Explosion Hazards
None

(Reproduce locally) * "BIOACT" IS A REGISTERED TRADEMARK OF PETROFERM INC.

Section V — Reactivity Data

Stability			
	Unstable		Conditions to Avoid
	Stable	X	

Incompatibility (*Materials to Avoid*) Strong Mineral Acids, Str[illegible]

Hazardous Decomposition or Byproducts None, other than normal [illegible]cts of [illegible]bustion.

Hazardous Polymerization			
	May Occur	X	Conditions to Avoid: Polymerization may occ[illegible] [illegible]amination with strong acids.
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry:	Inhalation?	Skin?	Ingestion?
	No	Yes	Yes

Health Hazards (*Acute and Chronic*) Excessive skin contact will remove natural skin oi[illegible] could lead to reversible dermatitis. Contact with eyes may cause irritation. [illegible] chronic inhalation in unventilated areas may cause irritation of the resp[illegible] inhalation overexposure should be avoided by adequate ventilati[illegible]ls.

Carcinogenicity:	NTP?	IARC Monographs?	OSHA Regulated?
	No	No	No

Signs and Symptoms of Exposure Dry, reddened skin, eye irritation, [illegible]piratory tract irritation.

Medical Conditions Generally Aggravated by Exposure Not Est.

Emergency and First Aid Procedures For suspected oral ingestion, do not induce v[illegible]ng. Seek medical attention. In case of eye contact, flush eyes with water and obtain [illegible] attention if symptoms persist. In case of skin contact, wash well with water and use skin cream if irritation is severe.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled Mop up spills on hard surfaces and transfer to waste container for disposal. Dilute spills on ground or porous surfaces with water.

Waste Disposal Method Collect contaminated material in containers and repro[illegible] or incinerate. Disposal must comply with all applicable government [illegible]ulations.

Precautions to Be Taken in Handling and Storing Store in original closed container, preferably in a [illegible] ventilated, fire resistant building.

Other Precautions None.

Section VIII — Control Measures

Respiratory Protection (*Specify Type*) None Required

Ventilation			
	Local Exhaust: Acceptable	[illegible]	None Needed
	Mechanical (*General*): Acceptable	[illegible]	None Needed

Protective Gloves Solvent Resistant — **Ey[illegible]** Safety Glasses/Goggles

Other Protective Clothing or Equipment Eyewash facilities

Work/Hygienic Practices None Known.

U.S.G.P.O. 1986-491-529/45775

SPL038

SPILL REPORT

DATE: May 9, 1988 **TIME:** 1:25 pm

NAME OF PERSON COMPLETING FORM: James E. Henderson

NAME OF PERSON REPORTING SPILL: John Bernal

WHAT WAS SPILLED: Bioact DG-1

QUANTITY: < 1 pint

LOCATION: Warehouse Receiving

WHO WAS NOTIFIED (NASA): R. Mitchell

DESCRIPTION: Bioact DG-1 (petroleum derivative, MSDS attached) was received by warehouse. Shipment, five 1-gallon cans, had leaked around the lids and contaminated the box and packing materials. The cans were washed and placed into stock and the box and packing materials were placed in the dumpster.

Material Safety Data She[illegible]
May be used to comply with
OSHA's Hazard Communication Stan[illegible]
29 CFR 1910.1200. Standard must b[illegible]
consulted for specific requirements.

[illegible]S. Department of Labor
[illegible]ccupational Safety and Health Administration
[illegible]n-Mandatory Form)
[illegible]m Approved
[illegible] No. 1218-0072

IDENTITY *(As Used on Label and List)*
BIOACT®* DG-1

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name: PETROFERM INC.	Emergency Telephone Number: 1-904-261-8286
Address *(Number, Street, City, [illegible], and Z[illegible])*: 5400 First Coast Highw[illegible]	Telephone Number for Information: 1-904-261-8286
Fernandina Beach, FL 320[illegible]	Date Prepared: 7/18/88
	Signature of Preparer *(optional)*

Section II — H[illegible]ormation

Hazardous Components [illegible] Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Terpene Hydrocarbons CAS # 138-86-3	Not Est.	Not Est.	Not Est.	65 - 95

All ingredients are listed [illegible] on the GRAS or as an approved substance for use either as an indirect [illegible]od [illegible]ditive or for use in the manufacture of metal food containers [illegible] the code of Federal Regulations, Title 21, Part 178, Secti[illegible]ion 3910.

None of the ingredients contained in the product are listed in the Threshold Limit Values and Biological Exposure Indices compiled by the American Conference of Governmental Industrial Hygienists.

Section III — Physical/Chemical Characteristics

Boiling Point	[illegible]0 - [illegible]72°F	Specific Gravity (H_2O = 1)	0.85
Vapor Pressure (mm Hg.)	at 70°F	Melting Point	< 0°F
Vapor Density (AIR = 1)		Evaporation Rate (Butyl Acetate = 1)	< 1

Solubility in Water: Emulsifiable

Appearance and Odor: Clear free flowing [illegible] Citrus odor.

Section IV — Fire and Explosion Hazar[illegible]

Flash Point (Method Used)	Flammable Limits	LEL	UEL
145°F COC / 120°[illegible]	at 302°F	0.7%	6%

Extinguishing Media: Dry chemical, Foam, CO_2 [illegible]

Special Fire Fighting Procedures: Precautions use[illegible] fires.

Use self-contained breathing apparatus.

Unusual Fire and Explosion Hazards: None

(Reproduce locally) * "BIOACT" IS A REGISTERED TRADEMARK OF PETROFERM INC.

Section V — Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable	X	

Incompatibility (*Materials to Avoid*)
Strong Mineral Acids, Str[illegible]

Hazardous Decomposition or Byproducts
None, other than normal [illegible]cts of [illegible]bustion.

Hazardous Polymerization	May Occur	X	Conditions to Avoid: Polymerization may occ[illegible]ntamination with strong acids.
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry:	Inhalation?	Skin?	Ingestion?
	No	Yes	Yes

Health Hazards (*Acute and Chronic*)
Excessive skin contact will remove natural skin oi[illegible] could lead to reversible dermatitis. Contact with eyes may cause irritation. [illegible]r chronic inhalation in unventilated areas may cause irritation of the resp[illegible] [illegible]ic inhalation overexposure should be avoided by adequate ventilati[illegible]ls.

Carcinogenicity:	NTP?	IARC Monographs?	OSHA Regulated?
	No	No	No

Signs and Symptoms of Exposure
Dry, reddened skin, eye irritation, [illegible]piratory tract irritation.

Medical Conditions
Generally Aggravated by Exposure   Not Est.

Emergency and First Aid Procedures   For suspected oral ingestion, do not induce vo[illegible]ing. Seek medical attention. In case of eye contact, flush eyes with water and obtain [illegible] attention if symptoms persist. In case of skin contact, wash well with water and use skin cream if irritation is severe.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled
Mop up spills on hard surfaces and transfer to waste container for disposal.
Dilute spills on ground or porous surfaces with water.

Waste Disposal Method
Collect contaminated material in containers and repr[illegible] or incinerate.
Disposal must comply with all applicable government [illegible]ulations.

Precautions to Be Taken in Handling and Storing
Store in original closed container, preferably in a [illegible]l-ventilated, fire resistant building.

Other Precautions
None.

Section VIII — Control Measures

Respiratory Protection (*Specify Type*)
None Required

Ventilation			
	Local Exhaust: Acceptable	Special	None Needed
	Mechanical (*General*): Acceptable	Other	None Needed

Protective Gloves: Solvent Resistant	Eye Protection: Safety Glasses/Goggles

Other Protective Clothing or Equipment
Eyewash facilities

Work/Hygienic Practices
None Known.

U.S.G.P.O. 1986-491-529/45775

SPL041

SPILL REPORT

DATE: June 14, 1989 TIME: 15:00 hrs.

NAME OF PERSON COMPLETING FORM: Ray Spencer

NAME OF PERSON REPORTING SPILL: Pat Matthews

WHAT WAS SPILLED: Diesel, Cutting/Motor Oil

QUANTITY: Unknown (see **)

LOCATION: ~ 100' NE of GWM Well BW-5-298

WHO WAS NOTIFIED (NASA): Ray Spencer, LESC

Jim Henderson, LESC

DESCRIPTION: Hydrocarbon odors were noted imminating from an arroyo approximately 100 feet northeast of groundwater monitoring Well BW-5-298. Upon investigation of the arroyo area, discolored soil was noted over a 20- to 30-foot length of the arroyo. Using a shovel, several points along the arroyo were excavated to a depth of 1 foot. Soils excavated were damp and exhibited a distinctly diesel odor.

In a search of the immediate area near the diesel spill, numerous other smaller spills of cutting oil and motor oil were also observed.

** Unknown due to the length of time elapsed prior to spill detection and surface grading performed adjacent to the spill area.

BW-5 DIESEL SPILL

During construction of the road to STGT during 1988, the area surrounding what is now BW-5 was used as a home base for heavy equipment and the asphalt plant. Occasional visits were conducted by the Environmental Section to check on waste management practices. Operations including refueling, oil changes, and minor repair were observed in this area. During one visit to the area, drums of discarded hydrocarbon (HC) based material, oil filters, and batteries were discovered. Poor product control was also noted during most visits. Drums of oils and other HC based materials were regularly observed leaking onto the ground. A request was made, through NASA, to the contractor in charge of the area to clean up the waste materials and maintain better product control. The waste materials were gone the next time the area was visited and product control had improved slightly. As the work at STGT was completed and the equipment was removed, some of the trash and scrap lumber was observed being placed in a nearby pit for burial. Because it is common practice for construction operations to bury trash on site and the fact that no hazardous materials were observed in the trash pit, no report was made.

After the area had been abandoned by the construction crew, a groundwater monitoring well (BW-5) was drilled at the northwest end of the area. During a sampling event on June 14, 1989, the sampling crew noted a diesel odor and followed the smell back up an arroyo. Contaminated soil was discovered along the length of an arroyo about 100 feet upgradient from the well. At the top of the arroyo was an area suspected of being a filled over disposal pit.

On July 11, 1989, a backhoe was used to dig several exploratory trenches through the arroyo and into what was the suspected location of the disposal pit. The arroyo trenches showed that the contamination ranged from the surface to a level about a foot down and was spread along the arroyo for about fifty yards. One exception was a dark oily area which went all the way to the caliche layer, but was limited laterally. It looked like someone had drained a crankcase of used oil directly into the ground at this one spot. A hard caliche layer existed at about three feet below the surface in all areas. The suspected disposal pit was not found, and additional holes to find it were not deemed justifiable. Based on the visual limits to the contamination and a failure to pick up any reading on an HNu, a decision was made to remove visual contamination and close out the investigation. Oily dirt was scrapped out of the arroyo and spread out on the hard pack area to the south to be broken down by exposure. The area was then scraped to restore the natural contours.

SPL047

SPILL REPORT

DATE: July 17, 1989 **TIME:** 7:00 a.m.

NAME OF PERSON COMPLETING FORM: J. Henderson JH

NAME OF PERSON REPORTING SPILL: K. Lambert

WHAT WAS SPILLED: Diesel

QUANTITY: 2-3 Gallons

LOCATION: 200 Area, east side between Bldg. 200 and North High Bay

WHO WAS NOTIFIED (NASA): R. Mitchell

DESCRIPTION: A diesel generator was filled with diesel and left. High temperatures apparently caused the diesel to overflow out of the tank and onto the ground. Spill dry was spread on the spill to absorb the liquid. Spill dry was swept up and bagged by Facilities and will be placed in the WSTF landfill.

SPILL REPORT

DATE: December 16, 1989 **TIME:** 5:30pm

NAME OF PERSON COMPLETING FORM: J. Henderson, LESC

NAME OF PERSON REPORTING SPILL: WSTF Fire Department

WHAT WAS SPILLED: Diesel

QUANTITY: 100 gallons

LOCATION: 150 Area overhead diesel tank

WHO WAS NOTIFIED (NASA): R. Mitchell, NASA

DESCRIPTION: The WSTF Fire Department noted a diesel spill at the overhead diesel tank in the 150 Area and notified the LESC Environmental Section. Fire Department personnel were able to stop the leak by securing the valve, but a puddle, 10 ft. by 10 ft. and 2-3 inches deep, of diesel had formed. The Environmental Section arrived on site at about 6:00pm to evaluate the spill. With assistance from the Fire Department, spill control materials were gathered and used to absorb the free liquids. R. Mitchell was contacted and informed of the spill at about 6:45pm. It was agreed that removal of the contaminated soil would be postponed until Monday.

On Monday, December 18, 1989, heavy equipment was utilized to remove the visually contaminated soil (TPS 6-HWM-158). The soil was transported to the WSTF land-fill and spread on the ground to degrade. The costs

SPILL REPORT

DATE: January 18, 1990 TIME: 2:15 p.m.

NAME OF PERSON COMPLETING FORM: J. Henderson

NAME OF PERSON REPORTING SPILL: G. Charles

WHAT WAS SPILLED: Paint

QUANTITY: < 1 gallon

LOCATION: 120 Warehouse

WHO WAS NOTIFIED (NASA): None

DESCRIPTION: A 1 gallon can of paint was received with a loose lid. The spilled paint was wiped up with rags and the can resealed for use.

MATERIAL SAFETY DATA SHEET

BARTIN CHEMICAL LTD.
2686 LISBON ROAD
CLEVELAND, OH. 44104
(216) 721-5755

SECTION I

EMERGENCY NO. 1/800-424-9300 - CHEMTEC

INFORMATION TELEPHONE NO. 216-721-5755

D.O.T. HAZARD CLASS Combustible Liquid UN1263

CHEMICAL NAME AND SYNONYM Blend-not applicable

CHEMICAL FAMILY Blend-not applicable

TRADE NAME 4010 Rubber Base Interior and Exterior Seal

PRODUCT CLASS Code 06, Varnish, Coatings-Clear

D.O.T. SHIPPING NAME Paint

CHEMICAL FORMULA Proprietary

DATE March, 1986

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENT	CAS NO.	%	VAPOR PRESSURE (mm Hg.)	OCCUPATIONAL EXPOSURE LIMITS
Aromatic HydrocarbonSolvent	64742-95-6	39-41	2.2 @ 68°F	100ppm (ACGIH-TLV/TWA) 125ppm (ACGIH-TLV/STEL) 500ppm (OSHA-PEL/TWA)
Mineral Spirits-Rule 66	64741-92-0	39-41	6.3	100ppm (ACGIH-TLV/TWA) 200ppm (ACGIH-TLV/STEL) 500ppm (OSHA-PEL/TWA)

SECTION III - PHYSICAL DATA

BOILING POINT (°F) 311

VAPOR DENSITY heavier than air

SOLUBILITY IN WATER nil

APPEARANCE AND ODOR Slight yellowish liquid with solvent odor.

SPECIFIC GRAVITY ($H_2O=1$) 0.850

PERCENT VOLATILE BY VOLUME (%) 78-81

EVAPORATION RATE FASTER x SLOWER THAN ETHER

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED) 105°F (COC)

FLAMMABLE LIMITS Lel= Uel= undetermined

EXTINGUISHING MEDIA

X FOAM _ ALCOHOL FOAM X CO_2 X DRY CHEMICAL _ WATER FOG _ OTHER

SPECIAL FIRE FIGHTING PROCEDURES DO NOT use direct water stream. Product will float on top if igni will spread fire rapidly. Spill will make surface slippery exercise due caution. Treat as A Class "B" Fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS Pressure increases in overheated tightly closed containers. Containers may be cooled with water provided that product is not on fire itself and that it is not detrimental to other involved materials. Vapors are volatile and are heavier than ai

SECTION V - HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE
Primary Entry; Dermal, Inhalation, Oral.
Skin-prolonged or repeated contact may result in defatting, irritation, and dermatitis.
Eyes-burning, irritant.
Ingestion-nausea, vomiting.
Inhalation of fumes may result in dizziness, headache, blurred vision, and unconsiousness.
None expected when good industrial hygiene practices are employed.

EMERGENCY AND FIRST AID PROCEDURES
Skin-wash thoroughly with soap and water.
Launder contaminated clothing before re-use.
Flush eyes with copius amounts of cool water for at least 15 minutes-seek medical attention.
If spontaneous vomiting occurs take steps to prevent aspiration into the lungs.
Contact nearest Poison control Center. If pain persists or further problems develop,seek medical attention. Inhalation-remove to fresh air. Administer oxygen if available. Treatment is to be based on the sound judgment of the physician and the individual reaction(s) of the patient.

SECTION VI - REACTIVITY DATA

STABILITY: ___ UNSTABLE x STABLE   CONDITIONS TO AVOID High temperature, open flames.

INCOMPATABILITY (MATERIALS TO AVOID) Strong Oxidants.

HAZARDOUS DECOMPOSITION PRODUCTS Carbon Dioxide, carbon monoxide and unidentified organic constituents. Smoke.

HAZARDOUS POLYMERIZATION ___ MAY OCCUR x MAY NOT OCCUR

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED Contain spill,notify appropriate company personnel. Eliminate ignition osurces. Keep unecessary out of and away from the away. Avoid breathing fumes. Limit exposure as much as possible. If spill enters sewers or waterways use Booms (if available) ot control dispersion.

WASTE DISPOSAL METHOD
Dispose of in accordance with Federal, State and Local Laws. Check also your company's policy. Notify local fire department of spill as a safety precaution and alert.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION As required to stay below TLV. Use NIOSH approved breathing apparatus.

VENTILATION Yes-to keep below TLV. In accordance with Reg. 29 CFR. Part 1910

PROTECTIVE GLOVES yes impervious gloves

EYE PROTECTION splashproof goggles

OTHER PROTECTIVE EQUIPMENT Eyewash station/ safety shower Impervious boots, apron suggested to minimize skin contact. long sleeve shirt/pants suggested/

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING Wash hands before and after use. Store only in clean dry areas in properly labelled containers. Do not re-use empty containers. DO NOT take internally. Keep out of the reach of children. Please read the complete directions and precautions before use. NO SMOKING signs should be posted and enforced. For industrial use ONLY. DO NOT weld or use cutting torches on or near empty containers. Vapors are volatile. DO NOT permit personnel to use without proper safety/hazards training.

OTHER PRECAUTIONS
The suggestions and data provided herewith are based upon tests and information which we believe to be reliable. However, users should make their own investigations to determine the suitability of the information or products for their particular purpose. Technical data and/or consultation available on request during regular business hours. Values listed represent typical data and are NOT to be taken as product specifications. As information and/or becomes available you can be assured we'll do our best to keep you informed. All electrical equipment in areas where material is stored and/or handled should be installed in accordance with applicable requirements of the National Electric Code N.F.P.A.

SPILL REPORT

DATE: May 2, 1990 **TIME:** 11:15 a.m.

NAME OF PERSON COMPLETING FORM: Harold F. Harrison HH

NAME OF PERSON REPORTING SPILL: Gilbert E. Avalos

WHAT WAS SPILLED: Gasoline, Leaded

QUANTITY: Approximately 15 gallons

LOCATION: Temporary fuel tanks

WHO WAS NOTIFIED (NASA): John Edwards, DCAS
Harold Harrison, LESC

DESCRIPTION: Vendor set automatic nozzle while refueling the temporary gas tanks with leaded gas. While the tank was filling, he stepped into his truck to do paperwork as the gas pumped. Once the tank was full, the automatic nozzle got jammed and did not turn off. The tank overflowed, spilling approximately 15 gallons on the floor before the vendor shut off the flow from a switch inside the truck.

Upon observation of the gasoline mixed with gravel, H. Harrison recommended the contaminated gravel be picked up with a spark-proof shovel, double-bagged in poly bags, and taken to the landfill. At the landfill the the gravel should be spread out to air dry on a vinyl vapor barrier.

SPL060

SPILL REPORT

DATE: 10-5-90 TIME: 15:00

NAME OF PERSON COMPLETING FORM: D SANTNER

NAME OF PERSON REPORTING SPILL: MARV ALDRICH

WHAT WAS SPILLED: IPA

QUANTITY: 40-50 GALLONS

LOCATION: ALCOHOL RUN TANK

WHO WAS NOTIFIED (WSTF): BEN SWARTZ

DESCRIPTION: THE AUTOMATIC SHUTOFF DID NOT OPERATE PROPERLY WE WERE TRYING TO GET TANK AS FULL AS POSSIBLE FOR SUPPORT FIRING AT T/S 401

A.B. Swartz 10/10/90: Directed cleanup operation on OT 10/5/90. Liquid IPA to be pumped with E.P. Haz. waste pump to closed head barrel. The solid (ground) contaminated with IPA would be dug-out & placed on plastic to air dry. The solid would then be placed in an open head drum.

As of 10/10/90 initial clean up is complete, but final clean up is not.

National Aeronautics and Space Administration

SWMU 49, 700 Area Landfill Historical Information Summary

~~December 2017~~Revised March 2019

NM8800019434

Executive Summary

This report summarizes information regarding historical site operations, hazardous chemical use, and hazardous waste management practices at the NASA White Sands Test Facility (WSTF) solid waste landfill, located within the 700 Area. This summary will facilitate identification of any potential releases of hazardous substances or hazardous waste to the environment and is designed to support the development of the 700 Area Landfill Phase I Investigation Work Plan (IWP; NASA, 2017g). Attachment 16 of the WSTF Hazardous Waste Permit requires that this IWP be submitted to the New Mexico Environment Department (NMED) on or before December 29, 2017 (Permit; NMED, 2016b).

Operations and waste management practices at WSTF were not well documented prior to 1985, when a full-time Environmental Department was established at WSTF to implement waste management practices (including off-site shipment/disposal of hazardous wastes) and ensure regulatory compliance. Prior to 1985, the only WSTF wastes shipped off site for disposal were vehicle batteries (1963-present) and polychlorinated biphenyls (PCBs; 1980-present). Any wastes generated at WSTF prior to 1985, including hazardous wastes, were disposed on site. In general, liquid wastes were managed in surface impoundments and solid wastes were disposed in the 700 Area landfill. Documentation regarding 700 Area landfill waste management is incomplete. NASA has researched existing historical records and conducted interviews of both retired and active long-term site employees to determine the nature and timing of any releases or potential releases to the environment.

The SWMU number as listed in the Permit for the 700 Area landfill is SWMU 49, and the WSTF 700 Area landfill began operation between 1963 and 1965. The last waste was received on October 27, 1997. The total volume of waste within the landfill has been estimated as 78,000 cubic yards (cu. yd.), based on an estimate of 3,000 cu. yd. per cell and 26 total cells that were surveyed. This estimate may not be accurate; however, because the cells are not all uniform in size, and the survey may not have identified all cells.

The majority of wastes disposed in the 700 Area landfill included office and non-hazardous laboratory wastes with lesser amounts of construction and demolition debris, wood, yard waste, cafeteria waste, and animal carcasses, placed in a separate trench. Known wastes disposed in the 700 Area landfill that would be prohibited under current regulations include:

- Special wastes such as:
  - Infectious waste (sharps, blood, etc.) from the on-site dispensary.
  - Chemical or petroleum contaminated soils (lead, benzene, arsenic, cadmium, chromium, solvents).
- Hazardous wastes disposed in the 700 Area landfill included:
  - Contaminated debris (such as soft goods, hardware, and clean-up materials) contaminated with:
    - Fuels (unsymmetrical dimethylhydrazine [UDMH], Aerozine-50 [A-50]. monomethylhydrazine [MMH], and hydrazine).
    - Oxidizer (nitrogen tetroxide [N_2O_4]).
    - All 200 Area laboratory chemicals (e.g., trichlorofluoromethane [Freon 11], 1,1,2-trichloro-1,2,2-trifluoroethane [Freon 113], trichloroethene [TCE], tetrachloroethene [PCE], other solvents, isopropyl alcohol [IPA], other alcohols, acetone, methyl ethyl ketone [MEK], phosphorus, etc.).
    - Hydrocarbons (e.g., diesel, gasoline, hydraulic fluid, lubricating oils, motor oils, etc.).
    - Krytox lubricant (Appendix C contains material safety data sheets [MSDS]),

        - Teflon grease. and
        - Mercury (cloth used to clean broken thermometers or spills prior to initiation of shipping wastes off-site for disposal).
    - Small amounts of metals (stainless steel, carbon steel, titanium, aluminum, iron, mercury, copper, tin, gold, silver, chromium).
    - Fluorescent lights (lead, cadmium, mercury).
    - Fluorescent light ballasts (containing PCBs).
    - Mercury lamps (mercury).
    - Construction debris, insulation (asbestos).
    - Oil-based paints and primers (chromium, lead, ignitable).
    - Epoxies, resins, oils, adhesives, plastics, caulking, floor finish (solvents; possibly containing PCBs).
    - Copy paper, tapes, caulking.
    - Batteries (corrosive, lead, cadmium).
    - Photographic papers/negatives (silver [silver bromide]).
    - Etching plates (copper, metals).
    - Automotive wastes (tires, brake parts, filters, antifreeze, used oil).
    - Aerosol cans (barium, benzene, MEK, TCE, PCE, ignitable, corrosive, reactive wastes).
    - Broken or inoperable equipment/meters (metals, possibly asbestos and PCBs).
    - Pipes/plumbing (metals).
    - Spent charcoal (fluorine, reactive wastes).
    - Possibly wastewater (sewage) lagoon sludge.
- Liquids (estimated to be 10s to 100s of gallons [gal] annually from mid-1960s to 1985).
    - Unused or off-specification substances within containers or free liquids (lead, mercury, solvents, paints).
    - Freons (Freon 11 and Freon 113 in 55-gal drums and free liquids).
    - Other solvents (TCE, MEK, etc.).
    - Paints (barium, benzene, MEK, ignitable wastes; possibly PCBs).
    - Epoxies.
    - Electrolytes from batteries (from mid-1960s-1968; corrosive, lead).

Fires or explosions were also historically conducted within the trenches at the 700 Area landfill. During three different testing programs at WSTF (one in the 1960s, one in the 1970s, and one in 1985), small propulsion engines were destroyed using explosives within active trenches at the landfill. These engines may have contained fuel and oxidizer, and the solid propellant motor contained full solid propellants/oxidizer when destroyed. If the composition of the propellant was aluminum/ammonium perchlorate, then residual perchlorate may be present.

Long-term WSTF employees recalled one fire resulting from the destruction of engines within the landfill. The fire involved the active cell and an adjacent covered cell. One employee witnessed one "spontaneous" fire of flammable rags in the mid-1970s, and weekly intentional fires were set to destroy sensitive documents and computer cards within active trenches/cells conducted from the mid-1960s to the mid-1980s.

Table of Contents

List of Figures/Tables

List of Acronyms

µg/L	Microgram per Liter
A-50	Aerozine-50
ADF-SW	Aerospace Data Facility-Southwest
AML	Assessment monitoring level
amsl	Above mean sea level
AOC	Area of concern
$BaSO_4$	Barite
BATES	Ballistic Test and Evaluation System
BEHP	Bis(2-ethylhexyl)phthalate or di(2-ethylhexyl phthalate)
bgs	Below ground surface
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
cu yd	Cubic yard(s)
DoD	Department of Defense
DP	Discharge Plan
DR	Discrepancy Record
EIB	Environment Improvement Board
EPA	Environmental Protection Agency
ETU	Evaporation Tank Unit
Freon 11	Trichlorofluoromethane
Freon 113	1,1,2-Trichloro-1,2,2-trifluoroethane
ft	Foot or feet
FY	Fiscal year
gal	Gallon(s)
GCL	Geosynthetic clay liner
GeCL	Geoscience Consultants, Ltd.
HAFB	Holloman Air Force Base
HIS	Historical Information Summary
HWB	Hazardous Waste Bureau
HWMU	Hazardous Waste Management Unit
in.	Inch(es)
IPA	Isopropyl alcohol
IWP	Investigation Work Plan
JER	Jornada Experimental Range
JSC	Johnson Space Center
K	Hydraulic conductivity
lbs	pounds
LEL	Lower explosive limit
MCL	Maximum Containment Level
MEK	Methyl ethyl ketone
mg/L	Milligrams per Liter
MMH	Monomethylhydrazine
MSDS	Material Safety Data Sheet(s)
n.t.	No title
N_2O_4	Nitrogen tetroxide or dinitrogen tetroxide
NASA	National Aeronautics and Space Administration

NiCad	Nickel Cadmium
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMEID	New Mexico Environmental Improvement Division
NMSLO	New Mexico State Land Office
NOI	Notice of intent
ODU	Open Detonation Unit
PCB	Polychlorinated biphenyl
PCC	Post-closure care
PCE	Tetrachloroethene
PVC	Polyvinyl chloride
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAM	San Andres Mountains
SCAPE	Self-contained atmospheric protection ensemble
STGT	Second TDRSS Ground Terminal
SWB	Solid Waste Bureau
SWMR(s)	Solid Waste Management Regulation(s)
SWMU(s)	Solid waste management unit(s)
TCE	Trichloroethene
TDRSS	Tracking and Data Relay Satellite System
TDS	Total dissolved solids
TPS	Test Preparation Sheet
UDMH	Unsymmetrical dimethylhydrazine
UST	Underground Storage Tank
WSMR	White Sands Missile Range
WSTF	White Sands Test Facility

1.0 Introduction

1.1 Purpose

The National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC) White Sands Test Facility (WSTF) Hazardous Waste Permit (Permit) issued by the New Mexico Environment Department (NMED) requires the preparation and submittal of a historical information summary (HIS) for each solid waste management unit (SWMU) or area of concern (AOC) to be investigated (NMED, 2016b, Section VII.H.1.c). The information gathered during preparation of each HIS will be used to aid the development of unit-specific investigation work plans (IWPs). The purpose of this HIS is to evaluate past site operations, hazardous chemical usage, and waste management practices to identify known or potential releases of hazardous waste or hazardous substances to the environment in or around WSTF SWMU 49, the 700 Area landfill. The SWMU 49 Phase I IWP (NASA, 2017g) will be submitted concurrently with this HIS.

1.2 Scope

Information compiled in this summary was obtained from review of historical documentation, including reports, correspondence, files, and photographs. Additional information was obtained from questionnaires from, or interviews with, current and former WSTF employees. NASA collected and reviewed the information in this HIS between April and December 2017.

The observations and interpretations presented in this document are strictly limited in time and scope to the information obtained during the review process. No subsurface exploratory drilling, sampling, or chemical analyses were performed during the course of this evaluation. However, previous methane gas and groundwater monitoring associated with the 700 Area landfill is discussed.

1.3 Limitations and Assumptions

WSTF historical operations and waste management practices were not well documented from the inception of the site in 1963 through the mid-1980s. For this HIS, NASA relied on a limited assortment of documents, correspondence, and the recollections of long-term WSTF employees to provide waste disposal practices for SWMU 49, the 700 Area landfill. The information is subject to the limitations of historical documentation, availability and accuracy of pertinent records, and the personal recollection of the individuals interviewed. In many cases, there is insufficient information available to provide independent verification that the information is accurate and complete.

2.0 Site Description

2.1 Location

WSTF is located in Doña Ana County, 18 miles northeast of Las Cruces, New Mexico and 65 miles north of El Paso, Texas. Figure 2.1 provides a WSTF location map. Access to the site is provided via a paved road (NASA Road) that intersects U.S. Highway 70, one mile west of Organ, New Mexico.

2.2 Land Ownership

WSTF administrative and testing facilities are located on White Sands Missile Range (WSMR), owned by the U.S. Department of the Defense, Department of the Army (DoD). NASA is the operator of the facility under an inter-agency agreement with the U.S. Army (DoD, 1982). NASA also maintains land-use agreements with the Bureau of Land Management (BLM; a right-of-way agreement; BLM, 1978), the

New Mexico State Land Office (NMSLO; a water exploration/development easement; NM, 1989), and the U.S. Department of Agriculture, Agricultural Research Service Jornada Experimental Range (JER; an easement deed; USDA, 2003) for the use of lands located to the west of the industrial facility. Figure 2.2 provides an ownership overview of lands used by NASA.

2.3 Land Use

SWMU 49 is located within the industrial area of WSTF (Figure 2.2). All of the WSTF industrial areas are strictly for industrial use. Security and firefighting personnel staff the facility 24-hours per day, seven days per week; however, there are no full-time residents at WSTF. WSTF is a restricted access area closed to the public, and access by visitors is provided only in accordance with NASA JSC policies.

2.4 General Physical Setting

WSTF is located on soil composed of coalescent alluvial fans that are locally dissected by arroyos. The facility is bordered on the east by the north-south trending San Andres Mountains (SAM) that ascend over 6,000 feet (ft) above mean sea level (amsl). The WSTF site is bordered on the west by a broad uniformly sloping alluvial pediment plain extending into the Jornada del Muerto Basin and to the Doña Ana Mountains. The major alluvial fan systems originate from Bear Canyon to the northeast and Loman Canyon to the southeast of WSTF. Foothills on the western pediment of the SAM at WSTF are typically 4,800 to 5,000 ft amsl, are moderately sloping (15 to 25%), and consist of thin layers of alluvium covering fractured limestone and volcanic bedrock. The numerous dissecting arroyos only flow during periods of heavy rainfall. Figure 2.3 provides a topographic map of WSTF and surrounding areas.

3.0 SWMU 49 Background

3.1 Location and Current Use of the 700 Area

The 700 Area is located in Section 26, Township 20 South, Range 3 East. Access to the 700 Area is provided by gravel roads (Road P and Cereus Drive) from Apollo Boulevard, the main paved access road through WSTF. Currently, southwest of the landfill and also within the 700 Area is a high-energy blast facility used for expending ordnance and propellant blast testing as needed (Figure 3.1).

3.2 Physical Setting at the Property

Sections 3.2, Surface Conditions and 3.3, Subsurface Conditions in the SWMU 49, 700 Area landfill IWP provide detailed descriptions of the physical setting at the landfill (NASA, 2017g).

3.3 Description of Structures

Attachment 22 of the Permit (NMED, 2016b) identifies SWMUs at WSTF. The 700 Area contains two SWMUs, a remote testing area titled the 700 Area High Energy Blast Facility (SWMU 18) and the WSTF 700 Area landfill (SWMU 49; Figure 3.1).

Buildings and structures in the 700 Area High Energy Blast Facility include a control center, three temporary buildings/shelters, and several steel pole remnants. There are no buildings located within the 700 landfill area, but structures include both conventional and multiport groundwater monitoring wells surrounding the landfill and methane gas monitoring wells within the boundaries of the 700 Area landfill (Figure 3.1).

3.4 Current Uses of Adjoining Properties

3.4.1 Open Detonation Unit

The Open Detonation Unit (ODU) was an unlined, ramped, open trench surrounded by protective 3-ft high soil berms to restrict surface water drainage into the unit. The ODU was used for waste explosives treatment and disposal operations and was located adjacent to the northeast side of the 700 Area Landfill (Figure 3.1). The dimensions of the ODU were 46 ft long by 9 ft wide by up to 6 ft deep. The unit began operation in 1987 as an open burning/open detonation unit and was under interim operational status until the unit was permitted as only an open detonation unit (no burning allowed) under HWMR-6, Part V, Subpart X in 1993 as part of the WSTF Hazardous Waste Operating Permit (NMED, 1993b). The last waste disposed at the RCRA-permitted ODU was on March 23, 1999. In late 1999, NASA decided to permanently close the unit. Closure activities originally began on August 20, 2002. NMED approved the clean closure of this unit on August 12, 2005 (NMED, 2005). Disposal of excavated soil from the original ODU closure occurred on January 19, 2006. Final ODU backfill activities began on March 2, 2006 and were completed on March 3, 2006. The unit was backfilled with soil from the WSTF borrow area near Well J. NMED regulatory personnel inspected the closure on March 7, 2006 (NASA, 2006b).

3.4.2 Second TDRSS

The Second Tracking and Data Relay Satellite System Ground Terminal (STGT) is located to the west of the 700 Area (Figure 3.2). The STGT facility is part of the Space Network data communication system comprised of satellites in geosynchronous orbit (referred to as the Tracking Data Relay Satellites) and ground terminals with high-gain microwave antennas that relay data between satellites. Services include telecommunications, tracking and clock calibration, testing, and analysis 24 hours per day, 365 days per year (NASA, 2017e).

Buildings consist of a main operations building, a power plant, a vehicle maintenance building, a security guard building, and various storage and support buildings. Structures include two 15,000-gallon (gal) capacity fuel underground storage tanks (USTs), a 300,000-gal capacity potable water tank, and large antennas for satellite communications.

There are two SWMUs located within the STGT Area, the STGT small arms firing range (SWMU 29) and the STGT fuel UST (SWMU 52; also listed in the Permit as AOC 52). The STGT wastewater lagoon is listed in the Permit as AOC 51. It is currently managed in accordance with discharge plan (DP)-584 and is in the investigation and closure process.

3.4.3 600 Area

The 600 Area is located adjacent to the 100 Area and extends approximately 4 miles to the west of the other industrial areas at WSTF (Figure 3.2). The 600 Area is currently used for support of the WSTF water supply system, the groundwater monitoring well network, and the groundwater remediation systems. Buildings and structures adjacent to the 100 Area include groundwater assessment support buildings containing generators, gas cylinders, tools, and equipment necessary for performing groundwater assessment activities. Buildings and structures located in the 600 Area west of the industrial areas include buildings for chlorination and transfer of WSTF site water, WSTF water supply production wells, piezometers, exploration wells, groundwater monitoring wells, groundwater extraction and injection wells and associated buildings, and two groundwater treatment facilities, where groundwater contaminated with n-nitrosodimethylamine and volatile organic compounds is treated with ultraviolet light and air-strippers. The treated groundwater is then reinjected into the uncontaminated aquifer.

The 600 Area contains five SWMUs, the terminus of the historical 200 Area hazardous waste transmission line (SWMU 10), the JP remote test areas (SWMU 14), the 600 Area burn pit (SWMU 15), the BLM or 600 Area off-site soil pile (SWMU 16), and the 600 Area overflow wastewater lagoons (SWMU 34, managed in accordance with DP-392 and currently in the investigation and closure process). One hazardous waste management unit (HWMU) is also located in the 600 Area, the former 600 Area surface impoundments that historically contained dilute hazardous waste resulting from 200 Area laboratory operations (NASA, 1996d). This HWMU was closed in 1989 as an interim landfill. An HWMU investigation was completed in March 2011 (NASA, 2011c), and NMED Hazardous Waste Bureau (HWB) approved the 600 Area Closure Investigation Report on June 9, 2011 (NMED, 2011a).

3.4.4 500 Area

The 500 Area contains two separate locations, one area is located south of the 300 Area and the other is located south of the 700 Area (Figure 3.2). The 500 cryogenic storage area is used for storing large quantities of gases used at WSTF, including nitrogen and oxygen. There are no SWMUs associated with this area.

The 500 fuel and oxidizer storage area was designed to store fuel and oxidizer for use at WSTF. Buildings and structures include small control buildings, shelters, piping, breathing air generation equipment, and the permitted Fuel Treatment Unit, where fuel wastes are diluted and stored until shipment off site for disposal. There is one SWMU located in the area, the 500 Fuel Storage Area (SWMU 47), identified by NASA in March 2000 (NASA, 2000b). A preliminary investigation consisting of three soil sampling events was completed in July and December 2000 and May 2001. The results of this investigation were summarized in the 500 Fuel Storage Area HIS (NASA, 2011d).

3.4.5 400 Area

Both the WSTF 300 and 400 Areas are part of the WSTF propulsion test office. Both areas were designed and constructed to test various propulsion systems, including those necessary to accommodate cold flow and hot firing static testing (NASA, 1994f). Combined current capabilities include development, qualification, and acceptance testing, custom modifications, testing existing systems, developing new systems, certification requirements, propellant and aerospace fluids handling and expertise, decommissioning and decontamination of systems for repurposing and/or recycling, and developing, testing, or evaluating new technologies, standards, services, protocols, and best practices (NASA, 2017c).

The 400 Area is located south of the 700 Area (Figure 3.2). Test facilities and support buildings in this area include two altitude dual-position (vertical and horizontal) firing test stands, one ambient dual-position (vertical and horizontal) firing test stand, and two altitude horizontal-firing test stands (one capable of firing solid propellant engines), a test control building, and several preparation buildings. The altitude simulation test stands use either boilers to operate vacuum pumps or three alcohol/liquid oxygen combustion rocket engines to operate a water steam generator to create a vacuum that simulates high altitude conditions. Test support systems include pressurization, storage, and handling of large amounts of alcohol, liquid oxygen, nitrogen, oxidizer, hypergolic propellants, diesel generators, and a pretreatment boiler water system.

SWMUs located within the 400 Area include the 400 Area oxidizer burner (SWMU 12), the 400 Area historical aspirator discharge pipe (SWMU 13), the 400 Area main septic tank (SWMU 27, managed in accordance with DP-392), and the 400 Area four-cell, boiler water discharge (salt) pond (SWMU 48, managed in accordance with DP-1170). The three septic tanks historically used in the 400 Area were removed in January 2015, February 2016, and April 2016 accordance with NMED Liquid Waste Program regulations and the approved (with modifications; NMED, 2013c) septic tanks IWP, which included the septic tanks removal plan (NASA, 2013b).

The 400 Area also contains one HWMU. This HWMU consisted of two concrete-lined surface impoundments and three reinforced concrete treatment tanks that historically contained dilute hydrazine-type propellants (MMH, hydrazine, UDMH, A-50), oxidizer, and referee propellants (1,1,2-Trichloro-1,2,2-trifluoroethane [Freon®[1] 113] and Trichlorofluoromethane [Freon 11]). This HWMU was approved as an interim landfill by NMEID in 1989 (NMEID, 1989), and the 400 Area Closure IWP (NASA, 2011d) was approved by NMED HWB in November 2011 (NMED, 2011c). The 400 Area HWMU is currently being investigated.

3.4.6 300 Area

The 300 Area is located to the southeast of the 700 Area (Figure 3.2). Test facilities and support buildings in the 300 Area include one ambient, dual-position (vertical and horizontal) firing test stand, one altitude simulation, dual-position (vertical and horizontal) firing test stand, one altitude simulation, horizontal-firing test stand, one ambient, horizontal-firing test stand, two below grade structures for instrumentation and control signal conditioning equipment, a test control center, a remote command building, and shelters for equipment storage. Test support systems include fuel and oxidizer storage, pressurizing, and handling.

SWMUs located within the 300 Area include the 300 Area oxidizer burner (SWMU 11), three septic tanks (the 300 Area main septic tank [SWMU 24], the Building 320 septic tank [SWMU 25], and the Building 364 septic tank [SWMU 26], all three were managed in accordance with DP-392), and the 302 condensing water discharge pond (SWMU 33, managed in accordance with DP-697). The three septic tanks historically used in the 300 Area have been removed in May 2015, February 2016, and April 2016 in accordance with NMED Liquid Waste Program regulations and the approved (with modifications; NMED, 2013c) septic tanks IWP, which included the WSTF septic tanks removal plan (NASA, 2013b).

There is one HWMU located within the 300 Area. This HWMU consisted of two concrete-lined surface impoundments and three reinforced concrete treatment tanks that historically contained dilute hydrazine-type propellants (Monomethylhydrazine [MMH], hydrazine, unsymmetrical dimethylhydrazine [UDMH], Aerozine-50 [A-50]), and oxidizer. This HWMU was approved as an interim landfill in 1989 by NMEID (NMEID, 1989). An investigation of the HWMU was completed in October 2011. NASA submitted the Closure Investigation Report on August 30, 2011 (NASA, 2011e), and NMED HWB approved the 300 Investigation Closure Report on October 13, 2011 (NMED, 2011b).

3.4.7 200 Area

The 200 Area is located to the south of the 400 Area (Figure 3.2). Personnel in the 200 Area conduct materials and component testing in hazardous environments, including materials properties determination, materials compatibility and toxicity analyses, detonation studies, flight article outgassing characterization, systems analysis, orbital debris impact simulation testing, and propellant characterization. Area personnel contain expertise in composite material structures (testing, nondestructive evaluation, and analysis) and oxygen systems, including compatibility in air and space crafts and for industrial and medical applications. Personnel and facilities in the 200 Area also provide support for the Propulsion Test

[1] Freon is a registered trademark of The Chemours Company CF, LLC.

Department at WSTF, including preparing test articles, performing analytical services, and fabrication and cleaning of aerospace program articles. (NASA, 2017d).

The 200 Area laboratory and test preparation complex consists of offices, storage space, preparation rooms, clean rooms, shops, test facilities, various laboratories (including photography, fuel, oxidizer, chemistry, metallurgy, molecular desorption, analytical, gas and spectroscopy, x-ray, vacuum, and calibration laboratories), and support areas for testing activities. The laboratory and test preparation complex also contains systems for the storage and handling of many types of propellants, corrosive chemicals, flammable solvents, and compressed gasses.

SWMUs located within the 200 Area include the clean room discharge pipe (SWMU 4), the self-contained atmospheric protection ensemble (SCAPE) room discharge pipe (SWMU 5), the Building 203 discharge pipe (SWMU 6), the South Highbay discharge pipe (SWMU 7), the 200 Area sewage lagoons (SWMU 8), the 200 Area main burn pit (SWMU 9), the beginning of the historical hazardous waste transmission lines (SWMU 10), two septic tanks located adjacent to Building 272 (SWMU 23), and the 200 Area small arms firing range (SWMU 30). The SWMU 23 septic tanks were removed in December 2015 in accordance with NMED Liquid Waste Program regulations and the approved (with modifications; NMED, 2013c) septic tanks IWP, which included the WSTF septic tanks removal plan (NASA, 2013b). SWMU 9 was investigated in June 2015, and NMED HWB approved the IR with modifications in May 2016 (NMED, 2016). SWMU 10 was investigated in May through August 2016. NASA submitted the SWMU 10 IR to NMED HWB in December 2017 (NASA, 2017f). Accelerated corrective measures activities for SWMU 30 commenced in September 2015 and are still in progress currently.

The 200 Area contained three HWMUs (the clean-closed Evaporation Tank Unit [ETU]) and two separate closed HWMU sites that historically contained four hazardous waste USTs. The ETU treated aqueous wastes by evaporation in two open-top lined tanks in accordance with the Permit (NMED, 2016b). On January 17, 2012, NASA submitted the ETU Closure Plan to NMED HWB and was approved for implementation on June 19, 2012. NASA conducted a soil investigation of the soil beneath the hazardous waste drain line and ETU tanks, and NASA submitted the ETU Closure Certification Report to NMED on August 1, 2013 (NASA, 2013c). On September 5, 2014, NASA received NMED HWB approval for the ETU Certification Report (NMED, 2014).

The two closed HWMUs were the west and east closures. The west closure consisted of two steel USTs for storing hazardous wastes derived from the clean room. The east closure consisted of two USTs, one steel and one concrete, for storing hazardous wastes derived from the 200 Area laboratories complex (other than the clean room). All of the USTs were excavated and removed, and the areas were closed as interim landfills in 1986, with NMEID approval received in 1989 (NMEID, 1989). A vadose zone investigation was conducted in the 200 Area in two phases. Phase I included geophysical and shallow soil vapor surveys in 2012. NMED HWB approved the phase I status report with modifications October 22, 2013 (NMED, 2013b). Phase II included drilling 18 soil borings and installing 15 soil vapor wells and 2 soil vapor, groundwater wells. NMED HWB approved the 200 Area Phase II IR on November 30, 2015 (NMED, 2015a). The 200 Area is currently undergoing a vapor intrusion investigation.

3.4.8 800 Area

The 800 Area is located adjacent to the 200 Area to the northeast (Figure 3.2). This area performs tests for ignition and combustion characteristics on a variety of materials in various liquid and gaseous atmospheres for aerospace, aircraft, medical, and industrial applications. Compatibility assessments and post-fire failure analyses are performed to identify potential problems and fire causes to recommend design criteria and avoid future real-world fires. The 800 Area contains a control building, 30 reinforced concrete test cells (18 Hazardous Fluids Test Area cells and 12 High Pressure Test Area cells), various test support structures, and test support systems for the pressurization, storage, and handling of cryogenic materials and oxygen. SWMUs located within the 800 Area include an oxidizer burner (SWMU 20) and a below grade storage tank (SWMU 19) for temporary storage of diluted and residual testing fuels. The SWMU 19 below grade storage tank area was investigated in November and December 2015, with an additional soil boring installed in October 2017 (NASA, in press).

3.4.9 100 Area

The 100 Area is located southwest of the 200 Area (Figure 3.2). Buildings and structures within the 100 Area include office facilities for administrative, management, and engineering activities, an emergency center (Fire Department and Clinic), security facilities, heavy equipment maintenance and related facilities, vehicle maintenance facilities, construction facilities, warehouse facilities, trade/fabrication shops, storage buildings, waste accumulation areas, a fuel station, a cafeteria, a fitness center, and an auditorium (NASA, 1994f). The warehouse and support buildings house all materials, supplies, and substances entering WSTF. Distribution of goods/substances to the appropriate industrial area is accomplished following receiving procedures at the warehouse.

SWMUs located within the 100 Area include the 100 Area burn pit (SWMU 1), the 100 container storage area (SWMU 3), two septic tanks (SWMUs 21 and 22), an abandoned small arms firing range located near groundwater monitoring well WB-2 (SWMU 31), and the WSTF active firing range (SWMU 53). SWMUs 1 and 3 were investigated in June 2015, and NMED HWB approved the IR with modifications in May 2016 (NMED, 2016). The SWMU 21 and SWMU 22 septic tanks were removed in July 2017 and November 2016, respectively, in accordance with NMED Liquid Waste Program regulations and the approved (with modifications; NMED, 2013c) septic tanks IWP, which included the WSTF septic tanks removal plan (NASA, 2013b). The SWMU 22 site is currently being investigated. Accelerated corrective measures activities were instigated for SWMU 31 in September 2015 and are still in progress currently.

3.4.10 TDRSS

TDRSS is located south of the 100 Area (Figure 3.2). The mission of TDRSS is to provide communications and data links between satellite users and spacecraft in earth orbit through the TDRSS fleet. The data is relayed from the orbiting tracking and data relay satellites to the TDRSS ground terminals for processing and transmitting to users (NASA, 2017e). Buildings and structures at the TDRSS facility consist of an operations building, a security guard building, a technical support building, the Extended TDRSS Ground Terminal, a wood building shop, hazardous chemical storage and flammable storage buildings, a remote generator building, various storage buildings, large antennae for satellite communications, and various fuel tanks and support systems. There is one SWMU located at the TDRSS facility, the TDRSS diesel release (SWMU 50).

3.4.11 ADF-SW

The Aerospace Data Facility-Southwest (ADF-SW) is located south of TDRSS (Figure 3.2). It is an Air Force facility that supports worldwide defense operations and the collection, analysis, reporting, and dissemination of intelligence information for multiple agencies. This area contains an operations building, a data storage building, a security guard building, a warehouse, a gymnasium, large-capacity water tanks, above-ground diesel storage tanks, emergency generators, and various support buildings and systems. There are no SWMUs managed by NASA located at the ADF-SW.

4.0 Historical Records Review

4.1 Record Sources

Reasonably ascertainable and practically reviewable records relevant to the history, operations, and environmental conditions of SWMU 49, the 700 Area landfill, were selected and reviewed dating back to 1964. The type and location of these records are as follows:

- NASA Environmental Records – Located on site in the WSTF Environmental Department and available in both paper and electronic forms. They include:
    - Reports (Resource Conservation and Recovery Act (RCRA) Facility Investigation [RFI] (NASA, 1996d), WSMR quarterly and annual reports, inspection reports, annual reports to regulatory agencies, site assessment, closure plan, groundwater monitoring reports).
    - Solid waste regulations (New Mexico Solid Waste Management Regulations [NM SWMRs], Code of Federal Regulations [CFR], New Mexico Administrative Code [NMAC], solid waste amendments).
    - Correspondence (NASA, contractor, NMED, Environmental Protection Agency [EPA]).
    - Internal WSTF documents (correspondence, analytical data, memoranda, reports, e-mail communications, records of communication, Environmental Committee meeting minutes, regulation reviews, internal inspections, field notes, waste minimization records, recycling records, landfill closure records, environmental resource documents).
    - Laboratory reports.
- WSTF Test Records – Located on site in the Quality Assurance Office available in electronic form including:
    - WSTF test preparation sheets (TPSs).
    - Discrepancy records (DRs).
- NASA Photographs – Located on site in the WSTF Photography Laboratory.
- NASA Engineering Drawings – Located on site in the WSTF Drafting Department.

4.2 Interviews and Questionnaires

In addition to the review of historical records, interviews with current long-term and retired WSTF personnel were also conducted. A summary of information obtained from interviews is provided in Appendix A.

5.0 Operational History

The following sections discuss the operational history for WSTF.

5.1 Pre-WSTF History

From the early 1800s to approximately 1935, the Organ Mountains and the SAM were mined for gold, silver, zinc, copper, and lead. There were several established mines located in the SAM and numerous prospect mines. The nearest established mine to WSTF was the Smith Mine located approximately 1 mile southeast of WSTF within the Loman Canyon area. The Smith Mine produced approximately $30,000 worth of silver ore during its operations. Deposits of galena (lead sulfide) and barite ($BaSO_4$) were also mined just north of the eastern mouth of Bear Canyon.

Lands now occupied by WSTF were historically open-range grazing lands. The ruins of a historic ranch house (Gardner Ranch) are located just east of the current 200 Area laboratory facilities, and Love Ranch is located approximately 1.6 miles east of the 700 Area. These properties were acquired by the federal government and became part of WSMR in 1952.

5.2 Inception of WSTF

NASA Headquarters announced selection of a testing site in south-central New Mexico on July 6, 1962. The site was chosen for the isolated location and topography, which minimized the inherent hazards of aerospace propulsion testing to the general population. From the date of the official announcement until January 1965, the site was known as the Propulsion Systems Development facility. From January to June 1965, the official designation was White Sands Operations. Then on June 16, 1965, the official name of the installation was changed to White Sands Test Facility (NASA, 1986a).

Site planning activities began in August 1962. Exploratory drilling to locate a water supply source began in December 1962, and drilling of water supply wells was completed in May 1963. Development of the site location began in May 1963 with construction of the access road (NASA Road) from U.S. Highway 70. The access road was completed in October 1963 (NASA, 1980b, 1986a). The first increment of the 300 Propulsion Test Area was completed, and the first permanent personnel began working at WSTF in January 1964 (Fire Department). By April 1964, full time employees were working in the Propulsion Department. The second increment of the 300 Propulsion Test Area was completed by June 1964, followed by the 200 Area Preparation Buildings (200 and 201 in December 1964 and 203 in March 1965) and the 400 Propulsion Test Area in November 1965. The 100 Area was constructed to be the project control area. Building 114 was constructed in 1963. Building 100 was completed in March 1964, followed by Building 101 in January 1965. The initial emergency center (Building 112), the security guard station (Building 116), the cafeteria (Building 111), the warehouse (Building 120), and maintenance shops (Buildings 113 and 121) were also constructed during 1964. Other support buildings were constructed as needed from 1965 through 1966. The 800 Area was completed between January 1974 and December 1979 (NASA, 1986a). The 200 Area Laboratory consolidation facility addition to Building 200 was constructed from 1989 to 1990, and the 250 and 270 testing areas were completed between 1987 and 1991 (NASA, 1994f).

TDRSS was constructed in 1977, with expansions built in 1982 and 1996. STGT was constructed in 1988 (NASA, 1994f) with additions in 1994 and upgrades in 1996. Currently, the ground terminals are undergoing a ground segment sustainment project to modernize the ground terminals while maintaining the space network (NASA, 2011b). According to a long-term employee, the Air Force facility, titled ADF-SW was constructed in 1983 and 1984, with expansions in 1991 and 2004 (Appendix A).

Locations for the specific areas of WSTF were chosen to minimize the potential impact and hazards in one area from affecting any other areas. Hazardous test and storage areas were located downwind from administration areas, the 300 and 400 propulsion areas were positioned so that they were not in line with respect to the prevailing wind direction, and the 200 Area was located far enough from the 300 and 400 propulsion areas for sufficient acoustic attenuation, blast pressure decay, and adequate reduction of fragment impingement hazards, but close enough for easy transport of test articles to and from the test areas (NASA, 1980b). The land use buffer zone surrounding WSTF was designed to ensure a safe distance for diffusion of vapors or other hazards to avoid impacts to off-site inhabitants, livestock, and agriculture.

6.0 700 Area Landfill (SWMU 49) History

This section outlines the history of solid waste regulation implementation at WSTF and the history of the 700 Area landfill (SWMU 49) design, operations, waste disposal, waste minimization, groundwater monitoring, methane monitoring, closure activities, and post-closure care (PCC). Figure 6.1 presents a map of the 700 Area landfill, and Figure 6.2 shows a photograph of the landfill while still in use in September 1993. There were no photographs located that show details of the 700 Area landfill prior to 1993.

6.1 700 Area Landfill (SWMU 49) Regulatory History

The current 20 NMAC 9.2 provides a history of New Mexico solid waste management regulations. "Pre-NMAC History: The material in this part was derived from that previously filed with the commission of public records – state records center." These regulations were NM Environment Improvement Board (EIB) 74-1, Solid Waste Management Regulations, filed 5/3/74, EIB/SWMR-2, Solid Waste Management Regulations, filed 4/14/89, EIB/SWMR-3, Solid Waste Management Regulations, filed 12/31/91, and EIB/SWMR-4, Solid Waste Management Regulations, filed 7/18/94. The EIB/SWMR-4 was renumbered into the first version of the 20 NMAC 9.1, Solid Waste Management Regulations, effective 11/30/95, and the 20 NMAC 9.1, Solid Waste Management Regulations were repealed 8/2/07, when the current 20 NMAC 9.2 regulations replaced them (20.9.2 NMAC).

20 NMAC 9.2 provided the definition of a landfill: "a solid waste facility that receives solid waste for disposal…" Solid waste is defined as "any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, construction, demolition and agricultural operations and from community activities…" (20.9.2 NMAC).

NM SWMRs of 1989 (EIB/SWMR-2) defined a sanitary landfill as "a facility employing an engineered method of disposing of solid wastes on land in a manner that minimizes environmental hazards and meets the design and operation requirements of these regulations" (EIB, 1989).

On October 19, 1978, NASA registered the 700 Area landfill with the New Mexico Environmental Improvement Division (NMEID). In this letter, NASA stated, "There is no record in our files of the system having previously been registered, and no record of an application having been submitted" (NASA, 1978), suggesting that this was the first regulatory action regarding the landfill taken by NASA. This began interim status operation of the 700 Area landfill.

In 1980, NASA completed an Environmental Resources Document that described the laws and regulations governing operations of the 700 Area landfill. "The generation, treatment, storage, and disposal of solid wastes at WSTF are subject to provisions of the Federal Water Pollution Control Act, the Solid Waste Disposal Act, the Resource Conservation and Recovery Act, and various other Federal laws and regulations administered by the EPA…State of New Mexico laws and regulations regarding solid wastes include the Solid Waste Management Regulations, the New Mexico Water Quality Act, and various Water Quality Control Commission Regulations" (NASA, 1980b).

Also in 1980, NASA filed a RCRA Part A Hazardous Waste Permit application with the NMEID (NASA, 1980a). The 700 Area landfill was originally included in the permit application. NASA applied to NMEID to remove the landfill from the Part A Hazardous Waste Permit application in October 1984. NASA stated that the 700 Area landfill had been erroneously included in the Hazardous Waste Application due to disposal of warfarin rat poison. NASA replied that "the landfill has never been used for the disposal of any hazardous wastes, including warfarin (EPA ID number P001), the rat poison chemical for which the landfill was originally listed" (NASA, 1984b). On October 19, 1984, NMEID approved the removal of the landfill from the Permit application and requested that NASA file an amended Part A form (NMEID, 1984). On November 30, 1984, NASA submitted a revised Part A permit application that did not include the 700 Area landfill (NASA, 1984c).

On November 9, 1984, the Hazardous and Solid Waste Amendments of RCRA were signed into law, and NMEID sent a letter to NASA in March 1985 regarding changes that may affect WSTF.

> "These Amendments add a considerable number of new requirements for the treatment, storage and disposal that EPA and the States permit under Subtitle C of the RCRA…If you are a generator and have an on-site facility after September 1, 1985, you must certify, at least annually, that you have reduced the volume and toxicity of the waste to the maximum degree economically practicable, and that the method you use to manage the waste minimizes the risk to the extent practicable… After May 8, 1985, you will not be able to dispose of bulk or non-containerized liquid hazardous waste or free liquids contained in hazardous waste (regardless of whether or not absorbents have been added) in your landfill. After November 8, 1985, you will not be able to dispose of non-hazardous liquid wastes in your landfill…until EPA authorizes your State to manage aspects of the program based upon the provisions in the Amendments, your RCRA permit will need to be jointly issued by the State and EPA to be fully effective" (NMEID, 1985a).

To comply with these and other regulations, NASA initiated a full-time Environmental Department and began a site-wide program of waste management and waste reduction. NASA listed the 700 Area landfill as a SWMU in a report provided to the EPA on June 14, 1985 (NASA, 1985a). Then, in March 1987, a variance from NM SWMRs, Sections 108.F.1 and 2, was requested regarding requirements for fence and cattle guard installation around the 700 Area landfill. The justification for the variance request was, "The NASA/White Sands Test Facility (WSTF) landfill is used only by the institutions located at this site. Access to the WSTF site is restricted and the location is entirely fenced and protected by cattle guards at roads. Because the Facility is protected from the entrance of cattle, a variance is requested to exclude the 700 Area landfill from the requirements of fencing and maintaining a gate or cattle guard at the landfill" (Lockheed, 1987). NMEID granted the variance for one year on April 1, 1987 (NMEID, 1987). The variance was requested and granted again for 1988 (NASA, 1988d; NMEID; 1988).

NASA requested a variance from the same requirements of the newly enacted NM SWMR-2 regulations in 1989 (NM SWMR-2, Section 301.E); however, a fence seems to have been installed at the landfill by 1989. "…the landfill itself is enclosed with a three-strand barbed wire fence. A variance is therefore requested from additional requirements for access control at the facility landfill," i.e., maintaining a gate or cattle guard at the landfill entrance. NASA also included two additional variance petitions: for the control of methane gas generation and inspection procedures (NASA, 1989g). The justification for methane gas control, NM SWMR-2, Section 301.C, was:

> "The NASA WSTF landfill is remotely located from all WSTF structures and is over 3 miles from any public or private structures. Construction and office trash, which is not expected to generate significant amounts of methane gas, account for the majority of material disposed in the WSTF landfill. Based upon the distances involved and the nature of disposed materials, a variance from the methane gas control requirement is requested."

For inspection procedures, NM SWMR-2, Section 301.N.1.c, 2.b, 2.c, and 2.d, the justification stated,

> "In order to insure proper operation, the NASA WSTF landfill is inspected on a weekly basis. Several other factors also facilitate control of waste disposal in the landfill. These include the

small size, operational limits, employee education, and utilization of only one vehicle for transportation of wastes. Based upon these factors, the following variances are requested:

- 301.N.1.c: An inspection area located away from the tipping area is not needed because of the small size of the operation and direct inspection of the tipping area during unloading operations.
- 301.N.2.b: A written record of the transportation company and driver transporting waste to the facility landfill is unnecessary as WSTF utilizes only one Government vehicle for this purpose.
- 301.N.2.c: NASA WSTF has only one vehicle for transport of waste which renders the requirement to maintain a written record of truck license and description unnecessary.
- 301.N.2.d: NASA WSTF does not receive waste from offsite which makes it unnecessary to maintain a written record of the waste source" (NASA, 1989g).

NMEID toured WSTF in response to the variance requests and determined that NASA did not need a variance for methane gas control "as the Division has determined the types and small quantities of waste landfilled are accepted as a demonstration that the waste will not generate methane which will migrate laterally from the landfill site so as to endanger structures, vegetation or occupants of adjacent properties" (NMEID, 1990). NMEID personnel also stated that a variance for maintaining a cattle guard at the landfill was not required due to the existing security measures at WSTF and the landfill. The inspection and record requirements variances were granted; however, NMEID required NASA to determine current landfill fill rates (NMEID, 1990). In response, NASA provided a description of the solid waste transport vehicle at WSTF (NASA, 1990b) and a way to track waste to the landfill. "The method which will be utilized will be to calculate the size of the trench and monitor the quantity of fill dirt and the amount of time it takes to fill it up. This will provide a quantity of waste per trench and when combined with the dates the trench is opened and closed, give the rate…This information will be maintained…for the current and future trenches, but will not be retroactive" (NASA, 1990c). Detailed records of wastes, quantities disposed, and amounts of fill dirt used were not located; however, general waste types and estimates of quantities disposed annually were provided to NMEID/NMED in annual reports beginning in 1990.

From an internal WSTF memorandum regarding new requirements of NM SWMR-2, "New Mexico has recently issued new regulations (effective May 15, 1989) for solid waste landfills restricting the disposal of infectious waste…(sharps, blood, etc.)…The new regulations will require that infectious waste either be treated to render it non-infectious or disposed of as 'special waste.' In order to dispose of 'special waste' in the WSTF landfill, operational and permitting modifications would be required. The increase in operating cost and permitting requirements do not make this a reasonable choice" (NASA, 1989d). Special wastes were no longer accepted to the WSTF landfill by May 1989.

The NM SWMRs of 1989 also required that landfills certify operations and obtain a permit for operation if requested. NASA submitted a certification letter to NMEID on August 8, 1989, "This letter will serve as certification, as required under section 201.B of the NM SWMR-2, that the WSTF landfill will continue to operate after May 15, 1989, on a temporary basis until a permit is issued" (NASA, 1989e). NMEID acknowledged the receipt of NASA's notice of intent (NOI) to continue operating on August 14, 1989. The letter also stated, "An application for a permit to operate a solid waste management facility may be requested at anytime [sic] from the Solid Waste Section. The application, however, will not need to be submitted to the Solid Waste Section until you are given notification to send in your application for review. The application must then be submitted within 90 days after receipt of the request for review" (NMEID, 1989). However, a solid waste operating permit was never applied for nor obtained from NMEID/NMED in the active life of the 700 Area landfill, since it was never requested of NASA.

A groundwater monitoring program began at the 700 Area landfill in late 1989, and the first solid waste facility annual report was submitted to NMEID in March 1990, summarizing landfill information from

May 15, 1989 (the effective date of the NM regulations) through December 31, 1989 (NASA, 1990d). Refer to Section 6.6 for details of the 700 Area landfill groundwater monitoring program.

Continuing compliance with newly enacted solid waste regulation requirements, by May 1991, 700 Area landfill operators were trained and present during operational hours of the landfill, according to an inspection conducted by NMED Solid Waste Bureau (SWB) personnel (NMED, 1991).

NASA received a notice of violation from a NMED SWB landfill inspection in late November 1991. "Notice of Violation items were § 106.A.1 and 2, recording the quantity of waste received on a diagram or map and § 301.B., litter (minor) in the landfill area." Better compaction was also suggested for the landfill. In response to these violations, corrective actions proposed included strictly controlling landfill access with locked gates and only two operation days a week, removing cardboard from the solid waste disposed at the 700 Area landfill, keeping a log of "pit" location and contents, and compacting waste after each load was delivered (NASA, 1991h); however, documentation suggests that cardboard was not recycled until October 1995 (see Section 6.6), and landfill waste logs were not initiated (NASA, 1991g).

The NM SWMRs were amended again (third revision) in December 1991 (effective date January 31, 1992). These regulations required that NASA submit a NOI to continue operation of the 700 Area landfill and also a preliminary site assessment summary within one year. NMED would then rank the landfills in New Mexico and request submittal of permit applications based on the landfill rankings. Variances in effect for landfills would be honored until their expiration dates. New groundwater remediation standards were added that were derived from the New Mexico Water Quality Control Commission Standards and the Safe Drinking Water Act standards (NASA, 1991e).

A regulatory review of NM SWMR-3 was performed by a WSTF Environmental employee. Any operational changes, such as disposal of special wastes or expansion of the landfill area, would require modification of the original registration. Special wastes were revised for these regulations to include:

> "solid waste…residue from a chemical spill of a chemical substance or a commercial product (including contaminated soils)…no person shall dispose of petroleum waste, certain sludges, sewage or septage at a facility, dispose of hazardous waste at a facility unless permitted for such; dispose of bulk liquids at a landfill…" (NASA, 1991f).

NASA altered landfill operations to comply, no longer accepting chemical or petroleum spill residues.

The regulations also increased documentation requirements. "All facilities must maintain daily records and submit annual reports. The annual report must summarize facility activities including waste types, quantities, remaining capacity, a narrative of the operator's progress in implementing the closure plan, and any monitoring results." Other requirements included:

- Keeping a schedule of cell filling and methods of compaction of solid waste.
- A description of ground water monitoring, vadose zone monitoring, liner, leachate collection, landfill gas monitoring and control.
- Confining solid waste to the smallest practical area.
- Preventing unauthorized access.
- Providing fire control measures.
- Providing contingency, closure, and PCC plans.

- Operators must also be certified every 3 years by passing training courses in landfill operation, design, geology/hydrology, engineering, and environmental issues.
- Any variances must be accompanied by proof of public notice (NASA, 1991f).

It was recommended that NASA:

> "…seek variances from any inappropriate requirement due to the site security, lack of public access, written disposal procedures, and the uniqueness and isolation of the facility. Currently WSTF maintains variances for load checking and record maintenance, methane gas monitoring, access control" (NASA, 1991f).

Other recommendations included submitting a NOI to continue operating, surveying the landfill to locate areas for future use, placing future cells close together, completing a preliminary site assessment, training and certifying a 700 Area landfill operator approved by NMED, disposing of no special wastes, and developing closure and PCC plans (NASA, 1991f). As part of the required preliminary site assessment, soil samples would need to be collected and analyzed. This soil sampling could be conducted in conjunction with excavating a new cell, estimated in mid-October 1992 (NASA, 1992d). On January 29, 1992, NASA submitted the NOI to continue operating the 700 Area landfill in interim status (NASA, 1992b).

In April 1993, NMED SWB prompted NASA:

> "This is to remind you that site assessments are required to be completed on all landfills which are currently being operated under interim status…The site assessments are required as a condition to maintaining interim operating status under the Solid Waste Management Regulations. The information will be used to rank landfills for calling in permit applications in the future" (NMED, 1993c).

NASA submitted the 700 Area landfill site assessment to NMED SWB on June 2, 1993 (NASA, 1993c). The site assessment summarized:

- The landfill field investigation (installing four groundwater monitoring wells; 700-A-253, 700-B-510, 700-D-186, and 300-D-153).
- The surface geology (Quaternary alluvial fan/piedmont slope alluvium).
- The subsurface geology (limestones of the Pennsylvanian Heuco and Permian Panther Seep Formations, the Eocene or Oligocene Orejon Andesite, and late Tertiary to Quaternary Camp Rice Formation and piedmont slope alluvium).
- Groundwater occurrence (within fractured bedrock flowing from east to west).
- Wind direction (predominantly from the south and east).
- The subsurface soils (no continuous clay beds; fine-grained soils were not encountered in borings; NASA, 1993c).

For the category "Proximity to Water Courses," the 700 Area landfill was reported as "Within 200 feet of a major arroyo/intermittent stream." Stormwater runon/runoff was accomplished naturally. "The channels of intermittent streams in the landfill area…directs stormwater run on away from the surface of the landfill. The landfill surface is topographically higher than adjacent stream channels" (NASA, 1993c).

In 1994, landfill compliance with proposed NM SWMR-4 (fourth revision) regulations was discussed in an internal memorandum.

> "WSTF's existing landfill is located within 200 feet of a watercourse. This provision will not apply to WSTF until the Secretary requests a permit application…a permit application will be called for within the next year…The operating record must include the type and amounts of solid wastes received, haulers of the waste, deviations from approved designs and plans, and document groundwater monitoring activities…Based on the review of these regulations, NASA will be required to initiate closure of the existing landfill within the next year" (NASA, 1994h). Refer to Section 6.8, Closure, for details.

On December 30, 1994, NMED received EPA approval of the NMED Solid Waste Program. NMED SWB now had primacy for solid waste regulations and implementation at the 700 Area landfill. "…compliance with the State regulations will ensure compliance with the federal criteria" (NMED, 1994b).

As described in the 2004 NASA response to an NMED HWB request for additional information during the WSTF Hazardous Waste Permit renewal process, the 700 Area landfill was included in Annual Unit Audit (AUA) list of SWMUs prior to closure. However, the landfill was removed from the AUA list of SWMUs when it was formally closed and PCC was initiated. At closure, the landfill was transferred to "Solid Waste Bureau authority…to ensure no problems with dual regulatory oversight. The unit was officially closed per NMED Solid Waste Bureau requirements and is currently managed under authority of an in-place Post-Closure Care Plan issued by the Solid Waste Bureau." The landfill was listed as a WSTF SWMU that did not require corrective action (NASA, 2004b). However, in the 2009 renewal of the Permit, the 700 Area landfill was included as SWMU 49, and an IWP was originally required to be submitted to NMED HWB for investigation of the 700 Area landfill by December 30, 2015 (NMED, 2009c). NASA submitted a Class I Permit Modification request on November 17, 2015 to the NMED HWB requesting a new due date for submittal of the IWP and HIS of December 29, 2017 (NASA, 2015b). Additional time was requested since there was still 12 years remaining under the original PCC monitoring period. At that time, NASA was still evaluating potential investigation options for SWMU 49 and wanted to focus on several other concurrent investigations at WSTF. NMED HWB approved the Permit Modification Request on December 16, 2016 (NMED, 2015b).

6.2 Inception

The 700 Area landfill (SWMU 49) began use between 1963 and 1965. WSTF documentation and employee statements provide contradictory information regarding the year of landfill inception. In an inventory list of disposal areas at WSTF in 1985, it was stated that the 700 Area landfill had been in operation since 1963. This 1963 operational date was also reported in 1986, in an EPA survey (NASA, 1986d), and from the landfill registration with NMEID in 1978, "The modified landfill at White Sands Test Facility has been in operation for approximately fifteen years" (NASA, 1978). Then, in an internal plan for landfill operation, generated in 1992, it was stated, "The existing WSTF landfill has been in continuous operation since 1964" (NASA, 1992d). One long term WSTF employee interviewed for the landfill site assessment stated that the landfill began use in late 1964, and early construction debris was transferred to an off-site landfill (NASA, 1993c). Finally, within the groundwater monitoring system plan, the landfill Closure Plan, and the Design Capacity Report, it was stated that the landfill began operation in 1965 (NASA, 1994g, 1996g, 1998j). One employee stated in 1993 that the 700 Area landfill opened in October 1965, and "the waste was being transferred to the first cell on the SW end when I started delivering site waste" (Appendix A).

6.3 Design

The 700 Area landfill (SWMU 49) is an approximately 24-acre (reported as 24.32 acres in the Closure Plan; NASA, 1996j) trapezoid-shaped piece of land, with the long axis oriented northwest-southeast that was designed to contain solid waste for disposal within excavated cells or trenches (Figure 6.1). Trench depth was reported as between 14 ft and 20 ft. In a 1981 application for landfill registration to NMEID, it was stated, "The trench is dug to a 20 ft. depth" (NASA, 1981). Later documents describe average trench depths of 14 ft (NASA, 1994b, 1994g, 1996j).

The original design capacity of the landfill was reported in a required EPA survey in December 1986 as 72,000 cubic yards (cu. yd.) with a ratio of waste to cover material of 8.5 to 1 (NASA, 1986d); however, in August 1998, the design capacity of the 700 Area landfill was reported to be 60,000 m^3 (or 55,044 cu. yd.; NASA, 1998j). Both of these values were estimated.

The 700 Area landfill has been described as a "modified landfill" (NASA, 1978), a sanitary landfill, (NASA, 1990i), and a "Class B landfill", which was "a sanitary landfill serving a population of less than 3,000" (NASA, 1991f). Refer to Section 6.1, 700 Area landfill (SWMU 49) Regulatory History, for a definition of a sanitary landfill. A definition for a modified landfill, as used in the 1978 landfill registration, was not located in solid waste regulations; however, a long-term WSTF employee stated that the term "modified" was likely referring to the different wastes disposed at WSTF compared to most landfills. WSTF only disposed of wastes generated at WSTF, never commercial or residential wastes from off-site sources (Appendix A). A definition of "modified" was provided by EPA as "an increase in the permitted design capacity caused by an increase in the horizontal or vertical dimensions of the landfill" (EPA, 1999). However, this definition was referring to gas monitoring regulations, not specifically to the landfill types.

6.4 Operations

In the early 1960s, when use of the 700 Area landfill (SWMU 49) began, generators of solid waste included major WSTF industrial areas (100, 200, 300, and 400 Areas). There were no other tenants using the WSTF site at that time. Then, as stated in Section 5.2, TDRSS was built in 1977, ADF-SW was initially completed in 1984, and STGT was constructed in 1988; therefore, these facilities eventually became solid waste generators (NASA, 1994f).

The terms "trench" and "cell" are used interchangeably in WSTF documentation to describe the disposal area at the 700 Area landfill (SWMU 49). A synopsis of the 700 Area landfill operations was provided in the Landfill Groundwater Monitoring System Plan submitted to NMED SWB in October 1994. "NASA operates a 24-acre landfill on land owned by the Department of Army, White Sands Missile Range (WSMR). Wastes are transferred to the landfill by WSTF site contractor personnel using a 30-cubic yard garbage truck" (NASA, 1994g). Wastes were deposited to the current active trench/cell from the edge (Figure 6.3). Driving into the trenches was only permitted when compacting loads or when retrieving unacceptable items if a crane could not retrieve them from the trench top (Appendix A). From the 1978 landfill registration to NMEID, "Dempster dumpster storage containers are located at all occupied buildings on WSTF, into which all waste is placed. These containers are checked frequently and are transported to the modified landfill as required" (NASA, 1978). The term Dempster dumpster was derived from the Dempster company, that in 1935 developed portable storage (trash) containers and a device for lifting and transporting these containers. The containers and front loading truck became known as Dempster dumpsters (Voytko, 2006). In 1978, when the 700 Area landfill was first registered with the NMEID, WSTF was using 26 Dempster dumpster containers and an "International Harvester Truck with Integral Dempster Dumpster Handling Mechanism" (NASA, 1978).

The shortest transport distance from waste generation point to the landfill was reported in a 1981 landfill registration application as 1.5 miles, and the farthest was reported as 3.4 miles. Regarding landfill site security, it was stated, "The site Fire Department makes a check of the landfill every 90 minutes," and regarding runoff: “The landfill is on higher ground and water is diverted by natural and manmade channels” (NASA, 1981).

This 1981 registration application also provided additional details regarding WSTF solid waste management. “All office waste is contained in plastic bags…The disposal trenches are dug, using the bulldozer, as they are needed. Upon completion they are approximately 600 ft. long x 20 ft. wide x 20 ft. deep. The trench is covered as required in Section 108.F and the solid waste is compacted to conserve space” (NASA, 1981). Wastes were covered in trenches/cells using the previously excavated cell material (soil; NASA, 1994b; Appendix A). In 1981, compaction of wastes was completed using an “Allis-Chalmers HD-21 bulldozer” and a “Lorrain front-end loader” to drive over the loads (NASA, 1981; Appendix A).

There was not a strict procedure for new trench placement at the 700 Area landfill. In general, older trenches were excavated at the southeast side of the landfill, oriented in line with the short axis of the landfill and close to the landfill entrance; however, there are two trenches that were excavated in line with the long axis of the landfill and perpendicular to all other trenches (Figure 6.1). Also, as space became limited in the 1990s, the areas between older trenches were used for new trenches. This is discussed in more detail below.

In November 1991, diminishing capacity of the landfill was first mentioned in WSTF documentation. “Material deposited at the landfill has more than doubled over the past year. Due to the large number of additional buildings sitewide, landfill usage has increased to a point which demands stricter control for proper maintenance (NASA, 1991h). “…the current WSTF landfill operator has projected expansion of the landfill will be necessary within 5 years…based on the present rate of cell closures and staff increase at STGT.” It was recommended that NASA “survey the current landfill and establish the area that can be used for future cells…[and] place future cells close together…The current fenced area is estimated at approximately 24.5 acres;” however, the original certificates of registration in 1978 and 1981 stated the size of the landfill was 29 acres. It was stated that this additional five acres could be used with no landfill modification (NASA, 1991f); however, this extra land was never used as part of the 700 Area landfill due to the required closure of the landfill discussed in Section 6.8, Closure. Figure 6.4 shows the 700 Area landfill with the unused five acres to the north.

To continue utilizing the present landfill, the capacity needed to be increased. As a means to do this, increased compaction could be employed. It was recommended that NASA purchase a bulldozer and compactor,…survey, mark, and use areas between existing trenches, and research and implement waste reduction (NASA, 1991f, 1992d). Refer to Section 6.1, 700 Area landfill (SWMU 49) Regulatory History, for further details. Figure 6.5 shows a photograph of the landfill in 1995. Notice that the current open cell was located in the approximate middle of the 700 Area landfill, between older, previously filled and covered cells and not adjacent to the cell that was open in 1993 (Figure 6.3). Even though it was recommended that NASA use the additional five acres to the north of the landfill to supply additional capacity, this area was not utilized in the life of the 700 Area landfill. Refer to Section 6.8, Closure, for details.

In September 1992, NMED SWB commented in a landfill inspection that NASA had purchased a new bulldozer (a 40,870-pound [lb] Caterpillar D8L bulldozer) and compactor (a 39,800-lb Caterpillar 816 landfill compactor; NMED, 1992; NASA 1994b, 1995b). Figure 6.3 shows a close-up view of the 700 Area landfill, open trench, and heavy equipment used during landfill operations. NMED SWB personnel also commented that NASA was “getting ready to dig a new pit” (NMED, 1992). In the September 10, 1993 landfill weekly inspection log entry, the comments read, “old pit covered and filled. Start new” (NASA, 1993a). This cell was filled by August 15, 1994, as reported, “old cell partially closed,” and the next week (August 22), “new cell totally open/old cell covered” (NASA, 1994a). Landfill procedures required that dates cells were opened and closed at the landfill be recorded on a landfill drawing; however, this was not consistently done. A list of known landfill cell open and close dates are provided as notes on Figure 6.4. Refer to Section 6.1, 700 Area landfill (SWMU 49) Regulatory History, for further details.

To comply with stricter access control requirements within the revised NM SWMR-4, NASA installed a new gate and keyed lock (NMED, 1994; NASA, 1994a) and further restricted access to the 700 Area landfill, "Starting 12 December, 1994 the landfill will be closed to all personnel unless a landfill operator is present. All personnel or organizations wishing to use the landfill will be required to call…an operator…" (NASA, 1994i).

NASA began the closure process by contracting an off-site company to provide solid waste disposal service to WSTF in October 1995. There were 40 Dempster dumpsters in use at WSTF, TDRSS, STGT, and ADF-SW at the time (NASA, 1994g). After October 1995, only construction/demolition wastes and dead animals could be disposed at the 700 Area landfill. As reported in the solid waste annual report, between October and December, 1995, 1 ton of construction/demolition debris was disposed at the 700 Area landfill; dead animal wastes were not recorded (NASA, 1996b).

The landfill Closure Plan provided a summary of historical landfill drainage and cell cover: "Throughout the landfill's active life, cells were covered with a minimum of two feet of native soil prior to excavation of new trenches." Both WSTF and the landfill were fenced, and the landfill was not accessible to the public or unauthorized site personnel. Operations at the landfill were limited to the working hours from 7 am to 3:30 pm Monday through Friday. The landfill entry was controlled by key issuance. "The site's natural grade, 2.5 percent, accommodates drainage with no impacts upon the surrounding area" (NASA, 1996j). "Historically stock piles were redistributed in areas showing settling and the landfill operator estimates that 20 percent of the cell volume consists of natural soil, at least two feet of which is final cover…" (NASA, 1996j).

"No liner or other modifications were made to the trench bottoms prior to waste disposition. The trench bottoms serve as the lower-most layer of the unit. An investigation of 700 Area soils determined that the conductivity of the material composing the undisturbed lower surface is 3.7×10^{-6} cm/s" (NASA, 1996j).

6.4.1 Landfill (SWMU 49) Documentation

From the inception of the 700 Area landfill (SWMU 49) until 1985 (when the WSTF full-time Environmental Department was established), there were no landfill documentation requirements; therefore, there were no records regarding oversight, waste disposal, operations, or procedures for the 700 Area landfill. One long-term employee estimated documentation generation began in the early 1990s (Appendix A).

The first document discussing the need for landfill records was Environmental Advisory Committee meeting minutes for October 16, 1986. It was stated that control procedures needed to be developed for the landfill and past trenches needed to be mapped (NASA, 1986c). This statement emphasizes that WSTF did not have written procedures and that the locations of past/filled trenches had not been documented. By March 1987, a written landfill operation procedure was completed for WSTF (NASA, 1987b); however, this document could not be located. In May 1987, WSTF personnel began conducting weekly visual inspections of the landfill and generating inspection logs. Categories on the inspection logs included date, time, unpermitted items (items not allowed for disposal in the landfill), burning (evidence of burning), blowing refuse (loose trash blown out of the trench), berm condition, refuse coverage, and animal coverage for the dead animal pit (NASA, 1987c).

As required by solid waste regulations, NASA began submitting annual solid waste summary reports to NMEID in 1990 (NASA, 1990d). Documents regarding exact waste amounts and types were not generated, so wastes were estimated. During the process of requesting several variances from NM SWMR, it was determined that NASA needed to develop and maintain better landfill records.

> "During the inspection of the facility on January 30, 1990, the inspector discovered, while NASA maintains records of the number of truckloads of solid waste entering the facility, NASA does not translate this information into quantity or volume of solid waste deposited. The records need to reflect the current fill rates at the facility" (NMEID, 1990).

NASA responded with a proposed tracking method (NASA, 1990c). (Refer to Section 6.1, WSTF Landfill (SWMU 49) Regulatory History, for details.) However, when the NM SWMR-4 regulations were proposed in November 1994, NASA WSTF personnel stated, "NASA is required to maintain an operating record during a facility's active life (operations, monitoring, closure, and PCC activities). The operating record must include the type and amounts of solid wastes received, haulers of the waste, deviations from approved designs and plans, and document groundwater monitoring activities. An operating record is not maintained at this time…" (NASA, 1994h).

In December 1994, NASA proposed more restricted access to the 700 Area landfill. "These operational changes will allow the…section to provide a certified landfill operator who will inspect and log the quantity and type of all waste material going into the landfill (NASA, 1994i)"; however, no waste logs could be located. The 700 Area landfill also did not have a contingency plan in 1994 for coping with potentially exceeding groundwater, surface water, air quality, gas, or other applicable requirements (NASA, 1994c).

Even though many historical landfill records provided sporadic operational data, including regulatory reviews, surveys, and DRs for unpermitted items observed in the landfill, the only systematic operational records for the 700 Area landfill located were the weekly inspection logs and annual reports.

6.4.2 Dead Animal Pit

The dead animal pit was a small active cell within the 700 Area landfill (SWMU 49) with approximate dimensions of 20 ft long by 14 ft wide, and approximately 10 ft deep. The pit was located "directly inside the landfill entrance and to the right as you came into the gate, right by the fence" (Appendix A). As surveyed during closure activities, this pit was approximately 330 ft northeast of the WSTF gate. As the name suggests, the dead animal pit was used for disposal of any animal carcasses found at WSTF. This pit was used for the entire life of the 700 Area landfill from the early 1960s to October 1997. Following landfill closure, any dead animals found at WSTF were disposed by the Doña Ana Animal Control (for domestic animals) or the NM Department of Game and Fish, (for wildlife; Appendix A). Figure 6.1 shows a map of the 700 Area landfill showing the location of the dead animal pit, and Figure 6.6 shows an aerial view of the dead animal pit in September 1993.

Although records of animals added to the dead animal pit were not generated at WSTF, a total amount was estimated for the WSTF Closure Plan in 1996: "The dead animal pit, located near the gate on the southeast end of the landfill has received an average of one animal per year" (NASA, 1996j). Also, from a weekly inspection log in 1997, 11 dead oryx were discovered at WSTF and added to the dead animal pit between late February and early April 1997 (NASA, 1997a). Other dead animals known to have been disposed in the dead animal pit at the 700 Area landfill (SWMU 49) include cows, birds of prey, other birds, cats, dogs, coyotes, and snakes (Appendix A).

6.4.3 Wind-Blown Debris

Stacking of refuse within the active cell at the 700 Area landfill (SWMW 49) was required to be low enough to prevent wind blowing of trash or debris out of the trench; however, solid waste debris within the landfill (outside the active trench) was common in the windy spring and summer seasons at WSTF, based on weekly landfill inspection logs. In May and June 1987, wind-blown debris was listed as minimal and “light” (NASA, 1987c). No wind-blown waste was documented for 1988 in the weekly inspections, but in February 1989, personnel wrote that the refuse was “stacking too high blowing waste across [the] desert” (NASA, 1988a). Wind-blown solid waste was reported in weekly inspections three times between April and early May 1991 (NASA, 1991c). No wind-blown debris was documented in 1992, but in 1993, trash blown from the trenches was listed on the weekly inspection log ten times, mostly within the spring and summer months (NASA, 1993a). For 1994, wind-blown debris was present at the landfill May and June. This waste was removed prior to June 27, as documented in the weekly inspection logs. Wind-blown debris was listed in July and August, September 26, and October 24, 1994. The landfill area was cleaned up and all wind-blown waste removed in late October 1994 (NASA, 1994a). For 1995, wind-blown debris was again listed, once each in January, March, April, and June (NASA 1995a). Finally, wind-blown solid waste was listed only once in 1996, on January 22, and was removed by February 5, 1996 (NASA, 1996a).

6.5 Waste Estimates and Disposal Rates

Cell usage and waste disposal rates were not historically tracked at the 700 Area landfill (SWMU 49). When required for regulatory reporting, waste volumes were estimated based on cell size, disposal truck capacity, and disposal frequency. Reported waste estimates differed over time.

An estimate of historical solid waste generated at WSTF was performed in response to requirements from 40 CFR 245.100 (g) in 1976. NASA estimated 0.3 tons per day of solid waste was generated based on the formula provided in the regulations of 1.55 lbs per person per day with a total of 383 employees working at WSTF at the time (NASA, 1976). In 1977, an EPA required cost analysis was performed for paper recycling at WSTF. It was estimated that “high-grade paper” waste amounted to 4.1 tons per month at WSTF (NASA, 1977). Then, in 1980, reported estimates were 120 cu. yd. per month of “office and other organic waste, including paper” and 20 cu. yd. per month of “miscellaneous wastes from on-site construction and maintenance activities” (NASA, 1980b).

In a 1986 EPA survey, it was estimated that the average annual quantity of waste was 2,000 cu. yd., generated by 1,100 employees. At that time, it was reported that 11 trenches/cells had been previously filled and covered, and one cell was active or open at the time. Waste disposal fill rates for each cell were estimated to be 2 years, with an average waste height of 22 ft, placed in the cell in a single lift, (waste layer) with 2.5 ft of sand/gravel cover material at the top (NASA 1986c).

This estimate was increased to 2,400 cu. yd. in 1989, when NASA provided a certification of operations to NMEID following adoption of new Solid Waste Management Regulations (NASA, 1989e). The first solid waste facility annual report estimated 1,000 cu. yd. disposed between May 15, 1989 and December 31, 1989. Then, in March 1990, a summary of previous waste estimate methods was provided in an internal WSTF memorandum:

> “Facilities estimates that the garbage truck makes two runs a week. The truck can hold 30 cubic yards of uncompacted solid waste. This translates into 60 cubic yards a week or 3,120 cubic yards a year. Previous estimates…were based on the number of trips made by the truck and the fact that the truck is not normally filled to capacity. The annual report gave 1,000 cubic yards over a 6 month period and the NOI gave 2,400 cubic yards per year. It has been estimated that

> two trenches a year are being cut at the landfill. The size of the last trench was 8' x 10' x 450' which would hold about 2,000 cubic yards a year. A surface survey of the number of old trenches, estimate of trench size, and distance between trenches, provided a historical estimate of 16 trenches. Assuming that the size of trenches has remained constant a total of 35,000 cubic yards of solid waste have been buried in the WSTF landfill over the past 27 years. Use of the trench size provides a more accurate estimate and will be used for future estimates" (NASA, 1990e).

Current waste estimates provided in a solid waste questionnaire in November 1990 were 80 cu. yd. per week, generated by 1,200 employees (NASA, 1990i), and the total amount of estimated uncompacted solid waste disposed for 1990 was reported as 3,120 cu. yd., (for 1,100 employees; NASA, 1991a). By May 1991, the waste disposed at WSTF was estimated to be approximately 15 cu. yd. per week (NMED, 1991), based on estimates provided to NMED during inspections; however, the 1991 solid waste annual report to NMED SWB listed the annual waste received as 2,976 cu. yd., generated by 1,192 employees (NASA, 1992c). This is much greater than the estimated weekly rate of 15 cu. yd., which would yield 780 cu. yd. of solid waste annually. The 1991 annual waste was further categorized as yard/landscaping wastes, estimated at 1 cu. yd. monthly, construction/demolition wastes, estimated at 22 cu. yd. monthly, and industrial wastes (office, shop, and non-hazardous laboratory wastes) estimated at 225 cu. yd. monthly (NASA, 1992c).

Within NMED SWB inspection lists, the disposal rates were reported as 15 cu. yd. per week until January 1993, causing this discrepancy in WSTF landfill solid waste disposal amounts. When the estimate was revised to 237 cu. yd. per month (NMED, 1993a) in January 1993, this represented a closer estimate to the waste estimates in the annual report. In the solid waste facility annual report, it was stated that 1,235 employees disposed an estimated 2,844 cu. yd. of solid waste for 1992 (NASA, 1993b), which is consistent with the monthly reported estimate of 237 cu. yd. Like the 1991 annual report, wastes were again further categorized as yard/landscaping (1 cu. yd.), construction/demolition (22 cu. yd.), and industrial office, shop, and non-hazardous laboratory wastes (215 cu. yd.; NASA, 1993b).

From July 1993 to June 1996, the waste estimate provided during NMED SWB inspections was 240 cu. yd. per month (NMED, 1993d, 1996). The annual report for 1993 listed 3,036 cu. yd. as the estimated annual waste received at the landfill, (for 1,346 employees; NASA, 1993b), and the annual report for 1994 estimated 468 tons of waste received at the 700 Area landfill from 1,235 employees (NASA, 1995b). Annual waste estimates for 1995 were 283 tons, generated by 1,160 employees (NASA, 1996b).

As discussed in Section 6.4, Operations, NASA began using an off-site solid waste disposal company in October 1995, so only 1 ton of waste was reported as disposed in late 1995 (NMED, 1996). In the 700 Area landfill Closure Plan, NASA stated that a total of 78,000 cu. yd. of solid waste had been deposited in the landfill over the 31 years of use within 26 total individual cells/trenches. The estimate was based on 26 trenches and 3,000 cu. yd. of solid waste within each trench (NASA, 1996j), which may not be accurate due to inaccurate trench number estimates and variations in cell sizes (Figure 6.1).

6.6 Groundwater Monitoring

The quarterly report to WSMR for the first quarter of fiscal year (FY) 1990 (October-December 1989) listed the completion of drilling, well installation, and development of two groundwater monitoring wells adjacent to the 700 Area landfill (SWMU 49): 700-A-253, located approximately 80 ft to the south of the central portion of the landfill, and 700-D-186, located approximately 95 ft to the west of the northern portion of the landfill (NASA, 1990a; Figure 6.1; Figure 6.7). Well completion diagrams are provided in Appendix B. Initial sampling for halogenated volatile organics, aromatic volatile organics, priority pollutant volatile organics, n-nitrosodimethylamine, metals, general inorganics, and dissolved metals was completed in January 1990. Detections consisted of 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113), barium, calcium, magnesium, and sodium in both wells (NASA, 1990d). Table 6.1 provides a summary of Freon 113 results in 700 Area wells 700-A-253, 700-D-186, 700-J-200, and 700-H.

~~Freon 11, TCE, and PCE have also been detected in 700 Area wells at low levels. Summaries of these constituents are provided in Table 6.2, Table 6.3, and Table 6.4, respectively. Freon 11 (Table 6.2) was first detected in 700-D-186 in April 1994 and in 700-A-253 in October 1997. Freon 11 has never been detected in well 700-H. In well 700-J-200, Freon 11 was only detected in one isolated event in January 2001 (Table 6.2). Low levels of TCE were detected mostly in 700 Area monitoring wells 700-D-186 and 700-J-200. TCE was only briefly detected in 700 Area well 700-A-253 in 1996 and again in May 1998, and only one isolated detection of TCE was present in 700-H in September 2014. TCE was first detected in well 700-D-186 in May 1996 and well 700-J-200 in December 1999 (Table 6.3). For PCE, low levels were detected only a few times in 700 Area wells 700-A-253, 700-D-186, and 700-H. PCE was not detected in well 700-J-200 (Table 6.4).~~

In the second quarter of FY 1990 (January-March 1990), groundwater monitoring well 700-E-458 was drilled and completed (Appendix B). This well is located approximately 7,700 ft (1.5 mi) west southwest of the landfill (NASA, 1990f; Figure 6.7). In the third quarter of FY 1990 (April-June), development was completed and well 700-E-458 was sampled. "…results of analyses indicate no hazardous waste contamination" (NASA, 1990g). Groundwater monitoring well 700-B-510, located approximately 3,250 ft (0.6 mi) west of the western corner of the 700 Area landfill was drilled, completed, and developed in the fourth quarter of FY 1990 (July-September; NASA, 1990h; Figure 6.7).

Finally, during the second quarter of FY 1991 (January-March 1991), monitoring well 700-F-455, located approximately 4,400 ft (0.8 mi) northwest of the north corner of the 700 Area landfill, was completed (Appendix B) and sampled. The purpose of this well installation was to bound the WSTF groundwater plume to the north (NASA, 1991b). No groundwater contamination was detected in this well (NASA, 1991d).

In October 1994, NASA submitted a landfill groundwater monitoring system plan as required by the NM SWMRs-4. This plan outlined monitoring frequencies, assessment monitoring levels (AMLs), plans for AML exceedences, descriptions of well sampling equipment, descriptions of well sampling procedures, and required documentation (NASA, 1994g). NMED SWB approved the plan on November 3, 1995 (NMED, 1995).

During landfill compliance groundwater monitoring in 1996 and early 1997, di(2-ethylhexyl)phthalate (also known as bis(2-ethylhexyl)phthalate or BEHP) was detected for the first time. Table 6.2 provides a summary of BEHP detections in landfill groundwater monitoring wells. Detections were above the established AML of 3 µg/L (NASA, 1997f). On July 28, 1997, NASA provided a letter to NMED SWB with analytical data, compliance status, and statistical analyses for constituents detected above background levels or above AMLs. Constituents listed were Freon 113, fluoride, TDS, sulfate, and BEHP. NASA reported that Freon 113 concentrations were statistically above background levels in well 700-A-253; however, Freon 113 was not a listed hazardous constituent in the NM SWMRs-4. Fluoride concentrations were statistically above the AML in well 700-D-186; however, the average concentration of 0.76 mg/L was below the AML of 0.8 mg/L. TDS and sulfate concentrations were both above the AML in 700-D-186; however, these two constituents are non-hazardous. BEHP was reported as the only hazardous constituent statistically above the AML (well 700-A-253; NASA, 1997f).

On August 14, 1998, NMED SWB responded to NASA's analytical data submittal and stated,

> "Due to the assessment monitoring level (AML) exceedance of di-(2-ethylhexyl)phthalate in wells 700-A-253 and 700-D-186, NASA must initiate an assessment monitoring program in accordance with §806 within 90 days of receipt of this letter. [An intrawell statistical comparison between the respective background concentration and each successive sampling result must be conducted for other constituents to determine an AML exceedance such as fluoride, TDS, and sulfate]…NASA must also:
>
> a. characterize the nature and extent of the release by installing additional monitoring wells as necessary (NASA will be required to submit a plan with the well or probe locations and a time line for conducting this characterization);
> b. install at least one additional monitoring well at the facility boundary in the direction of the contaminant migration and a minimum of four independent samples from this well will need to be collected and analyzed to establish background concentrations for all detected constituents from sampling of the other wells…" (NMED, 1998).

Regarding Freon 113 detections, NMED SWB stated, "At this time, NASA has adequately addressed the issue of freon-113 detection," meaning that NASA would not need to conduct assessment monitoring for Freon 113.

NASA submitted a 700 Area Solid Waste Landfill Monitoring Well Installation and Groundwater Characterization Work Plan on January 19, 1999. This plan proposed installing one downgradient multiport groundwater monitoring well, one upgradient conventional groundwater monitoring well, and two supplemental conventional monitoring wells "to adequately characterize the 700 Area groundwater," and specifically to identify potential plume boundaries of BEHP. The multiport well was proposed to provide a vertical contaminant profile. The proposed groundwater sampling schedule included sampling 700-A-253, 700-D-186, 700-B-510, 700-E-458, 700-F-455, BW-6-355, the proposed new 700 Area wells, and the upgradient well 300-D-153, used at that time as the background well for the 700 Area landfill (NASA, 1999a). Well 700-J-200 was proposed approximately 340 ft to the east (upgradient) of the landfill, and well 700-H was proposed approximately 1,100 ft west of the landfill. NMED SWB approved the work plan in March 1999 (NASA, 2000a).

NASA also concurrently conducted a BEHP investigation of other RCRA groundwater monitoring wells at WSTF and of fluids and materials used in drilling groundwater wells. The 700 Area monitoring well installation work plan stated that BEHP was pervasive in PVC, solvents, defoaming agents, plastics, rubber materials, resins, industrial oils, film, wire and cable. NASA stated that possible sources of BEHP contamination at WSTF included the 700 Area landfill, well installation activities, or laboratory cross-contamination. "Preliminary evaluations (of RFI monitoring well data) indicate that the BEHP detections have a poor correlation to other contaminant plume profiles observed at WSTF…data thus far suggest that the BEHP detections in the RFI wells may not be representative of groundwater contamination" (NASA, 1999a). With continued sampling and data evaluation, WSTF "…personnel observed a definite correlation between phthalate detections and the use of non-dedicated well purging equipment. It was noted that nearly all phthalate detections were obtained from wells that had been purged with non-dedicated equipment" (NASA, 2000c). The non-dedicated well purging equipment used was a Bennett pump, which was suspended in the well by a tubing bundle bound together by a wrapped layer of plastic adhesive tape. Testing of Bennett pump sampling procedures and components indicated that the adhesives used on the tape contained sufficient quantities of phthalate based compounds to adversely affect the quality of groundwater samples. Phthalates were volatilized by steam cleaning equipment during decontamination and deposited on the pump and tubing, then subsequently transferred to the groundwater during well purging operations. NASA installed dedicated sampling equipment in the 700 Area groundwater monitoring wells at WSTF, and the BEHP concentrations dropped (not detected for most sampling events; NASA, 2000c).

From the WSMR quarterly report for the third quarter of FY 1999 (April-June 1999), it was reported that the conventional upgradient well 700-J-200 (NASA, 1999c) and Westbay®[2] multiport monitoring well 700-H were completed in August 1999 (Appendix B). Well 700-H contains three monitoring zones with measurement ports located at 350 ft, 535 ft, and 670 ft below ground surface (bgs). The other supplemental wells proposed were not completed. 700-G did not contain groundwater and was plugged and abandoned in 1999 after drilling. Proposed well 700-I was not drilled due to the suspected lack of groundwater.

In March 2000, NASA submitted an explanation letter and requested to return to detection monitoring at the 700 Area landfill from assessment monitoring. NMED SWB approved the request in August 2000 (NMED, 2000).

In response to a request from NMED (NMED, 2018), the following discussion is provided on Freon 11, TCE, and PCE in groundwater that have also been detected in 700 Area wells at low levels. Summaries of these constituents are provided in Table 6.3, Table 6.4, and Table 6.5, respectively. Freon 11 (Table 6.3) was first detected in 700-D-186 in April 1994 and in 700-A-253 in October 1997. Freon 11 has never been detected in well 700-H. In well 700-J-200, Freon 11 was only detected in one isolated event in January 2001 (Table 6.3). Low levels of TCE were detected mostly in 700 Area monitoring wells 700-D-186 and 700-J-200. TCE was only briefly detected in 700 Area well 700-A-253 in 1996 and again in May 1998, and only one isolated detection of TCE was present in 700-H in September 2014. TCE was first detected in well 700-D-186 in May 1996 and well 700-J-200 in December 1999 (Table 6.4). For PCE, low levels were detected only a few times in 700 Area wells 700-A-253, 700-D-186, and 700-H. PCE was not detected in well 700-J-200 (Table 6.5).

Freon 113 continues to be detected at low levels within groundwater monitoring well 700-A-253 and at higher levels in 700-D-186 (Table 6.1)~~; however, this constituent does not require assessment monitoring since Freon 113 is not listed as a hazardous constituent in the 20.9.9 NMAC regulations~~. Freon 11 continues to be detected at low levels within groundwater monitoring well 700-D-186 (Table 6.3). In 700 Area monitoring wells 700-D-186 and 700-J-200, TCE continues to be detected at low levels (Table 6.4). PCE has not been detected in 700 Area monitoring wells since July 2011 (Table 6.5). Detections of Freon 113, Freon 11, TCE, and PCE have not required assessment monitoring to date.

In February 2011, cadmium was detected at 0.0031 mg/L and confirmed at 0.003 mg/L in May 2011. Both results were above the AML of 0.0025 mg/L (NASA, 2012a). At NMED SWB's request, NASA provided a cadmium time-concentration graph to determine if cadmium concentrations were increasing over time (NMED, 2012). Cadmium concentrations have fluctuated from not detected to higher than the AML since 2011. As a result, NMED SWB requested that NASA provide a cadmium time-concentration graph within all reports when cadmium is detected above the AML (NASA, 2013d).

Occasionally, other constituents (e.g., sulfate and TDS in 1999) were detected in 700 Area groundwater monitoring wells above AMLs that required reporting to NMED SWB and additional sampling (NASA, 2000a). These constituents have not required assessment monitoring to date.

6.7 Methane Gas Monitoring

Methane gas monitoring at the 700 Area landfill (SWMU 49) was not initiated until the mid-1990s. The nearest building at WSTF to the landfill (SWMU 49) was located 3,500 ft away, as reported in January 1998 (NASA, 1998b), and therefore, methane gas monitoring was not considered a high priority

[2] Westbay is a registered trademark of Nova Metrix Ground Monitoring (Canada) Ltd.

environmental concern. The first methane gas monitoring event was conducted in a routine inspection conducted by NMED SWB in January 1993. Six methane gas samples were collected “throughout the old cells of the landfill.” No methane gas was detected (NMED, 1993a). Figure 6.4 provides a map of the locations where the gas samples were collected.

Methane gas monitoring was required at both active and closed landfills as part of the revised NM SWMRs-4. NMED SWB personnel determined that NASA should begin methane monitoring at the 700 Area landfill “to establish a background” during a landfill closure consultation in February 1995. If methane gas was not detected, then NASA could request an annual PCC methane gas monitoring frequency (NASA, 1995c).

In preparation for landfill closure, ten methane monitoring wells were installed (NASA, 1996f). An example completion diagram for the methane soil gas wells is provided in Appendix B.

> “The gas monitoring system…consists of 10 monitoring locations at the landfill perimeter. Each monitoring well consists of a seven foot long, 1.25-inch diameter well point with 30 inches of #60 mesh screen set into a six-foot deep, four-inch diameter augered hole with a sand pack and bentonite seal. A four-foot square, 4-inch thick cement pad was poured around each well head and a brass cap was installed in the concrete which depicts the well name, Northing, Easting, and elevation” (NASA, 1996h).

Then on April 14, 1997, additional methane gas monitoring was conducted at the landfill. A description from the corrected closure and PCC plan follows:

> “Seven covered trench locations were monitored utilizing 5-foot long sandpoints that were driven 2 ½ to 3 feet into the cover of filled cells and a combustible gas monitor calibrated to methane at between 5 and 1,000 ppm. The sandpoints were sharpened, reinforced, threaded, and capped, 1 ½-inch-diameter carbon steel pipes that were made on site and steam cleaned prior to use. The sandpoints were inserted using a “T” post hammer. Following being driven to the prescribed depth, the caps were removed and the monitoring tube inserted to approximately 2 inches from the bottom of the perforated sandpoint. Reading durations were between 3 and 5 minutes in length, and the highest value registered was entered in the Landfill Methane Monitoring logbook…” (NASA, 1997e).

Cells 1 and 25 did not contain any methane gas. Cells 5 and 17 contained very small amounts of methane gas, 6 ppm and 8 ppm, respectively. Cell 11 was located adjacent to the Open Detonation Unit and contained 22 ppm (0.002 percent gas or 0.04 percent of the lower explosive limit [LEL]). Cell 23 contained 42 ppm, and Cell 3 contained 200 ppm (0.02 percent gas or 0.36 percent of the methane LEL; NASA, 1997d, 1997e).

Methane monitoring of the permanent landfill methane gas wells (MW-1 through MW-10) was conducted May 31, June 14, July 23, and October 18, 1996; January 21, April 9, July 21, and October 22, 1997; and January 21, and April 21, 1998. All results from these methane gas sampling events were non-detect (<5.0 ppm methane) using a Foxboro Hydrocarbon Analyzer Model OVA-128 (NASA, 1997c, 1998b, 1996h, 1999b).

On January 21, 1998, there was one detection of methane gas in well MW-5 of 7.6 ppm (NASA, 1998a). Then in April 1998, NASA began monitoring methane gas using a Gastec Gem 500 gas monitor. This monitor measured gas as percent LEL in air to one tenth of a percent instead of gas level in ppm. All wells were measured at 0% LEL except MW-5, which could not be located following placement of the closure cap. "MW-5 was apparently destroyed during cover and closure activities…MW-2 was damaged but is still functional" (NASA, 1998d).

> "MW-2 had been hit and the well had partially bent over. The well pad was intact, the pipe did not have any holes in it. The threaded cap was still functional, and the monitoring tube could still pass through the bent section of the pipe. The damage to MW-2 was thus determined to be inconsequential…MW-5 had completely vanished…surveyors located the site of the well, detected metal in the subsurface and dug. At 18-24 inches below surface they came across the remains of the well. The top section of pipe had…been removed from the coupling without stripping the threads. Part of the original bentonite plug was still intact. The remaining pipe was filled with dirt" (NASA, 1998f).

On April 22, WSTF facilities personnel repaired the well by removing the dirt from the pipe, installing an additional joint of pipe for well stick-up, filling the annulus to surface with bentonite, and pouring a cement pad with brass cap surrounding the well (NASA, 1998f). Methane gas was then measured at 0% (NASA, 1998e).

Methane gas monitoring was conducted with the new Gem-500 gas monitor on April 21, July 21, and October 22, 1997; January 21, April 21, July 21, and October 21, 1998; and February 1, April 26, and July 28, 1999. All results were 0.0% methane gas in air. On August 10, 1999, NASA requested that PCC landfill methane monitoring be changed from quarterly to annually based on the lack of methane detected in the 10 gas monitoring wells up to that time (NASA, 1999d), and NMED SWB approved the reduction in methane gas monitoring frequency for the 700 Area landfill on August 12, 1999. NMED SWB requested that NASA report the methane gas monitoring results with the groundwater monitoring results in the annual report (NMED, 1999a).

From October 1999 to December 2016 all methane gas monitoring results at the 10 landfill methane gas monitoring wells were 0.0% methane (NASA, 1999b, 2000a, 2001, 2002a, 2003, 2004a, 2005a, 2006, 2007, 2008a, 2009b, 2010a, 2011a, 2012a, 2013a, 2014a, 2015a, 2016, 2017a). In October 2002, methane gas was detected at well MW-8 (0.1% methane in air); however, the instrument read the same 0.1% methane in the ambient air and was re-zeroed prior to sampling MW-9, which measured 0.0% methane.

6.8 Closure

As early as May 1992, NASA began discussing the possible necessity for closing the 700 Area landfill (SWMU 49). A Plan for Landfill Operation was developed "due to the increased environmental regulation and increased usage during the last ten years." This plan examined the landfill operations and outlined suggestions for continued solid waste disposal at WSTF. The options for solid waste disposal were listed as:

- Use the current landfill.
- Relocate the landfill to another site at WSTF.
- Participate in a cooperative Federal landfill with WSMR, Holloman Air Force Base (HAFB), and other surrounding federal facilities.
- Use a municipal sanitary landfill facility (NASA, 1992d).

By June 1994, NMED had completed a draft of the fourth revision of the NM SWMRs, and in a regulatory review, NASA personnel stated,

> "WSTF's existing landfill is located within 200 ft of a watercourse…When NMED requests a permit, due to the landfill's proximity to an arroyo and existing groundwater contamination, NASA will be required to submit closure and PCC plans for the facility…If stricter controls are implemented at the landfill, the landfill can continue operations until closure is initiated" (NASA, 1994h).

> "WSTF has two options available for future long-term disposal of solid wastes. WSTF can either contract waste disposal to an outside entity or attempt to permit a new facility on WSTF property" (NASA, 1994h).

Contracting an off-site company to dispose of WSTF solid waste would result in closing the 700 Area landfill (NASA, 1994h). If NASA chose to permit the current landfill, a protective layer (either geosynthetic liner or low conductivity soil layer) would need to be installed beneath the solid waste, and additional requirements would need to be met for monitoring systems, operation, maintenance, inspections, contingency plans, training, and record keeping. All landfills were also required to submit a permit application or closure plan to NMED SWB when requested. NASA estimated that the 700 Area landfill permit would be requested by NMED SWB between May and November 1995. For cost efficiency, it was recommended that NASA close the landfill and begin using an off-site firm for solid waste disposal (NASA, 1994d).

In a consultation with NMED SWB personnel regarding landfill closure procedures in February 1995, NMED SWB personnel stated that NASA would be required to submit a permit or closure/PCC plan within six months. Additional advice regarding cover material and drainage was provided. NMED SWB personnel stated that the cell caps must be compacted and tested to meet a hydraulic conductivity (K) of 10^{-5} cm/sec standard. NMED SWB personnel continued, "Preliminary K soils testing should be taken from the bottom of the existing open cell to compare to cover cap testing and demonstrate that the K value is less than or equal to the bottom liner (soil material)." Run-on water diversion could be accomplished by constructing a ditch or berm on the southeast end and minimal earthwork on the northeast side. Run-off was already controlled, since the 2-5% natural slope of the landfill site provided (and would continue to provide) adequate drainage (NASA, 1995c).

The 1995 solid waste facility annual report discussed the phase-out process for 700 Area landfill use. "Until October 1, 1995…dumpsters were serviced twice a week…The average solid waste volume was equal to 7.25 tons per week for the nine month time period. On October 1, 1995, WSTF issued a contract for dumpster pickup and off-site disposal… The NASA WSTF landfill will remain open for construction and demolition waste and dead animal disposal until closure and PCC plans are prepared for submittal to NMED" (NASA, 1996b).

NMED SWB personnel provided NASA with EPA computer software that was used for landfill cover liner performance demonstrations. Submittal of these demonstrations was required in the 700 Area landfill closure plan (NASA, 1996c). In April 1996, NASA began investigating Geosynthetic Clay Liners (GCLs) for use as the landfill closure cap. NMED SWB was contacted for advice in modeling the liner using the EPA computer software. NMED SWB personnel cautioned NASA that if a GCL liner was used, the liner would need to be installed carefully to ensure integrity. Root penetration information should also be included in the closure plan (NASA, 1996i, 1996e).

As part of the closure process, NASA attempted to locate all the historical covered cells at the 700 Area landfill by trenching in April 1996 (NASA, 1996b, 1996e). Ten soil samples were obtained in the landfill prior to April 15, 1996 to evaluate natural WSTF clay in preparation for closure. Four soil samples were obtained from the bottom of the trench, four samples were obtained from the stockpiles of soil planned for trench covering, and two soil samples were obtained from other clay soil locations. A revegetation specification for the landfill cover/cap was also received from the NM highway department (NASA, 1996e). Then, in May 1996, NASA made the decision to use the GCL liner instead of local WSTF clay to ensure the liner would be a proper low K barrier as required (NASA, 1996g).

From an NMED inspection conducted in June 1996, NMED SWB personnel stated that NASA was "getting ready for closure" and "operating one trench," and "most of the waste is hauled away by Southwest Disposal now." Personnel also stated that NASA was "surveying old cells" in preparation for closing (NMED, 1996).

NASA submitted the closure and PCC plan to NMED SWB on July 5, 1996. The closure plan provided additional landfill survey details. "The 26 cells were located and surveyed utilizing the following methods: survey data resurrection; trenching using a backhoe and ripper; site investigations of observed settling; aerial photographs; and interviewing WSTF employees familiar with early landfill operations" (NASA, 1996j). Figure 6.1 shows the landfill and the identified cells. "Cover has been placed over 25 of 26 cells…There is no existing documentation specifying final cell cover thickness; however, excavation trenches indicate that the general cover thickness exceeds two feet" (NASA, 1996j). "The area of cells requiring cover within the 24.32 acres is estimated to be 173,046 square feet (3.97 acres)" (NASA, 1996j).

"The one remaining cell, currently covered with six inches of soil, will be used until NASA notifies the NMED Secretary of intent to close…NASA currently has a contract with an off-site solid waste disposal company to haul a majority of WSTF's wastes to an off-site permitted landfill. One WSTF landfill cell remains open for demolition and construction debris; in addition, the dead animal pit is operational at present" (NASA, 1996j).

Planned closure activities comprised the following:

> "No erosion control measures have been taken at the site. Natural grade facilitates drainage. In addition, natural seeding has resulted in considerable revegetation on approximately 60 percent of the active area. Since the entire area will be cleared and redistributed to a uniform grade the material will be stock piled and used for revegetation…The final cover shall consist of a geosynthetic clay liner (GCL) sandwiched between two inches of select fill (screened to one quarter inch and less in diameter) above and below to prevent any large rocks from damaging its integrity. Each cell or area requiring the GCL will be excavated to 90% of modified proctor. Two inches of select fill will be deposited and compacted over the local fill. The GCL will be lain next, with edges in a trench 20-inches deep and 24-inches wide. The trench will be cut around the edges of the cells. Another two inches of select fill will be deposited over the GCL. This select fill and 10 inches of uncompacted screened local material (topsoil) will complete the cover" (NASA, 1996j).

Literature suggests that roots of growing vegetation on top of the GCL cover would turn 90 degrees and grow parallel to the GCL instead of growing vertically and perforating the GCL. A final grading of 2.5 ± 0.5% slope prior to cell cover was planned to control run-on and runoff.

> "Three-foot high diversion berms will be constructed three feet outside the perimeter fence on the northeastern and southwestern sides of the landfill to prevent run-on following rainfall events. The berms will divert water into the two arroyos…In addition to the landfill slope and run-on berms…a downgradient run-off ditch will be constructed inside the southwestern perimeter fence and beyond the covered cell ends. The ditch will be three feet deep, nine feet wide at the cover surface and approximately 900 feet long. The outlet fan will be lined with rip-rap acquired from

material screened out of the final cover fill." No leachate collection (or removal) or vadose monitoring systems were proposed (NASA, 1996j).

PCC requirements included maintaining records documenting inspections, final cover maintenance, necessary repairs, monitoring, and control systems' data. Information submitted to NMED SWB would include monitoring performance, data collected from control systems, and maintenance summaries. The PCC plan also included requirements for groundwater monitoring, methane gas monitoring, inspections, and maintenance (NASA, 1996j).

NASA submitted requested corrections and elaborations to the closure and PCC plan to NMED SWB on May 2, 1997. This document included amended computer software modeling, proctor density test results, explanations of groundwater flow direction changes, an elaboration of the additional methane monitoring procedures conducted in 1997, the results from the 10 permanent methane monitoring wells, an explanation of open detonation unit operations, and an explanation of low water levels at monitoring well 700-B-510 (NASA, 1997e).

The Landfill closure and PCC plan was approved by NMED SWB on August 22, 1997 (NMED, 1997a). From the solid waste annual report submitted to NMED; "NASA continued to transfer the majority of WSTF- generated solid waste off site by utilizing an independent contractor…7.5 tons" (NASA, 1998b). The last waste was received at the 700 Area landfill on October 27, 1997 (NASA, 1998g).

By November 1997, NMED SWB personnel stated in a landfill inspection, "This landfill is not receiving any solid waste. Pit/trench [is] covered. [It is] in process [for] closure. [NASA] have received approved closure-PCC plan…NASA [is in the process of] bidding package preparation for actual closure. Waste [is] being picked up by Silva Sanitation" (NMED, 1997c).

NASA submitted a NOI to close the 700 Area landfill on February 3, 1998 (NASA, 1999a), and NASA submitted the final closure certification to NMED SWB on August 5, 1998 (NASA, 1998i). Actual closure activities were conducted by a subcontractor and included:

- Shaping, grading, and compacting the landfill cells and area;
- Constructing berms and a drainage channel;
- Installing the GCL liner over each cell area;
- Installing 12 in. of topsoil over the GCL liner;
- Completing final grading;
- Fencing the landfill; and
- Reseeding the landfill area (NASA, 1999b, 1999a).

Figure 6.8 shows a photograph of the installation of the GCL cover at the 700 Area landfill (SWMU 49). "…reseeding and the construction work were completed on June 12, 1998. NASA received the recorded plat, closure certification, and as-built drawings, and implemented the PCC care plan on July 31, 1998" (NASA, 1998i). Figure 6.9 shows a final WSTF drawing of the landfill closure.

On August 14, 1998, NMED SWB personnel conducted a landfill closure inspection and commented, "landfill fenced, closed, graded, covered, seeded, contoured to drain run off into ditch running southeast to northwest. Recent rain storm occurred two days ago and there is absolutely zero ponding. Berm exists outside fence line and new road constructed (Figure 6.1; Figure 6.9). Observed no violations" (NMED, 1998a).

"The WSTF landfill site will be maintained as an unused open space covered by selected and approved vegetation. Area entry will be restricted to inspections, damage repair and final cover integrity maintenance" (NASA, 1996j).

6.9 Post-Closure Care

The PCC Plan for the 700 Area landfill (SWMU 49) was implemented on July 31, 1998 and is effective for 30 years. NMED SWB established the official commencement of PCC on August 14, 1998 (NASA, 2000d). The plan includes requirements for groundwater monitoring, soil-gas monitoring, PCC quarterly inspections and maintenance for landfill cover integrity, adequate drainage, fencing for the landfill boundary, and vegetative cover (NASA, 1999a). Additional inspections are required for major rainfall events (1-in. or more; NASA, 1998h).

Since landfill closure, WSTF has performed quarterly inspections, annual methane gas monitoring, and mostly semi-annual groundwater monitoring, as part of the regularly scheduled PCC of the 700 Area landfill. Landfill inspections have resulted in removing or treating occasional deep-rooted vegetation (usually mesquite) with herbicide (NASA, 2013a).

NASA has also repaired the landfill cover several times since the PCC period began. On August 20, 1999, NASA requested permission from NMED SWB to modify the existing drainage channel at the landfill closure by lining the sides and bottom of the channel with a minimum of 6 in. of gravel (NASA, 1999e). NMED SWB approved the channel modification on August 25, 1999, if NASA used residual material from "sorting for the final cover material" (NMED, 1999b). NASA submitted the final repair drawings to NMED SWB on August 10, 2000. "The landfill channel was modified from a 1:1 slope to a 1:2 slope and lined with gravel to prevent channel scouring" (NASA, 2000d).

In January 2001, NMED SWB requested that NASA repair cracks in the covered 700 Area landfill, inspect the GCL cover and repair as needed, and submit a revised final 700 Area landfill contour map (NMED, 2001). NASA submitted a letter, soil sieve analyses of soil used in the repair, proctor density test results, seeding-contractor statement of work, photographs of the cracks and repairs, and a final contour map. "Repairs began with filling in the cracked areas with on-site clay material…The fill areas were shaped, graded, moistened, and compacted, and proctor density tests were conducted…The areas were graded to match existing lines and to preserve appropriate drainage. Drill seeding was conducted in the repaired areas" (NASA, 2002b). The soil used for cap repair was from WSTF near PFE-2 and Well J and had an average coefficient of permeability of 2.57×10^{-7} cm/sec (NASA, 2002b). NMED SWB approved the cap repairs on July 30, 2002 (NMED, 2002).

WSTF personnel again completed landfill cover repairs in December 2003 and cap and drainage ditch repairs in June 2005 (NASA, 2006a). For cover repair, work consisted of removing the top layer of soil, adding clay material, then shaping, grading, moistening, compacting, and performing proctor density tests. Soil used for repair was from the NASA soil borrow area (near Well J). The soil was tested, and the average coefficient of permeability (for three tests) was 1.01×10^{-6} cm/sec. "Repair work was also completed on the drainage trench that runs along the southern border of the landfill, which included debris removal and erosion repair" (NASA, 2005b).

Landfill repairs were needed again in late 2008. On December 17, 2008, NASA submitted a repair plan to NMED SWB for removing vegetation and repairing cracks and subsidence in the landfill cover (NASA, 2008c). NMED SWB approved the reseeding plan on February 12, 2009, and NASA submitted a repair summary letter on August 30, 2009 (NMED, 2009a; NASA, 2009c). "NASA has completed repairs to the 700 Area landfill closure in accordance with the landfill closure repair plan submitted on December 17, 2008, and February 9, 2009. In addition to repairing several areas of subsidence, and/or cracking, deep rooted vegetation was removed from the closure cap" (NASA, 2009c). The average coefficient of permeability was tested for three soil areas for use in repairing the landfill cap: one from a stockpile of soil at the 700 Area landfill (with an average permeability of 1.40 x 10^{-6} cm/sec), another from the WSTF borrow area south of Well J (with an average permeability of 3.41 x 10^{-6} cm/sec), and the last from the WSTF borrow area north of Well J (with an average permeability of 2.38 x 10^{-6} cm/sec). NMED SWB approved the repairs on September 30, 2009 (NMED, 2009b). Repairs of the 700 Area landfill (SWMU 49) were also completed on March 21, 2013, for five areas of subsidence on the landfill cap and one rutted area on the road. Soil from the WSTF borrow pit north of Well J was stockpiled in the 700 Area for use in cap repairs. The average coefficient of permeability for this soil was 1.44 x 10^{-5} cm/sec (NASA, 2014a). NMED SWB approved the repairs on July 3, 2013 (NMED, 2013a).

In March and April 2017, three areas within the landfill cap were repaired over identified cells 8, 8A, and 10 (Figure 6.9). Falling head permeability tests for fill soil were previously conducted. Fill soil was mixed with water, compacted, and placed on the damaged areas up to 9 in. thick, then compacted to at least 90% and density tested. The soil used for repairs was the same stockpiled soil originally from north of Well J used for repairs in 2013 and was previously tested to have an average coefficient of permeability of 1.44 x 10^{-5} cm/sec. Figure 6.10 shows the current repair locations and a contour map of the closure cap. NASA submitted a closure repair summary report to NMED SWB on June 1, 2017 (NASA, 2017b). NMED SWB approved the repair (in compliance with PCC requirements) on June 14, 2017 (NMED, 2017).

7.0 Findings

7.1 Tenant Waste Disposal

As discussed in Section 6.4, Operations, besides WSTF, other generators of solid waste that ultimately was disposed in the 700 Area landfill were TDRSS, STGT, and ADF-SW. No documents were located discussing solid waste generation at TDRSS or STGT; however, long-term personnel stated that only limited solvents and latex (water-based) paints were ever used at the facilities and the only wastes would be contaminated debris (rags, gloves, etc.) and empty paint cans. These would have been disposed historically in the 700 Area landfill, and then later, shipped off site for disposal like WSTF wastes (Appendix A). One document was located for wastes generated at ADF-SW in 1989.

> "The utility area is divided into several areas: an uninterrupted power supply and battery room, heating and air conditioning support, and a generator room, which is also used as a temporary storage area...The generator room is used for storage of chemicals and waste petroleum. Waste oils and diesel fuel are produced by generator maintenance at an annual rate of ~10 gal total. Disposal has not yet been necessary…Solvents are used for cleaning in the technical area; however, they are used in small quantities (less than 25 gal per year) and typically are used on rags, q-tips or swab. The swabs and rags are disposed of in separate containers and stored in the generator room for future disposal" (GeCL, 1989).

A long-term ADF-SW employee stated that buildings at ADF-SW were and are mostly used for data processing. Current wastes at ADF-SW are described below.

> "There are no hazardous wastes, only domestic and universal wastes. Used oil/batteries for fire alarms, lights, are all 'green' and shipped off-site for disposal…Very little maintenance is performed by ADF-SW personnel on-site. Government Services Administration maintains vehicles [at WSTF]. The only maintenance performed at ADF-SW involves changing oil in generators. At most, there would be 4-5 ounces of used oil absorbed with rags. The rags are then disposed of off-site. Batteries used at ADF-SW are sealed gel cells that require no maintenance.

> When they need service, they are disposed of off-site and new ones obtained. Any paints used were historically latex. Currently, items arrive painted, and no painting is done at ADF-SW."

Waste-generation has been the same since the employee began working at ADF-SW in 1995, and there was "no specific data available on any chemical used prior to 1997…" (Appendix A), after use of the 700 Area landfill had ceased.

7.2 WSTF Waste Disposal

From WSTF's inception until a full-time Environment Department was established in April 1985, almost no wastes were shipped off site for disposal. This was stated in an environmental resources document from 1980, "No chemicals are shipped off site for disposal except possibly small quantity [sic] of PCB's (polychlorinated biphenyls)" (NASA, 1980b). In a letter to De Leuw, Cather & Company in August 1985, it was also stated, "It should be emphasized that although no hazardous materials or wastes have been disposed off site except as noted, this practice will be changing in the near future. Spent solvents, flammable wastes, and other hazardous wastes are being considered for off-site disposal" (NASA, 1985a). (Refer to Section 7.7, Hazardous Substances Used at WSTF, for a discussion of the items that were shipped off site for disposal prior to 1985.)

Liquid wastes in the propulsion areas were washed into the concrete-lined flumes and into the gunnite-lined HWMU impoundments. 200 Area liquid hazardous wastes were stored in underground storage tanks, then pumped out (after 1968) and transported to the 600 Area HWMU. Flammable liquids were provided to the WSTF Fire Department for fire-fighting training practice. Refer to the 200, 300, 400, and SWMUs 1, 3, and 15 HIS' for details (NASA, 2012b, 2011d, 2011e, 2014e). Long-term WSTF personnel also agreed that prior to the establishment of a full-time Environmental Department at WSTF, all wastes were disposed on site (Appendix A).

7.3 Non-Hazardous Wastes

As discussed in Section 6.4.1, Landfill (SWMU 49) Documentation, there were no landfill records prior to 1987. There were also no records located (and likely not produced), for the 700 Area landfill that tracked specific wastes and volumes disposed at the landfill. One employee stated, "There were no records. They (supervisors) would tell me what to dump, and I would take it to the 700 Area and dump it" (Appendix A). Other long-term WSTF employees stated that wastes disposed at the WSTF landfill included office paper, cafeteria wastes, organic wastes (landscaping, weeds, etc.), copy and toner wastes, typewriter ribbons, type correction-fluid bottles, metal parts from building renovations/additions, empty or dried water and oil-based paints and epoxies, and tires (Appendix A).

A 1967 NASA memorandum is the earliest known document that discussed waste management processes for the 700 Area landfill. It included the statement "The dump is primarily a sanitary land-fill type operation. The types of wastes are paper, metal bands, wood, rags, metal containers, etc." (NASA, 1967).

In a 1985 landfill inspection conducted by NMEID, personnel stated, "no residential collection," "office and contractor disposal," and "one food establishment" (NMEID, 1985b). In December 1986, the EPA required that NASA fill out a landfill survey. Wastes listed as disposed were loose bulk wastes from WSTF only, and consisted of 90% commercial wastes from office buildings, restaurants, or other businesses and government offices and 10% construction/demolition wastes, with dead animals listed as accepted within a separate disposal area of the landfill. Asbestos, bulk liquids, containerized liquids, inorganic and organic chemicals, bulk liquid or containerized solvents, hazardous wastes, infectious wastes, and sewage sludges were listed as not accepted for disposal. The source of this information was listed as "estimates" (NASA, 1986d).

Additional evidence that drums were historically disposed in the landfill includes a WSTF DR from February 1987. A deteriorated poly barrel was found in the container storage area. The DR stated, "transport deteriorated barrel to trash receptacle and dispose of as trash (ultimate disposition is WSTF landfill)" (NASA, 1987a).

Disposal of construction and demolition debris or yard refuse at the 700 Area landfill was conducted throughout the life of the landfill (NASA, 1991f). Within the solid waste facility annual report, types of solid wastes disposed in the 700 Area landfill were listed as yard/landscaping, construction/demolition, and industrial (office, shop, and non-hazardous laboratory) wastes (NASA, 1992c).

Drilling mud and additives used to drill groundwater monitoring wells and drill cuttings were also disposed in the 700 Area Landfill. Several TPS' discuss disposal of drilling mud/cuttings in the landfill in the 1980s (NASA, 1984a, 1988b, 1989b). A small trench was also added in the landfill to contain mud/cuttings from portable mud pits (Figure 7.1; NASA, 1984a).

7.4 Banned Items

When a full-time Environmental Department was established in 1985, waste reduction through recycling, and waste management practices were initiated at WSTF to ensure compliance with federal and state regulations. This resulted in the identification of items that were prohibited from being disposed in the 700 Area landfill (SWMU 49). With prohibited items, oversight of landfill wastes needed to be initiated. As discussed in Section 6.4.1, Landfill (SWMU 49) Documentation, weekly inspections were conducted after May 1987, to ensure that no prohibited items were disposed at the 700 Area landfill. Long-term WSTF personnel also stated that landfill operators were also trained to ensure compliance with waste disposal practices (Appendix A). As stated in the landfill groundwater monitoring plan, "The operators are trained to recognize wastes which are prohibited from disposal at the landfill. Additionally, the site contractor Environmental Department inspects the landfill on an at least weekly basis" (NASA, 1994g). These weekly inspection logs, and associated DRs, provide evidence for items that were banned from the 700 Area landfill, and by extension, items that were likely disposed in the landfill prior to 1985. Banned, "unpermitted", or prohibited items documented included:

- In a DR in 1987, personnel stated that three metal drums discovered in the 700 Area landfill were placed there against procedures. They were not removed, however, due to subsequent trash covering the drums (NASA, 1987d).
- From a weekly inspection log in October 1987, it was stated, "some residue [was] remaining in [a] ~40 gal oakite®[3] container" (NASA, 1987c).
- A DR was completed in March 1988: "Metal, grating & metal cabinet found in landfill" (NASA, 1988c). The DR does not specify corrective actions. However, a long-term WSTF employee stated that the metal would have been removed for recycling (Appendix A).
- In August 1988, "During routine inspections, an aerosol can containing pesticides was found in the WSTF landfill. Aerosol cans which have emptied during normal use may be placed in the landfill. Full or partially full aerosol cans containing hazardous materials should not be disposed in the landfill. As with any waste material, the Environmental Section is available to provide disposal recommendations for aerosol cans and their contents" (NASA, 1988e).
- In 1988, two drums (in May) and wood pallets (in July) were documented (NASA, 1988a).

[3] Oakite is a registered trademark of Oakite Products, Inc.

- In January 1989, one 5-gal container of hydraulic fluid, two 5-gal containers of THR-Petroleum (possibly a roof sealant), pipe, angle iron, and polyvinyl chloride (PVC) were discovered in the 700 Area landfill during routine weekly inspections and documented in a DR. The containers were removed and the refuse was covered (NASA, 1988a, 1989a). The pipe and angle iron were metal and could be recycled; however, it is unknown why PVC was listed as part of the prohibited landfill items.
- In July 1989, more metal items were documented on the weekly inspection logs. These metal items consisted of a cabinet, a metal chair, and "other large metal objects" (NASA, 1989c).
- From an internal memorandum in May 1989, "Infectious waste (sharps, blood, etc.) currently generated at WSTF are disposed of in our landfill…The most cost effective solution for the small quantities of infectious waste generated at WSTF is off-site incineration" (NASA, 1989d). This statement indicates that all medical or infectious wastes generated at WSTF prior to May 1989 were disposed in the landfill but would be banned thereafter.
- It was commented in a weekly landfill inspection in April 1990 that personnel "found chemicals in [a] jar (soldering flox [sic]), [and] some boxes." Soldering flux is a paste or liquid that consists of soldering metals and chemicals for use in soldering. Appendix C provides several sample material safety data sheets (MSDS). The items were removed from the landfill. This statement suggests that chemicals and boxes were banned items as well. The boxes were likely used for fire-fighting practice.
- In the 1990 solid waste annual report, it was stated that two loads were rejected because they contained paint and wood (NASA, 1991a). Wood at WSTF was stacked in a pile located in the area just east of the GSA building in the 100 Area and used periodically for fire-fighting training. Refer to the SWMUs 1, 3, and 15 HIS for details (NASA, 2014e). Paint was shipped off site for disposal due to solvents and/or lead constituents in the paint (Appendix A).
- In May 1991, 13 poly drums were discovered in the 700 Area landfill (NASA, 1991c). The drums were removed (and recycled).
- On November 25, and December 6, 1991, "Unpermitted" items included two pieces of conduit (NASA, 1991c). These items were also removed and recycled (Appendix A).
- The NM SWMR were revised (third edition), with the result that NASA could no longer dispose of contaminated soils, including chemical or petroleum-contaminated soils, as of the effective date of the regulations, January 31, 1992 (NASA, 1991f). Refer to Section 6.1, Landfill (SWMU 49) Regulatory History, for details.
- In January 1992, through weekly inspections, copper wiring was listed as an unpermitted item in the landfill (NASA, 1992a). The copper wiring was removed and recycled (Appendix A).
- In November 1992, metal flanges with plastic pipe and wood were disposed in the landfill and a DR was written. "Flanges were removed by Heavy Equipment Section. Wood & other pipe debris removed by construction section." Flanges were delivered to the warehouse for "salvage" (NASA, 1992e).
- In July 1993, six metal fan shrouds, wire spools, and 10-12 glass ceiling tiles were discovered in the landfill (NASA, 1993a). The metal and wire were recycled, and the glass ceiling tiles may have contained asbestos that would have been shipped off site for disposal.
- In August 1993, two electrical test boxes and one clock were listed as unpermitted items (NASA, 1993a). These items were removed and recycled with other electrical equipment at WSTF (Appendix A).

- In 1994, paint cans with residual paint, wire (copper and other), wood, metal copper flex line, rebar, and an unspecified type and number of drums were listed as prohibited items discovered in the 700 Area landfill. In March 1994, an unspecified quantity of paint cans (containing over the allowable limit of paint) were listed in the weekly inspection log (NASA, 1994a). The paint cans were removed and sent off site for disposal, the wood was removed and added to the WSTF wood pile in the Firemen's training area, and the drums, wire, and metal were removed and sent for scrap/recycling (NASA, 1993a).
- In June 1995, "Thinner & PVC cement removed for proper disposal."
- Empty paint cans were listed in the comments section of the weekly inspection log in August 1995; however, since they were empty, it was not a banned item and they were not removed (NASA, 1995a).

From the 1994 solid waste facility annual report, "Landfill Inspection Procedures" section, it was stated, "White Sands Test Facility (WSTF) procedures currently require that the Quality Assurance (QA) Office inspect the WSTF Landfill weekly for the following prohibited items: metal, wood, concrete, hazardous materials/waste, and soils not originating at the facility" (NASA, 1994b).

7.5 Waste Reduction/Recycling

The first material recycled at WSTF was vehicle batteries. From a waste inventory generated in 1985, it was listed that approximately 30 (vehicle) batteries per year were shipped to HAFB for recycling (between 1963 and 1985; NASA, 1985a). Long-term WSTF personnel stated that WSTF vehicle batteries were recycled from WSTF's inception to the present (2014; Appendix A).

In 1977, NASA evaluated the recycling of office paper. In a letter from NASA headquarters to WSTF, it was stated, "EPA Guidelines for Source Separation for Materials Recovery (40 CFR 246) which was published in the Federal Register on April 23, 1977, requires office paper recycling in Federal facilities with 100 or more office workers." Decisions regarding compliance were required to be submitted by July 24, 1977 to the EPA. In response, NASA WSTF personnel submitted a cost analysis to NASA headquarters. The number of employees at WSTF at the time was 240. "The small volume of waste at this installation and the low price offered for high grade office paper on the local market makes it uneconomical to initiate source separation at this time" (NASA, 1977).

As stated in Section 6.1, 700 Area Landfill (SWMU 49) Regulatory History, the Hazardous and Solid Waste Amendments of 1984 required facilities to certify annually that the volume and toxicity of wastes was reduced to the greatest extent practicable. This resulted in the beginning of waste reduction at WSTF. This regulation was first implemented at the landfill by finding alternate disposal methods or recycling for items such as metals.

In a DR, it was stated,

> "On July 7, 1987, NASA QA [quality assurance] personnel discovered three metal drums in the WSTF landfill. Disposal of metal drums in the landfill is prohibited by Lockheed Procedure…Before the Environmental Section could require the removal of the drums and their delivery to the warehouse as scrap, the drums were covered by loads of trash subsequently delivered to the landfill. Please require your landfill operator to survey the contents of the landfill for the presence of unacceptable items prior to burying them with trash. Notify the Environmental Section in the event these items, or anything questionable, are discovered" (NASA, 1987d).

This shows that by 1987, metal drums were not allowed to be disposed in the 700 Area landfill, but were disposed/sold as scrap metal instead (NASA, 1987d).

In a solid waste questionnaire completed in November 1990, NASA stated that a pilot recycling program had been implemented at WSTF to recycle up to 10% of the total solid waste (NASA, 1990i). Items recycled in the pilot program were not specified, but assumed to be paper, based on information provided in the solid waste facility annual report to NMEID submitted in February 1991. “The site has been recycling paper on a trial basis for about three months. Information regarding the approximate quantity of waste recycled is unavailable. The paper waste is segregated at the point of generation and shipped off site” (NASA, 1991a).

For the first time, NMEID requested that the solid waste facility annual report for 1993 include an accounting of the final disposition of any waste materials generated that were not landfilled:

- “Waste oil, used anti-freeze, scrap metals, and non-hazardous products are recycled through the Defense Reutilization and Marketing Organization at Holloman Air Force Base;
- Aluminum cans [are] recycled off site;
- Scrap lumber and tree branches [are] collected and used for firefighter training with Burn Permits; and
- Concrete and asphalt [are] used for flood control and riprap” (NASA, 1994b).

The annual report for 1994 also listed the disposition of items not landfilled. Most items were the same as in 1993; however, lead acid batteries and rubber tires were added to the list of materials that were recycled through HAFB (NASA, 1995b).

The annual report to NMED SWB for 1994 listed, for the first time, specific amounts of recycled materials:

- 2 tons tires, 2,050 gal waste oil,
- 209 tons scrap metal, and
- 3 tons lead acid batteries were recycled through HAFB (Defense Reutilization and Marketing Organization; NASA, 1995b).

On October 1, 1995, NASA began recycling cardboard through Southwest Disposal Corp. as part of the solid waste disposal service (NASA, 1996b). Other items recycled in 1995 included:

- Scrap metal: 100 tons,
- Electrical wire/cable: 56 tons,
- Waste oil: 7.2 tons,
- Lead acid batteries: 3 tons,
- Tires: 1.75 tons, and
- Toner cartridges: 500 each (NASA, 1997b).

For FY 1996, amounts of solid material recycled were:

- Scrap metal: 67 tons,
- Electrical wire/cable: 7 tons,

- Waste oil: 11 tons,
- Lead acid batteries: 1.7 tons,
- Toner cartridges: 500 each, and
- Cardboard: 1.7 tons (NASA, 1997b).

For FY 1997, NASA recycled 23% of solid wastes, including:

- Scrap metal: 81 tons,
- Electrical wire/cable: 6 tons,
- Waste oil: 4.3 tons,
- Lead acid batteries: 1.6 tons,
- Tires: 1.3 tons,
- Toner cartridges: 287 each, and
- Cardboard: 8.2 tons (NASA, 1998c).

Besides the documented recycling or waste reduction procedures listed above, NASA conducted additional recycling efforts. Long-term personnel stated that NASA recycled:

- Broken, non-functional, or excess electrical equipment/instruments/meters through HAFB,
- Empty pressurized gas canisters were exchanged for full canisters at a local Las Cruces business,
- Computers, and
- Equipment not in use at WSTF.

Employees could not recall when these programs began at WSTF, but it was likely after 1985. One employee stated, “Recycling at WSTF early on was only for money or if there was no place to throw it away. There was no environmental control until later on in the Shuttle program” (Appendix A).

7.6 Landfill Burning

In the 1981 application to register the 700 Area landfill (SWMU 49), it was stated that no burning of solid waste was permitted, and a sign was posted to that effect (NASA, 1981); however, burning was conducted at the 700 Area landfill (SWMU 49). NMEID personnel stated in a landfill inspection in 1983: “You may wish to ask for a variance to the solid waste regulations or a burn permit to allow the burning of controlled paperwork” (NMEID, 1983). No burn permits were located; however, long-term WSTF personnel concurred that sensitive documents and computer cards were burned at the landfill, reportedly every Saturday or twice a week, until the mid-1980s. These items were burned within the trench that was active at the time. Since these fires were conducted in the trench that contained additional waste, any flammable waste would also burn within the trench (such as paper, rags, etc.). The WSTF Fire Department doused the fires with water to extinguish them. Evidence of these fires was noted by a WSTF employee who stated that while locating historical trenches for landfill closure activities, most trenches located contained burned material (Appendix A).

An accidental fire also started in the landfill, reportedly in the mid-1970s, when WSTF personnel had detonated small engines within the active trench. (Refer to Section 7.8.3, Evidence from Interviews, for details of these explosions.) This caused “paper and things” within the active trench to begin burning and also ignited waste within the adjacent covered trench. The WSTF Fire Department responded, and the fire was extinguished with water. Subsidence occurred in the area of the fire (Appendix A), and the subsided area was filled in with clean soil excavated from the active trench.

Another employee reported seeing a “spontaneous” fire of flammable rags occurring in the landfill in the late 1970s (Appendix A). The WSTF Fire Department extinguished the fire with water. Finally, regarding burning at the 700 Area landfill, it was stated within the landfill closure and PCC plans, “Trash was burned in open cells prior to the open burning regulation implementation” (NASA, 1996j).

7.7 Hazardous Substances Used at WSTF

Since records of the specific waste types and measured amounts of solid wastes disposed at the 700 Area landfill (SWMU 49) were not generated at WSTF, and few long-term WSTF employees recalled detailed disposal data, WSTF solid waste information is only estimated. As usual for a HIS, historical waste generation records were reviewed. Because recent NASA testing activities and waste generation are comparable, recent WSTF wastes were also reviewed as an analog to what may have been historically disposed at the 700 Area landfill.

Wastes that are, or have been, shipped off site for disposal were likely disposed in the 700 Area landfill prior to waste disposal shipments at WSTF (1985). Some solid wastes currently or historically generated and shipped off site, reused, or recycled at WSTF are described in this section.

From 1994 and 1995 waste reduction reports and correspondence:

- Batteries (mercury, lead, acid),
- Paints (with lead, chromates, and barium),
- Fluorescent lamps (with mercury),
- Scrap metal,
- Toner cartridges (NASA, 1994e, 1995d).

Prior to shipment off site for recycling in 1985, it was reported that acid from vehicle batteries was emptied into the 600 Area HWMU impoundment (NASA, 1985a). However, both long-term WSTF personnel and historical documents suggest that the 600 Area HWMU began to be used for hazardous liquid wastes, in 1968. Refer to the 200 Area HIS for details (NASA, 2012b). Prior to that time, it is unknown how the acid from recycled batteries was disposed. One employee speculated that it may have been disposed in the 700 Area landfill (Appendix A).

NMED SWB personnel stated during an inspection of the 700 Area landfill in April 1991 that NASA shipped asbestos and infectious waste off site for disposal (NMED, 1991). This was stated again in a regulatory review in November 1991, “WSTF generates medical and asbestos waste which are both special wastes, however, these wastes are shipped off-site for disposal” (NASA, 1991e). Shipping these wastes off site for disposal occurred by late 1991, likely in preparation for regulation changes in January 1992 (Section 6.1, 700 Area Landfill [SWMU 49] Regulatory History). Medical and asbestos wastes were disposed at the 700 Area landfill prior to the early 1990s (NASA, 1989b). Examples of asbestos-containing material used at WSTF may include: packings, gaskets, floor tiles, ceiling tiles, roofing products, and insulation (Appendix A).

WSTF spill reports documented chemicals/substances spilled at WSTF subsequent to 1985. Hazardous substances shipped off site for disposal (after 1985), and likely deposited in the 700 Area landfill prior to 1985, included contaminated soils from:

- Mercury,
- Oakites (Oakites used at WSTF include Oakite 33 [phosphoric acid], Oakite HD 126 [sodium hydroxide], Oakite Liqui-Det 2 [phosphates, amine, surfactants], Oakite Rustripper [caustic, alkaline salt, surfactants], Oakite Vistrip),
- Oils,
- Rust removal chemicals,
- Freons (Freon 11 and Freon 113),
- Acids,
- Bases,
- Ammonia,
- Isopropyl alcohol (IPA),
- Gasoline,
- Diesel fuel,
- Fuel (MMH, hydrazine) spills,
- Hazardous waste drainline spills,
- Photographic chemicals (developer, fixer, etc.), and
- Fuel contaminated vacuum pump oils.

Finally, a list of recent hazardous wastes shipped off site for disposal was reviewed to estimate past hazardous wastes disposed at the 700 Area landfill prior to 1985. Solid wastes that were shipped off site for disposal between September 2013 and September 2014 included:

- Contaminated debris (fuels [hydrazine, methylhydrazine, 1,1-dimethylhydrazine], oxidizer [nitrogen dioxide], arsenic, barium, cadmium, lead, chromium, mercury, benzene, methyl ethyl ketone [MEK], trichloroethene [TCE], tetrachloroethene [PCE] corrosive wastes, ignitable wastes, reactive wastes, F001 wastes, F002 wastes, and F005 wastes),
- Waste aerosol cans (barium, benzene, MEK, TCE, PCE, ignitable waste, corrosive waste, and reactive waste),
- Spent metal sludge (chromium),
- Spent mercury lamp debris (mercury),
- Contaminated oil (arsenic, cadmium, chromium, lead, benzene),
- Petroleum contaminated soils (lead and benzene),
- Fuel contaminated soils (benzene),
- Spent oil filters (benzene),
- Lead acid batteries (lead, corrosive waste),
- Nickel cadmium (NiCad) batteries (cadmium and corrosive waste),
- Paint related materials (barium, benzene, MEK, and ignitable wastes), and
- Unused chemicals (lead, mercury, and MMH sulfate; NASA, 2013c).

F001 wastes contain: "The following spent halogenated solvents used in degreasing: Tetrachloroethylene, trichlorethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures" (EPA, 2017a).

F002 wastes contain: "The following spent halogenated solvents: Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2- trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2, trichloroethane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F001, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures" (EPA, 2017a).

F005 wastes contain: "The following spent nonhalogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2- nitropropane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above nonhalogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures" (EPA, 2017a).

Finally, hazardous spent lamps that are currently shipped off site for disposal were likely disposed in the 700 Area landfill prior to 1985. "During routine operation of the facility, WSTF generates a variety of spent lamps. Typically, these lamps would be hazardous due to toxicity for mercury, lead, or other heavy metals…WSTF currently manages spent lamps in accordance with the universal waste regulations per 40 CFR 273…Examples of common universal waste electric lamps include, but are not limited to, fluorescent, high intensity discharge, neon, mercury vapor, high pressure sodium, and metal halide lamps…" (NASA, 2012a).

7.8 Evidence of Hazardous Substances Disposed at the Landfill

7.8.1 Evidence from Documentation

This section provides information on some wastes disposed in the 700 Area landfill and identified through WSTF documents. In a 1980 environmental resources document, it was stated, "scrap, garbage, and other solid wastes are picked up on a regular basis and disposed of through an onsite operated, state approved, landfill…All unused pesticides listed are stored in a locked building. All empty containers are disposed of in state-approved [WSTF] landfill." These pesticides included "spike, Hyvarx, MB Rat Guard, Pyrethrin, and Diazinon 4E" (NASA, 1980b). MSDS are provided in Appendix C. As stated in Section 6.1, 700 Area landfill (SWMU 49) Regulatory History, NASA originally listed warfarin rat poison as having been disposed in the 700 Area landfill, but in 1984, stated that this was not the case (NASA, 1984b).

From a 1985 WSTF waste inventory provided to DeLeuw, Cather & Company, WSTF disposed approximately 10 to 30 gal per year of latex and oil-based paint in the 700 Area landfill from the site's inception (listed as 1963) to the present time (of 1985). Included as part of this inventory, was a list of SWMUs that had been previously provided to the EPA. The 700 Area landfill was listed as a SWMU in the 700 Area. Types of waste disposed at the landfill were listed as, "Paper, rubbish, and assorted non-industrial materials…Except for the paint, the landfill, to the best of our knowledge, has not been used for the disposal of hazardous wastes" (NASA, 1985a).

Then, in May 1989, WSTF Environmental Department personnel performed a regulatory review of revised NM SWMRs. "New Mexico has recently issued new regulations (effective May 15, 1989) for solid waste landfills restricting the disposal of infectious waste. Infectious waste (sharps, blood, etc.) currently generated at WSTF are disposed of in our landfill" (NASA, 1989d). (Refer to Section 6.1, Landfill (SWMU 49) Regulatory Review for a continued discussion of this regulation.)

Asbestos was also historically disposed in the 700 Area landfill. An internal WSTF memorandum describes asbestos disposal in September 1989. "The 150 Yard has received several items, such as pipes, which contain or are coated with asbestos containing material…Because these items are non-friable asbestos, they may be placed in the WSTF landfill" (NASA, 1989f). It is unknown if friable asbestos was also disposed at the 700 Area landfill.

Contaminated soils were disposed at the 700 Area landfill until 1991. In a November 1991 regulatory review of NMSWMR-3 (third edition), it was stated, "Petroleum contaminated soils are the only special wastes the WSTF landfill currently receives that fall under the amended regulations…" (NASA, 1991f).

In the site assessment submitted to NMED SWB in June 1993, NASA reported, "Hazardous waste was disposed of at this site," based on interviews with long-term WSTF employees (NASA, 1993c). When asked if hazardous waste was disposed at the WSTF landfill, employee statements were:

- "Prior to the hazardous waste laws the landfilled materials would surely have exhibited current hazardous waste characteristics."
- "Probably, because at the time (prior to 1976) we were not aware of hazardous waste and now almost everything is hazardous."
- "In the early years there was no hazardous waste distinction; therefore, most probably we did."
- "Previous discussions with long time site employees indicated that the following wastes were probably placed in the landfill: paints (oil and water based), adhesives, fillers, batteries (mercury, NiCad, lead acid), glassware and soft goods contaminated with fuel (primarily monomethylhydrazine), and various solvents" (NASA, 1993c).

In the landfill closure and PCC plans, hazardous wastes disposed at the landfill were discussed:

> "WSTF employees familiar with historical landfill operations in the late 1960s, feel that it is likely that these installations disposed of the following hazardous wastes:

- Spent solvents,
- Waste paints,
- Hydrazine-contaminated soft goods, and
- Various spent sample materials that may have contained residual hazardous wastes" (NASA, 1996j).

7.8.2 Spill Reports

NASA WSTF personnel did not maintain any records of spills of chemicals/substances to the environment prior to waste management changes introduced by the full-time Environmental Department. The first spill report was written at WSTF in November 1985. This section summarizes spills at WSTF that were documented as disposed in the 700 Area landfill (SWMU 49). Appendix D provides the original spill report documents.

- SPL001 (4/3/1988): 7 gal of transmission fluid was spilled at the WSTF Fire Department. The spill was soaked up with spill dry and disposed in the dumpster (for transport to the 700 Area landfill).
- SPL002 (4/13/1987): the Southern transformer in Building 201/203 substation leaked ~1 quart of non-PCB containing oil after sampling 4/7/88. The spill was cleaned with spill dry and paper towels, which were taken to the 700 Area landfill for disposal.
- SPL005 (6/1/1987): stained soil under building 253 (the historical 200 Area chemical storage building) on the east side was determined to be approximately 5 gal Texaco Soluble oil D (stored since 1984). Contaminated soil was approximately 4 ft in diameter. The soil was drummed and spread at the 700 Area landfill.
- SPL009 (6/24/1987): approximately 1 gal of water-based paint was spilled at the WSTF warehouse. It was initially washed with water, cleaned with spill pillows, and disposed at the 700 Area landfill. This spill indicated the lack of employee training for environmental issues and the lack of written spill procedures at WSTF (Appendix D).
- SPL015 (11/18/1988): Approximately 1 gal of Given Black Enamel Paint was spilled on the floor of the WSTF warehouse. MSDS could not be located. The paint was cleaned up with “mineral spirits,” rags, and spill pillows. Liquids were drummed and taken to the drum storage facility (for shipment off site), and the rags and spill pillows were allowed to dry and placed in the 700 Area landfill.
- SPL016 (12/5/1988): IPA leaked into soil from two stock tanks during cleaning procedures for the 400 Area 10,000-gal IPA storage tank. There was approximately 147 cubic ft of contaminated soil. The IPA soil was analyzed for flash point (69ºC or 156ºF). Since the result was >140ºF, the soil was disposed in the 700 Area landfill.
- SPL018 (12/19/1988): A package of eight 1-gal containers of 52% hydrofluoric acid had leaked when it arrived at the WSTF warehouse. The containers were decontaminated at the 200 Area clean room pad. “The boxes and other decontaminated items” were put in the trash (for disposal at the 700 Area landfill). The hydrofluoric acid was added to Building 253 for use in the 200 Area.
- SPL023 (1/10/19890): one 8-ounce bottle of plastic polish (containing IPA) spilled at the WSTF warehouse. The spill was cleaned up with rags that were disposed in the 700 Area landfill. (The flash point of the product was 200ºF).
- SPL024 (2/2/1989): approximately 5-10 gal of gasoline were spilled when the gas pump did not shut off. Vermiculite (Floor-Dri) was used to clean up the spill. The vermiculite will be disposed at the 700 Area landfill “after airing out.”
- SPL025 (2/15/1989): The automatic gas shut-off did not function properly and 2-3 gal of gasoline was spilled. The gas was cleaned up with spill dry, which was disposed in the 700 Area landfill “after airing out.”
- SPL026 (2/21/1989): 2 liters hydraulic fluid was spilled in Room 119, 800 Area. The spill was cleaned up with rags, which were disposed in the 700 Area landfill.
- SPL031 (3/16/1989): <1 ounce total (estimated) of sulfuric acid (electrolyte battery fluid) leaked during transport to WSTF. The damaged containers were rinsed into the ETUs. The contaminated cardboard boxes and rinsed containers were placed in the 700 Area landfill.
- SPL033 (4/17/1989): approximately 2 quarts non-contaminated oil leaked from water pumps at test stand 401. The oily soil was allowed to dry and disposed in the 700 Area landfill.

- SPL034 (4/18/1989): an estimated <1 gal of Kodak 1st Dev. Replenisher Proc. R3 had leaked during transit to WSTF. The containers were rinsed (into the 100 Area sewage lagoon) and the box was put in the dumpster (for disposal at the 700 Area landfill).
- SPL035 (4/28/1989): an estimated <1 ounce tetraethylene pentamine had leaked during transit to WSTF. The cardboard box, vermiculite, and paper towels were placed in the dumpster (for disposal in the 700 Area landfill).
- SPL036 (5/4/1989): approximately 2 gal diesel spilled at the 400 Area diesel pad. Contaminated soil was "exposed" for five days then disposed in the 700 Area landfill.
- SPL037 (5/8/1989): < 1 pint Bioact DG-1 petroleum leaked in transit to WSTF contaminating papers. Cleaned cans with wipes, then wipes and contaminated papers "discarded." It is assumed that papers and wipes were disposed in the 700 Area landfill.
- SPL038 (5/9/1989): This may be the same spill as SPL027. Details are the same, except the date and this spill report stated that the box and packing materials were placed in the dumpster (for disposal in the 700 Area landfill).
- SPL041 (6/14/1989): Unknown quantity of diesel and cutting/motor oil was spilled to soil 100 ft northeast of monitoring well BW-5-298. 20-30 ft of the arroyo contained discolored soil to at least 1 ft depth. Disposition of the contaminated soil was not reported, but assumed to be at the 700 Area landfill.
- SPL045 (no date): This is the same spill as SPL041 but provides greater detail. This spill was reportedly caused by a subcontracted construction company that was building the road to the STGT. The contaminated soil was "spread out on the hard pack area to the south to be broken down by exposure." It is assumed that the soil was then disposed in the 700 Area landfill.
- SPL047 (7/17/1989): 2-3 gal of diesel fuel overflowed onto the ground east between Building 200 and the North high bay. Spill dry was used to soak up the spill, and the spill dry was disposed at the 700 Area landfill.
- SPL051 (12/16/1989): 100 gal of diesel spilled from an overhead diesel tank in the 150 yard. A 10 ft x 10 ft puddle had formed, contaminating soils 2-3 in. deep. Free diesel was absorbed. The absorbent and contaminated soils were "transported to the WSTF landfill and spread on the ground to degrade."
- SPL054 (1/18/1990): <1 gal oil-based paint spilled in transit to WSTF. The spill was wiped up with rags. It is assumed that the rags were disposed in the 700 Area landfill.
- SPL058 (5/2/1990): approximately 15 gal leaded gasoline was spilled onto gravel. The contaminated gravel was transported to the 700 Area landfill and "spread out to air dry on a vinyl vapor barrier."
- SPL060 (10/5/1990): 40-50 gal IPA was spilled in the 400 Area at the alcohol run tank. Liquid IP was pumped to a barrel. Contaminated soil was excavated and placed on plastic to air dry. "The solid would then be placed in an open head drum." Final disposition of the soil was not reported.

As stated in Section 6.1, Landfill (SWMU 49) Regulatory History, the revision of NM SWMRs-3 expanded the definitions of special wastes and implemented special requirements for disposal; therefore, WSTF stopped placing contaminated soils in the 700 Area landfill. This was stated in several documents, and is corroborated in WSTF spill reports, since no spill reports were located that discussed disposal in the landfill after SPL060.

7.8.3 Evidence from Interviews

Long-term WSTF employees interviewed for this HIS also provided information regarding what was or may have been disposed in the 700 Area landfill (SWMU 49). Personnel stated that many items were placed in the landfill prior to use of a full-time Environmental Department at WSTF (1985). One employee stated, "There seemed to be no historical procedure to deal with occasional extra, leftover, or off-specification liquids/chemicals" (Appendix A).

When asked if any hazardous substances or petroleum products, tires, or automotive or industrial batteries had been buried at WSTF, one employee stated, "The old dump. Everything went into it" referring to the 700 Area landfill. Some items disposed in the landfill that employees identified included:

- Both soft goods (e.g., cloths/rags, disposable PPE [gloves, outer clothing, aprons, face shields, goggles, SCAPE gear, splash gear, hard hats], wipes, elastomer parts from the valve shop, o-rings, gaskets, Tygon®[4] tubing, plastic, etc.) and hardware (e.g., glass bottles, other glassware, tubing, piping, plastic, spent 800 Area test samples, Teflon®[5] gaskets, "anything on an aerospace panel," etc.) contaminated with:
    - Fuels (UDMH, A-50, MMH, and hydrazine),
    - Oxidizer (N_2O_4),
    - All 200 Area laboratory chemicals (e.g., Freon 11, Freon 113, TCE, PCE, other solvents, alcohol, acetone, IPA, MEK, phosphorus, etc.),
    - Hydrocarbons (e.g., diesel, gasoline, hydraulic fluid, lubricating oils, motor oils, etc.),
    - Krytox®[6] lubricant (Appendix C contains SDSs),
    - Teflon grease,
    - Mercury (cloth used to clean broken thermometers or spills prior to off-site shipment).

Other waste items disposed at the 700 Area landfill reported by long-term WSTF employees included:

- Small amounts of metals (stainless steel 306, carbon steel, chrome decorations, titanium, aluminum, iron, machine shop metal tubing and residual or excess metal parts, mercury, copper, tin, gold, silver),
- Steel or aluminum cabinets,
- Photographic negatives and photo papers (silver [silver bromide]),
- Etching plates (metals),
- Contaminated spill dry (chemicals, oils, fuels),
- Fluorescent lamps (containing lead, cadmium, and mercury),
- Fluorescent light ballasts (containing PCBs; Refer to Section 7.9. Polychlorinated Biphenyls below for details),

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[4] Tygon is a registered trademark of Saint-Gobain Performance Plastics Corporation.
[5] Teflon is a registered trademark of E.I. du Pont de Nemours & Company Corporation (Dupont).
[6] Krytox is a registered trademark of E.I. du Pont de Nemours & Company Corporation (Dupont).

- Asbestos containing materials (insulation for wires and pipes, floor and ceiling tiles, automotive brake materials, etc.),
- Plastics,
- Meter cases,
- Oil-based paints (ignitable and contained chromium and lead),
- Latex (water-based) paints,
- Primers (contained lead),
- Waste epoxy coatings (dried and liquid),
- Resins,
- Adhesives,
- Filters (air, oil, etc.),
- Batteries (alkaline, mercury, lead-acid, NiCad),
- Automotive waste (tires, brake parts, filters, antifreeze, used oil, etc.), automotive wastes (rags, oils, greases, antifreeze residuals),
- Broken or inoperable equipment (meters and meter parts [wiring, inductors, capacitors, resistors, etc.]),
- Insulated wires,
- Pipes/plumbing,
- Respirators,
- Lumber/wood/pallets,
- Oils (not containerized),
- Spent activated charcoal from fluorine testing (may have been reactive),
- Aerosol cans (most empty, but some full),
- Engine cleaning solutions,
- Residual liquids left in empty steel or fiberboard drums (55-gal), bottles, or containers (1 gal, 2 gal, 5 gal) [included but not limited to: acetone, solvents, Freon 11, Freon 113, TCE],
- Liquids within containers up to half full (especially Freon 113) during clean-up activities for off-specification, leaking, or old chemicals/containers prior to a well-managed hazardous waste disposal program through the full-time Environmental Department (1985).

An employee that worked at WSTF during the Apollo program from 1965-1971 stated, “We used a lot of Freon, also Trich (TCE) was primarily used. Most evaporated…Landfilled most of waste. Used to be very generous with use of Trich (TCE). The landfill site north of the usage areas was used to dispose of drums of Freon waste” (Appendix A). This suggests that there may be buried 55-gal drums of Freon 11 and/or Freon 113 in the 700 Area landfill and perhaps TCE as well. Another employee stated that there was “no limit on the type of stuff that went into the landfill.”

One employee remembered pouring liquids directly into the landfill and adding mostly unmarked 55-gal drums and containers of chemicals (e.g., Freon 11, Freon 113, acetone, IPA, hydraulic fluids, engine oil, diesel fluid, spent oakites, spent MEK, spent Brulin®[7] solutions; Appendix A).

Long-term WSTF personnel also stated that some small propulsion engines and/or thrusters had been destroyed within the trenches of the landfill during three different propulsion testing programs at WSTF: one program in the 1960s (as part of the Apollo missions), one in the 1970s (Orbital Maneuvering System engines for the Space Shuttle), and again approximately in 1985. One employee explained that engine designs were proprietary and the designers required secrecy for each engine design. The engine contractor personnel did not want the engines returned after testing; therefore, the long-term WSTF employee stated that C4 explosives had been used to destroy these engines within trenches at the 700 Area landfill. Landfill procedure required a bulldozer to be present at the landfill, so when an engine needed to be disposed, a new trench was excavated, the disposal explosion was conducted, and then the remains were covered with soil. These engines contained minute residual amounts of fuel (UDMH, A-50, MMH, or hydrazine) and oxidizer (N_2O_4; Appendix A).

In addition to these liquid propellant engines, solid propellant engines with "trident propellant" and "BATES" (Ballistic Test and Evaluation System) motors for the Navy and U.S. Army were also destroyed within 700 Area landfill trenches in approximately 1985. The BATES engines were small (able to be hand carried), 40 to 50-lb thrust engines and "had a habit of blowing up." For WSTF testing personnel safety, the engines were routinely x-rayed prior to testing to determine if the engines might explode during the testing process. If any engines contained internal anomalies (e.g., voids, cracks, etc.) on the x-ray film, these engines were deemed unsafe to test and were taken to the landfill and destroyed. The engines would have been full to capacity of solid propellant/oxidizers when they were destroyed. The composition of the solid propellant/oxidizer was not specified; but one employee guessed that it could have been aluminum/ammonium perchlorate, which could possibly result in perchlorate contamination. Another employee stated that 50 engines would arrive at WSTF for testing at a time, and on one occasion, five of the 50 engines required destruction. Like the earlier disposal of the liquid propellant engines, when a solid propellant engine/thruster was disposed in the landfill, a new trench was excavated so that the explosion would not cause other items within the landfill to burn. After the explosions, any remaining small parts were left in the landfill and the trench was used for routine landfill waste disposal (Appendix A).

Items that personnel stated may have been disposed in the 700 Area landfill also included:

- Steel tanks (75-100-gal to 1,200-gal capacity) decontaminated with MEK,
- Titanium tanks (approximately 2 ft in diameter),
- Wastewater lagoon (sewage) sludge.

Sludge was cleaned out of the 100 Area wastewater lagoon at least once historically. There are conflicting accounts from long-term WSTF employees regarding whether this sewage lagoon sludge was ever disposed in the 700 Area landfill. One employee remembered wastewater lagoon sludge being placed in the 700 Area landfill; however, several other long-term employees from the facilities department stated that sludge from the WSTF 100 Area sewage lagoon was placed in SWMU 16, the 600 Area BLM off-site pile (and sludge from other WSTF wastewater/sewage lagoons has never been removed to date).

All long-term WSTF personnel interviewed for this HIS stated that early in WSTF's history, no solid wastes were shipped off site for disposal and everything thrown away would have ended up in the 700

[7] Brulin is a registered trademark of Brulin & Company, Inc.

Area landfill. Several employees stated that hazardous wastes were also placed in the landfill prior to 1985 (both by being placed in dumpsters and taken directly to the landfill by individual employees), but these items were not considered a safety hazard at the time. “Garbage was just thrown away” (Appendix A). Several long-term WSTF employees also stated that even after the establishment of a full-time Environmental Department and a formal waste management and waste reduction program, ending hazardous waste disposal at the 700 Area landfill was a gradual process, beginning in 1985. Changing long-term informal waste management and disposal practices took time. “Environmental concerns were not in the mentality of workers…There were educational battles.” Designing employee education programs and ensuring employees were trained adequately also took time (Appendix A). But by 1990, one employee stated, there was nothing hazardous being disposed at the 700 Area landfill, just paper, office supply items, cafeteria scraps, alkaline batteries, empty paint cans (with less than 1 in. of paint within the cans), etc. (Appendix A).

7.9 Polychlorinated Biphenyls

According to the EPA website, the manufacture of PCBs in the United States was banned in 1979; however, PCBs may be present in products produced prior to the 1979 ban. Historical items that may have contained PCBs included:

- Transformers and capacitors,
- Other electrical equipment including voltage regulators, switches, reclosers, bushings, and electromagnets,
- Oil used in motors and hydraulic systems,
- Old electrical devices or appliances containing PCB capacitors,
- Fluorescent light ballasts,
- Ceiling tiles,
- Cable insulation,
- Thermal insulation material including fiberglass, felt, foam, and cork,
- Adhesives and tapes,
- Oil-based paint,
- Coatings,
- Caulking,
- Window glazing,
- Spray-on fireproofing,
- Plastics,
- Copy paper,
- Floor finish (EPA, 2017b).

Known items at WSTF containing PCBs were transformers (pole and pad), oil capacitors, oil circuit reclosers, filters, and light ballasts (NASA, 1985b). From approximately 1980, some PCB-containing items at WSTF were shipped off site for disposal (NASA, 1980b; NASA, 1982; Lockheed, 1983). By 1985, and the establishment of a full-time Environmental Department, any types of equipment known to have contained PCBs in the past, were treated as PCB-containing items to ensure environmental compliance and protection of the environment (NASA, 1986b); however, any PCB-containing items disposed prior to 1980 would likely have been disposed in the 700 Area landfill (SWMU 49).

A long-term WSTF employee provided evidence for 700 Area landfill disposal of one type of PCB-containing item. This employee related WSTF electrician's statements that fluorescent light ballasts, which likely contained PCBs, were disposed in the 700 Area landfill "in the old days" (prior to 1980; Appendix A). It is unknown if any other materials identified above (e.g., copy paper, floor finish, oils, adhesives, tapes, caulking, paint, plastics, cable or thermal insulations, or capacitors from electrical equipment) potentially disposed at the 700 Area landfill contained any PCBs; and no documentation at WSTF discusses the possibility that these materials contained PCBs.

The only materials identified at ADF-SW, TDRSS, and STGT that could potentially contain PCBs were transformers. According to a long-term employee, all transformers at ADF-SW were sampled for PCBs in 1997/1998 with no PCBs detected. Additionally, due to the age of the facility (constructed in 1983/1984 after the manufacture of PCBs were banned), it is unlikely that any PCB-containing materials were used in the construction or operations of the facility. Several long-term TDRSS and STGT personnel stated that the transformers at both facilities have always been dry, contained no oils, and therefore contained no PCBs. STGT was also constructed and began operations (1988/1989) after the manufacture of PCBs were banned; therefore, it is also unlikely that any PCB-containing materials were disposed at the 700 Area landfill from construction or use at STGT. It is unknown if any PCB-containing materials were present, used, or disposed at the 700 Area landfill from the TDRSS facility.

7.10 Indication of Releases to the Environment

Evidence for releases from the 700 Area landfill to the environment was provided by long-term WSTF personnel. In the site assessment submitted to NMED SWB in June 1993, NASA reported that less than 5,000 gal of liquids had been disposed at the 700 Area landfill based on statements from long-term employees. Four employees interviewed as part of the landfill site assessment stated that liquids had been historically disposed in the 700 Area landfill. Examples of the types of liquids included paints (including off-specification paints), epoxies, solvents, residues from cleaning operations and within drums, and electrolytes from batteries. One employee stated that many liquid paints collected while cleaning out paint locker(s) were disposed in the landfill. When asked the amount of liquids landfilled, one employee stated, "A little bit of everything, but not a lot of anything." Another employee estimated the amount of liquids historically landfilled to be tens to hundreds of gals annually (NASA, 1993c).

The first regulations that banned bulk liquids in landfills were the RCRA Hazardous and Solid Waste Amendments of 1984, which banned land disposal of hazardous liquids after May 8, 1985 and any liquids after November 8, 1985. As discussed in Section 7.2, WSTF Waste Disposal, the Environmental Department at WSTF was established in April 1985, and ensured that NASA adhered to federal and state regulations and modified procedures/waste management practices when new regulations were enacted. Therefore, it is likely that no liquids were disposed in the 700 Area landfill after 1985.

There was an unknown stain documented at the landfill in January 1995 in the weekly landfill inspection log. It was stated, "stain NE side 18" in diam[eter]" (NASA, 1995a). The stain origin is unknown; however, it is believed that this stain could have resulted from a vehicle leak. Disposition of the soil was not documented.

The final evidence of 700 Area landfill releases to the environment (SWMU 49) is that the groundwater adjacent to the landfill contains low levels~~small amounts~~ of Freon 113, Freon 11, TCE, and PCE. Refer to Section 6.6, Groundwater Monitoring, for details.

8.0 References

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Figures

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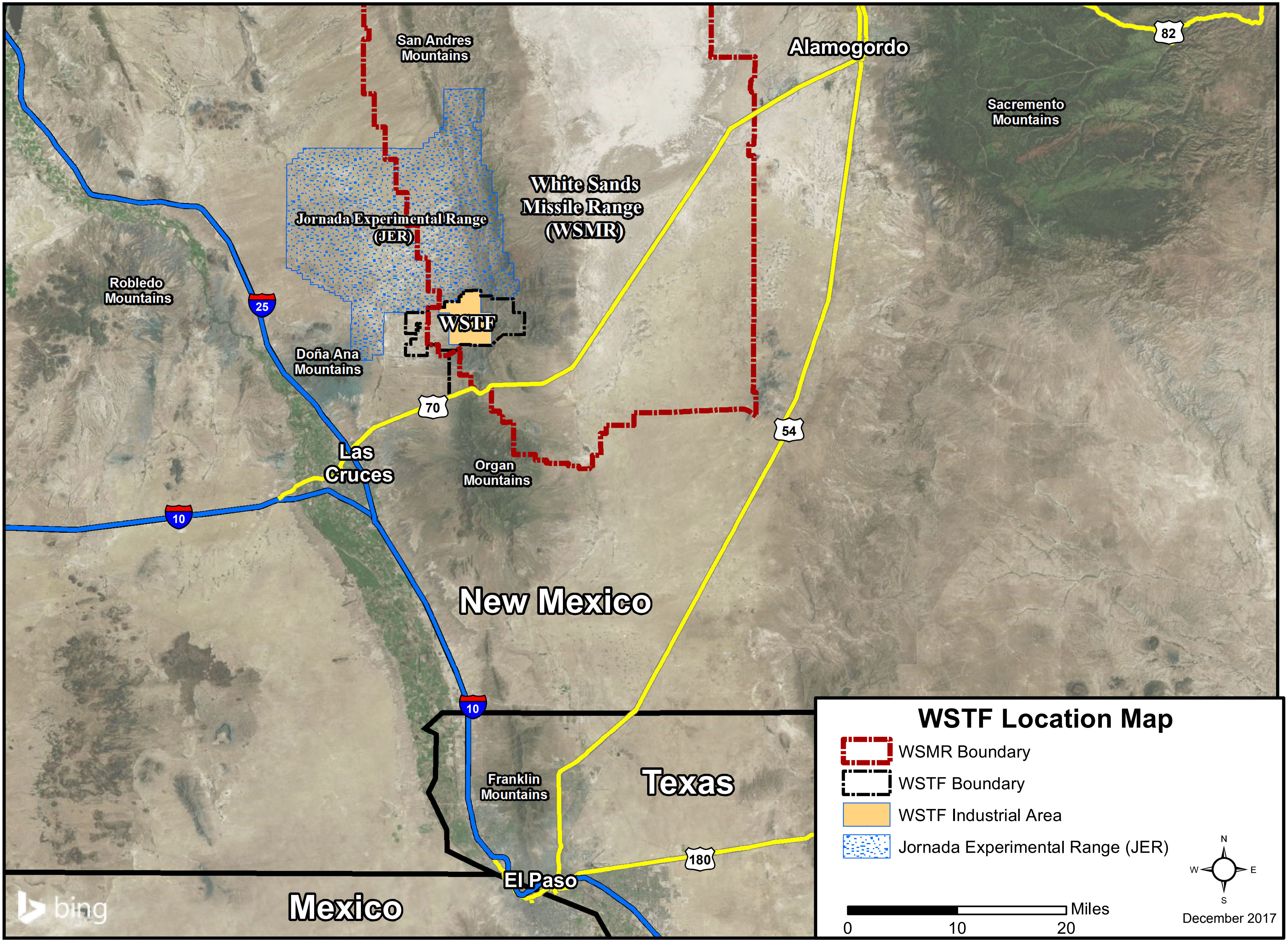

WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
N
S
E
W
0
10
20
Miles
December 2017
San Andres Mountains
Alamogordo
Sacremento Mountains
White Sands Missile Range (WSMR)
Jornada Experimental Range (JER)
Robledo Mountains
WSTF
Doña Ana Mountains
Las Cruces
Organ Mountains
New Mexico
Franklin Mountains
Texas
El Paso
Mexico
25
10
70
54
82
180
bing

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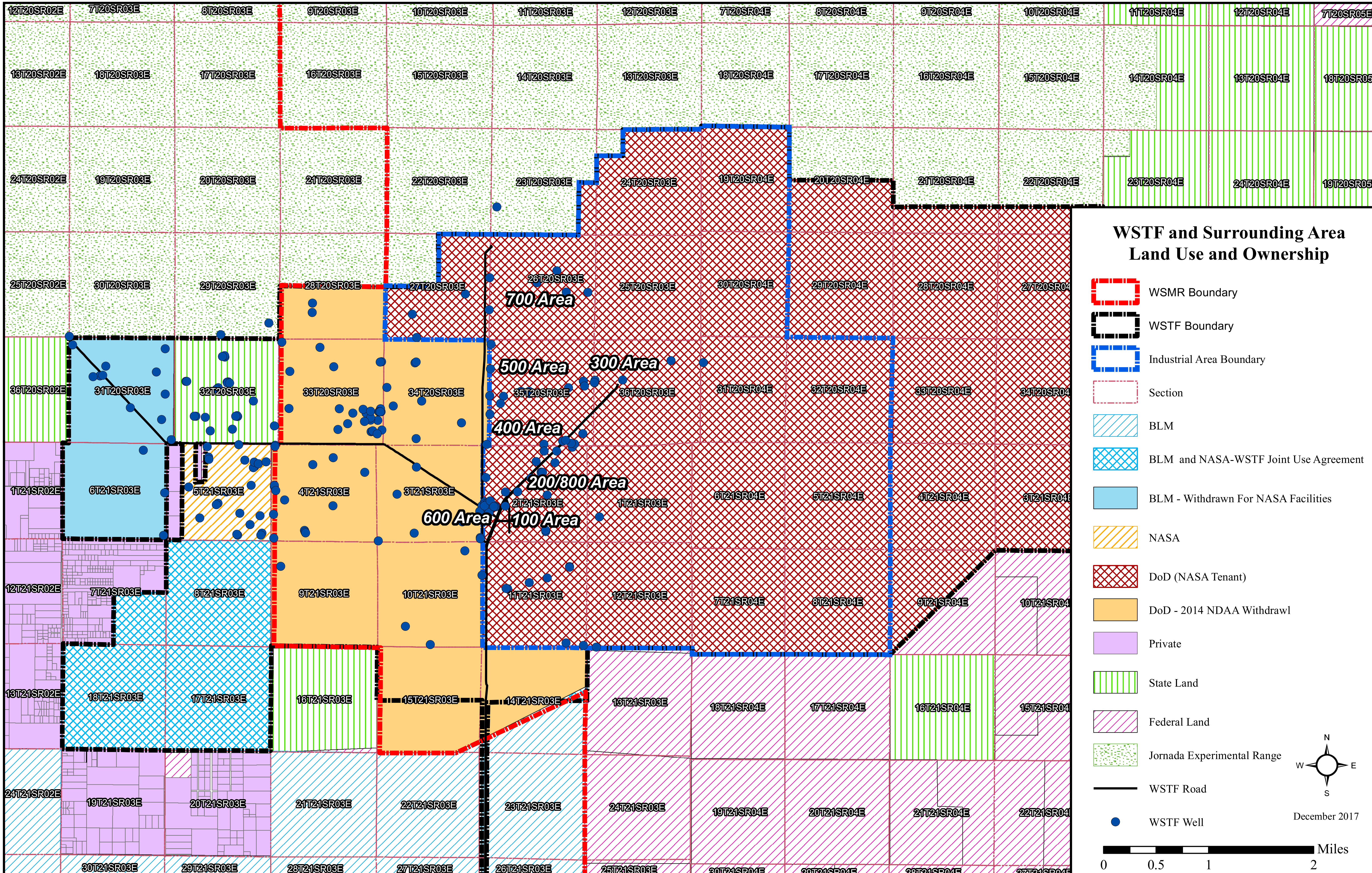

WSTF and Surrounding Area
Land Use and Ownership
WSMR Boundary
WSTF Boundary
Industrial Area Boundary
Section
BLM
BLM and NASA-WSTF Joint Use Agreement
BLM - Withdrawn For NASA Facilities
NASA
DoD (NASA Tenant)
DoD - 2014 NDAA Withdrawl
Private
State Land
Federal Land
Jornada Experimental Range
WSTF Road
WSTF Well
N
W
E
S
December 2017
Miles
0
0.5
1
2
700 Area
500 Area
300 Area
400 Area
200/800 Area
600 Area
100 Area
12T20SR02E
7T20SR03E
8T20SR03E
9T20SR03E
10T20SR03E
11T20SR03E
12T20SR03E
7T20SR04E
8T20SR04E
9T20SR04E
10T20SR04E
11T20SR04E
12T20SR04E
7T20SR05E
13T20SR02E
18T20SR03E
17T20SR03E
16T20SR03E
15T20SR03E
14T20SR03E
13T20SR03E
18T20SR04E
17T20SR04E
16T20SR04E
15T20SR04E
14T20SR04E
13T20SR04E
18T20SR05E
24T20SR02E
19T20SR03E
20T20SR03E
21T20SR03E
22T20SR03E
23T20SR03E
24T20SR03E
19T20SR04E
20T20SR04E
21T20SR04E
22T20SR04E
23T20SR04E
24T20SR04E
19T20SR05E
25T20SR02E
30T20SR03E
29T20SR03E
28T20SR03E
27T20SR03E
26T20SR03E
25T20SR03E
30T20SR04E
29T20SR04E
28T20SR04E
27T20SR04
36T20SR02E
31T20SR03E
32T20SR03E
33T20SR03E
34T20SR03E
35T20SR03E
36T20SR03E
31T20SR04E
32T20SR04E
33T20SR04E
34T20SR04
1T21SR02E
6T21SR03E
5T21SR03E
4T21SR03E
3T21SR03E
2T21SR03E
1T21SR03E
6T21SR04E
5T21SR04E
4T21SR04E
3T21SR04E
12T21SR02E
7T21SR03E
8T21SR03E
9T21SR03E
10T21SR03E
11T21SR03E
12T21SR03E
7T21SR04E
8T21SR04E
9T21SR04E
10T21SR04
13T21SR02E
18T21SR03E
17T21SR03E
16T21SR03E
15T21SR03E
14T21SR03E
13T21SR03E
18T21SR04E
17T21SR04E
16T21SR04E
15T21SR04
24T21SR02E
19T21SR03E
20T21SR03E
21T21SR03E
22T21SR03E
23T21SR03E
24T21SR03E
19T21SR04E
20T21SR04E
21T21SR04E
22T21SR04
30T21SR03E
29T21SR03E
28T21SR03E
27T21SR03E
26T21SR03E
25T21SR03E
30T21SR04E
29T21SR04E
28T21SR04E
27T21SR04E

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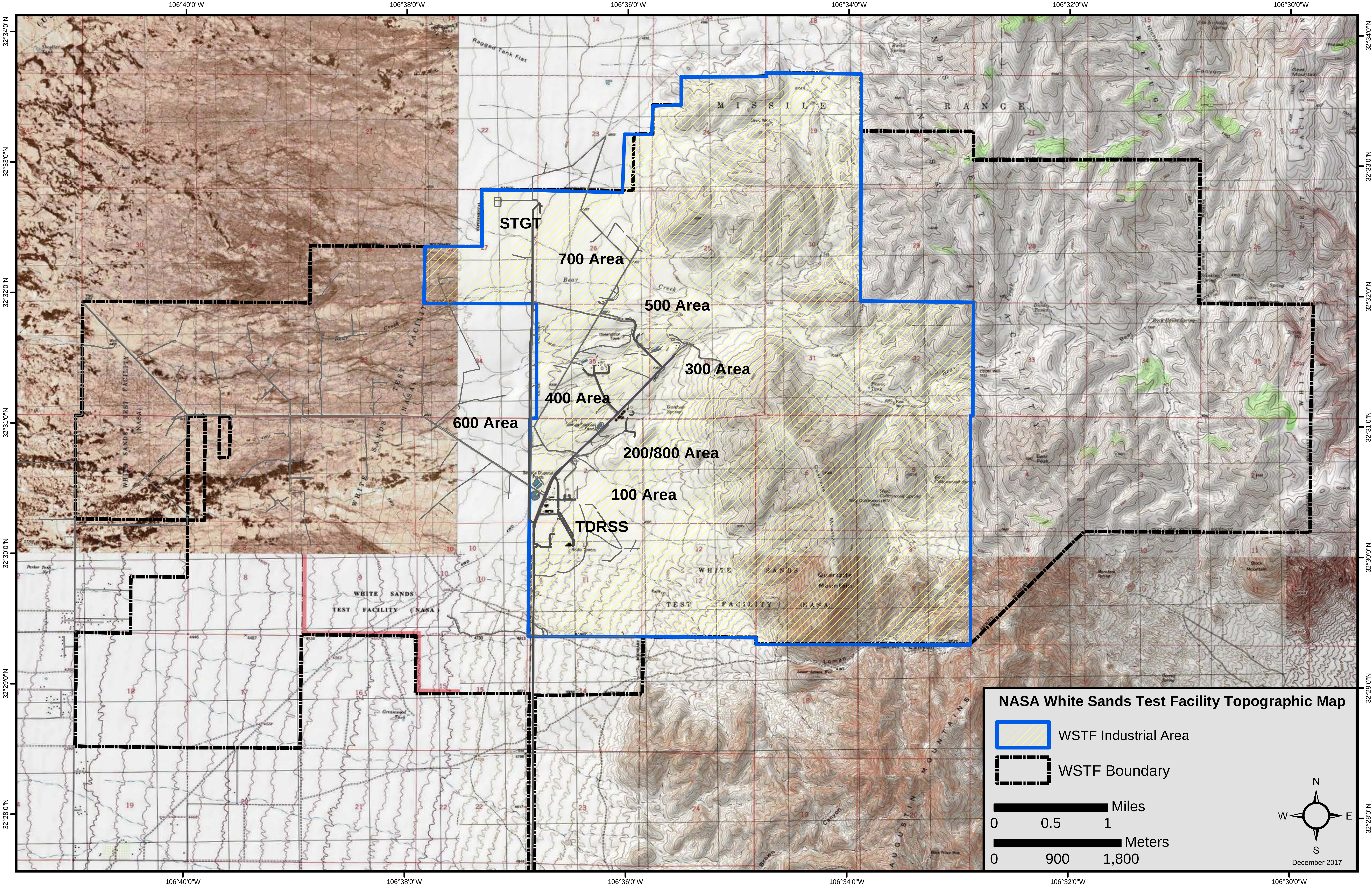
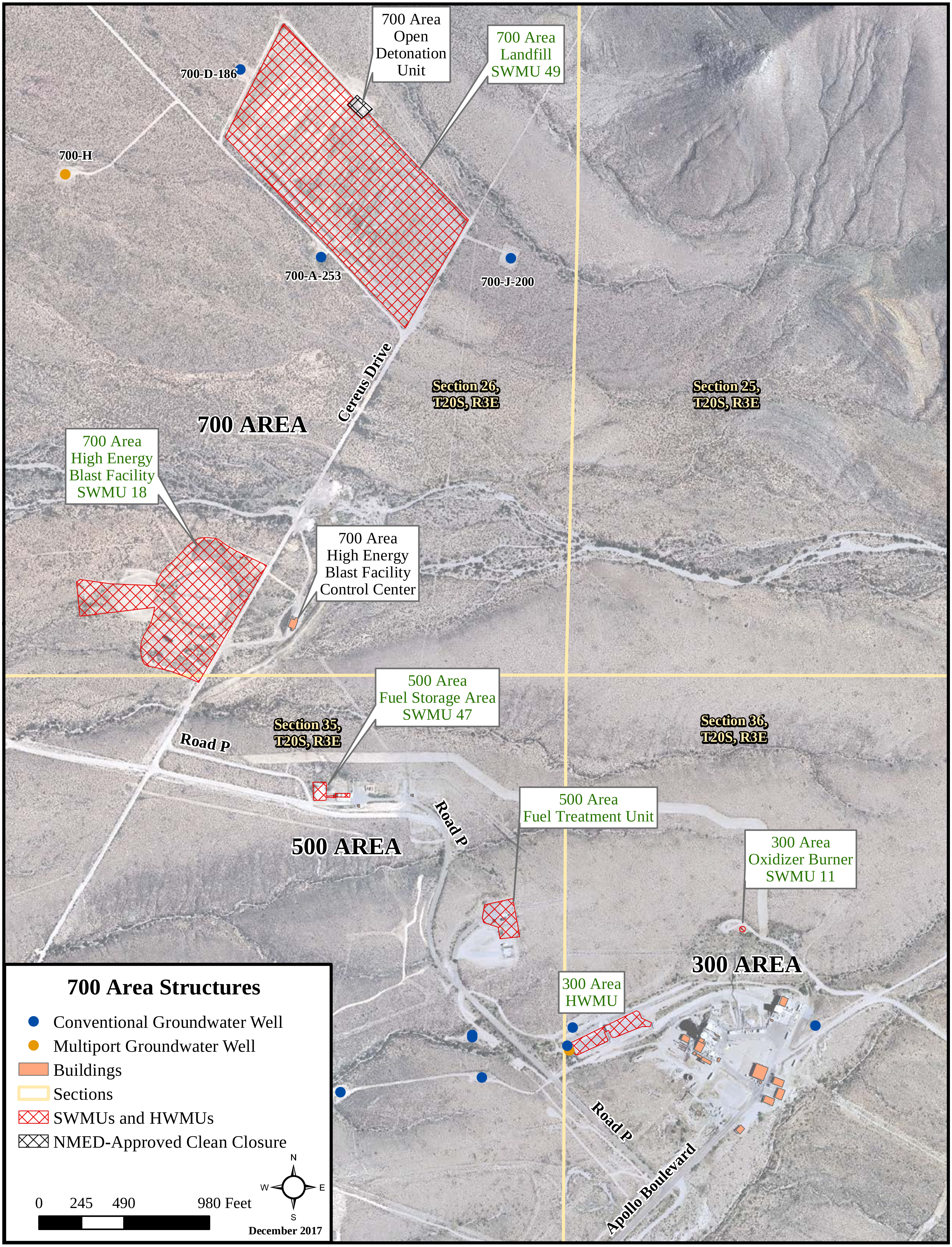
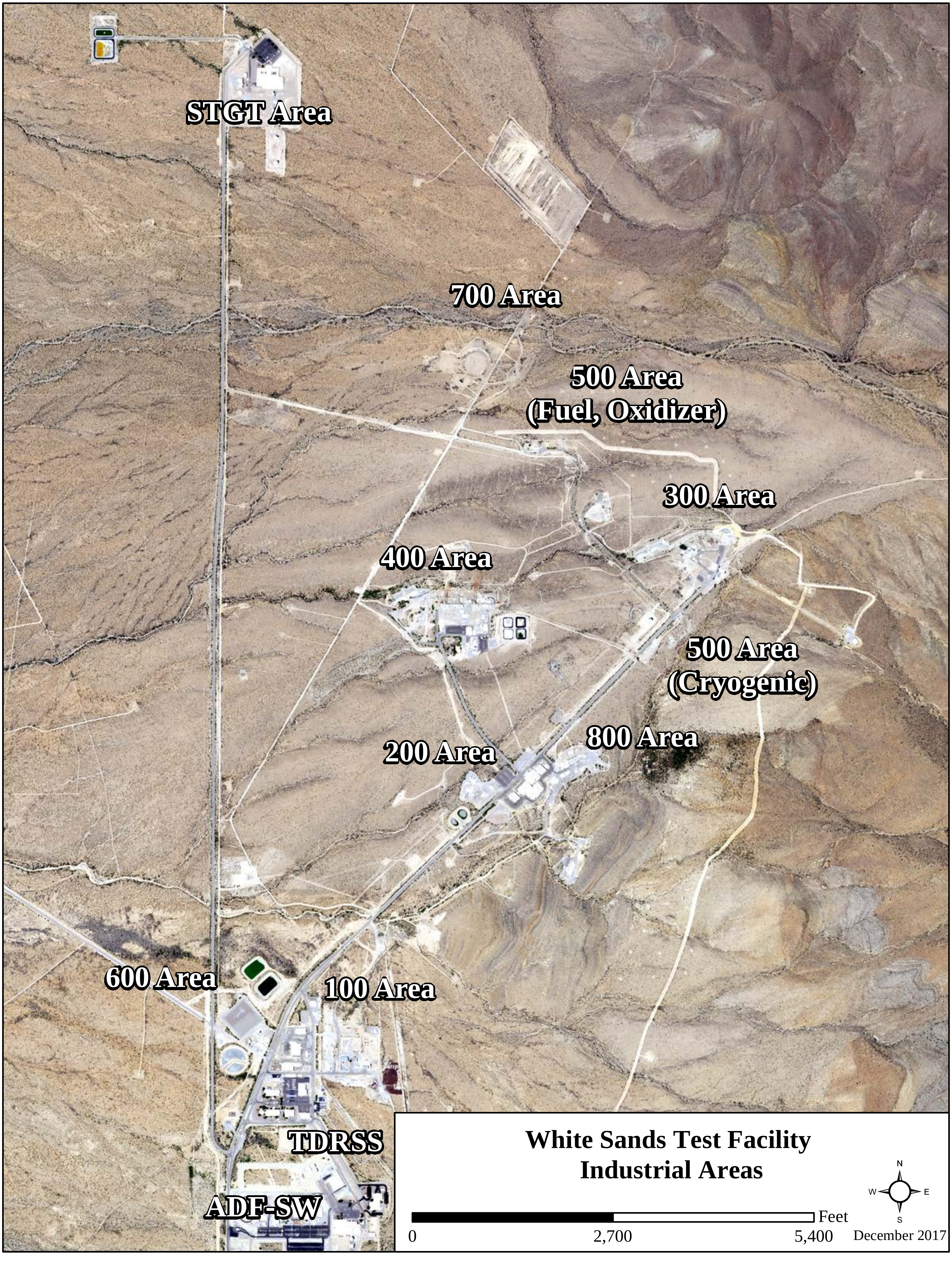


NASA White Sands Test Facility Topographic Map
WSTF Industrial Area
WSTF Boundary
Miles
0
0.5
1
Meters
0
900
1,800
N
S
E
W
December 2017
STGT
700 Area
500 Area
300 Area
400 Area
600 Area
200/800 Area
100 Area
TDRSS
106°40'0"W
106°38'0"W
106°36'0"W
106°34'0"W
106°32'0"W
106°30'0"W
32°34'0"N
32°33'0"N
32°32'0"N
32°31'0"N
32°30'0"N
32°29'0"N
32°28'0"N

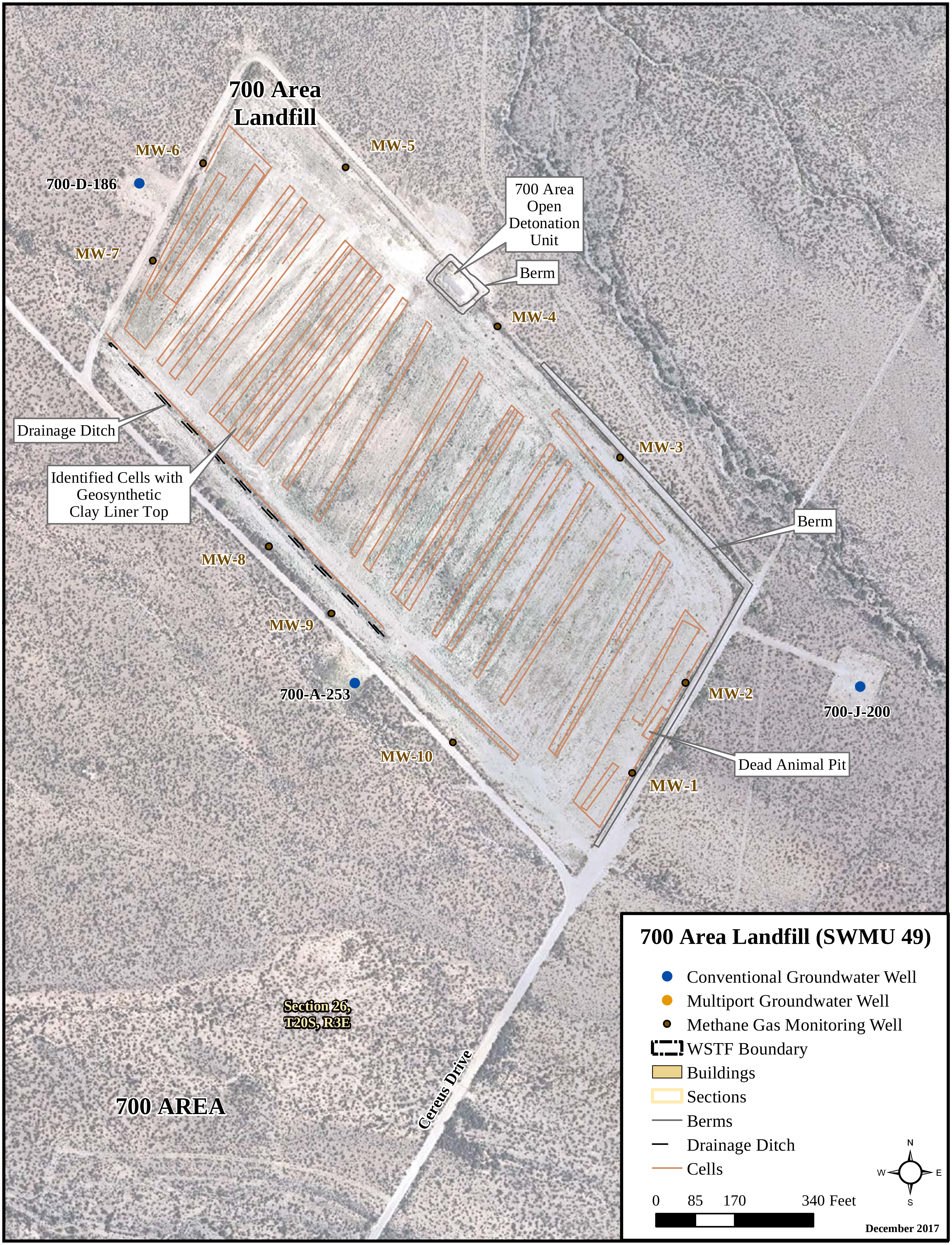
(SEE NEXT PAGE)


700 Area Open Detonation Unit
700 Area Landfill SWMU 49
700-D-186
700-H
700-A-253
700-J-200
Cereus Drive
Section 26, T20S, R3E
Section 25, T20S, R3E
700 AREA
700 Area High Energy Blast Facility SWMU 18
700 Area High Energy Blast Facility Control Center
500 Area Fuel Storage Area SWMU 47
Section 35, T20S, R3E
Section 36, T20S, R3E
Road P
500 Area Fuel Treatment Unit
300 Area Oxidizer Burner SWMU 11
500 AREA
300 AREA
300 Area HWMU
Road P
Apollo Boulevard
700 Area Structures
Conventional Groundwater Well
Multiport Groundwater Well
Buildings
Sections
SWMUs and HWMUs
NMED-Approved Clean Closure
0
245
490
980 Feet
N
W
E
S
December 2017

(SEE NEXT PAGE)


STGT Area
700 Area
500 Area
(Fuel, Oxidizer)
300 Area
400 Area
500 Area
(Cryogenic)
800 Area
200 Area
600 Area
100 Area
TDRSS
ADF-SW
White Sands Test Facility
Industrial Areas
N
W
E
S
Feet
0
2,700
5,400
December 2017

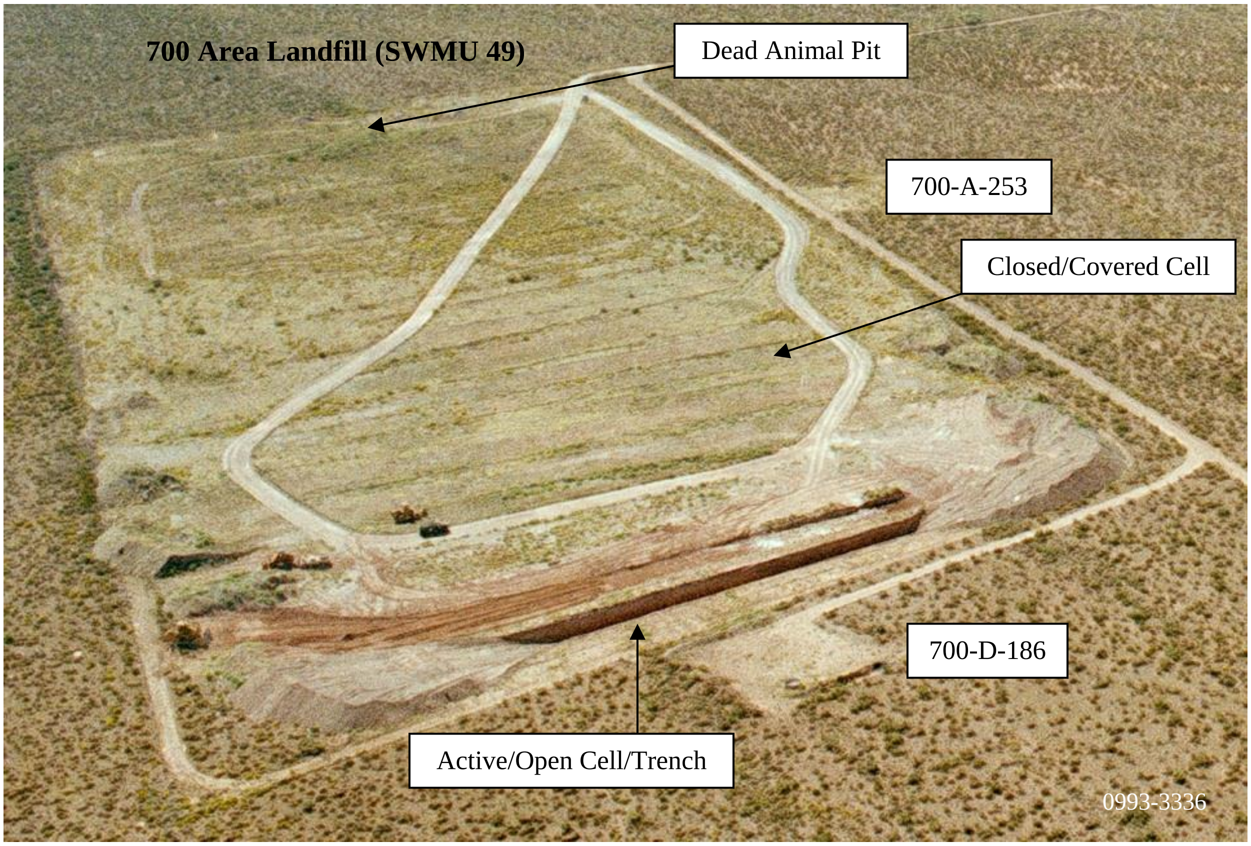
(SEE NEXT PAGE)



700 Area Landfill
MW-6
MW-5
700-D-186
700 Area Open Detonation Unit
MW-7
Berm
MW-4
Drainage Ditch
Identified Cells with Geosynthetic Clay Liner Top
MW-3
Berm
MW-8
MW-9
700-A-253
MW-2
700-J-200
MW-10
Dead Animal Pit
MW-1
Section 26, T20S, R3E
Cereus Drive
700 AREA
700 Area Landfill (SWMU 49)
Conventional Groundwater Well
Multiport Groundwater Well
Methane Gas Monitoring Well
WSTF Boundary
Buildings
Sections
Berms
Drainage Ditch
Cells
N
W
E
S
0
85
170
340 Feet
December 2017

Figure 6.2 **WSTF Landfill-SWMU 49 (1993)**

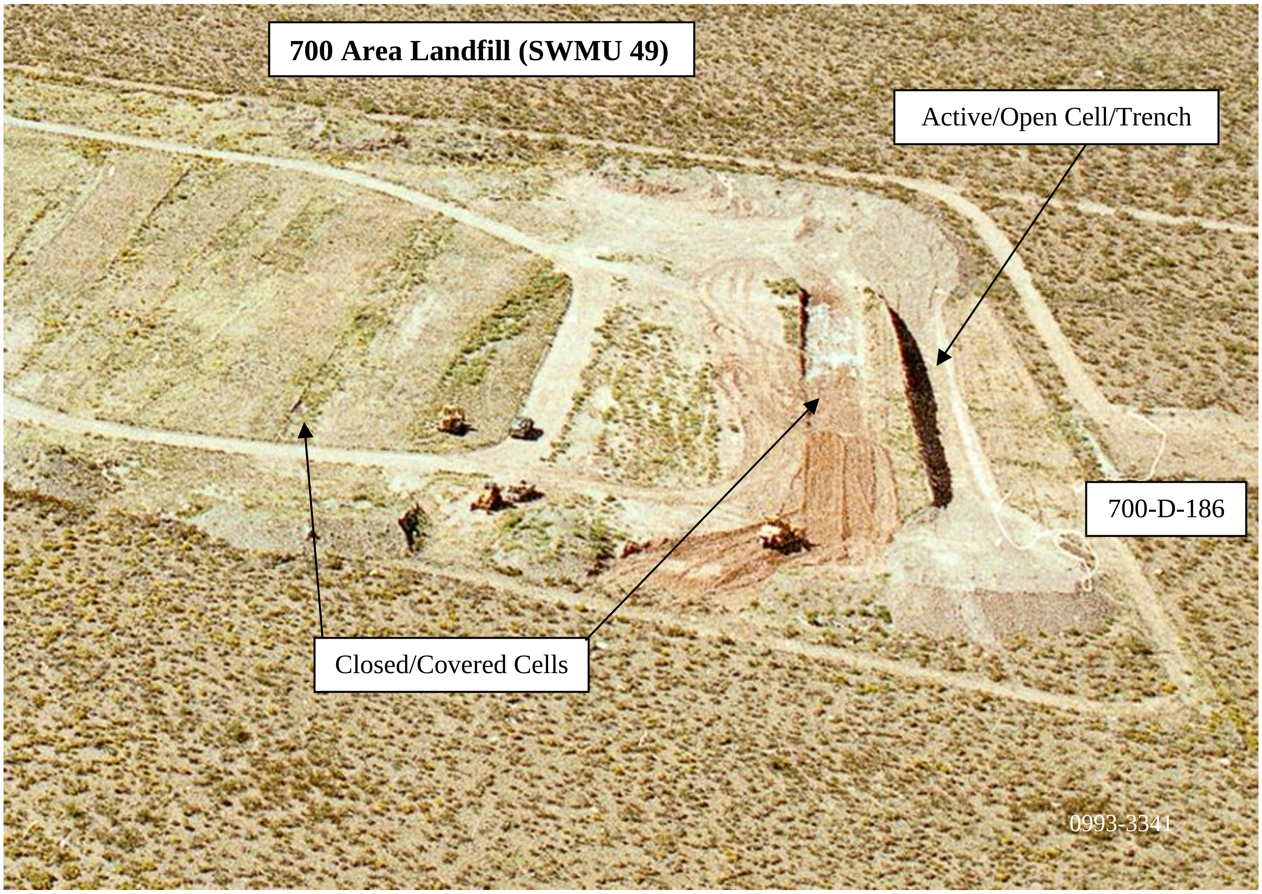
(September 1993 – view to the southeast)



This photograph shows the WSTF landfill (SWMU 49) in September 1993, when the landfill was still in use at WSTF. Note that some closed and covered trenches are still visible due to some subsidence. The dead animal pit was located near the entrance to the landfill (shown at the top of this photograph), and groundwater monitoring wells 700-A-253 (cross-gradient) and 700-D-186 (downgradient) are present on the sides of the landfill.

Figure 6.3 **Open Trench (1993)**

(September 1993 – view to the southwest)

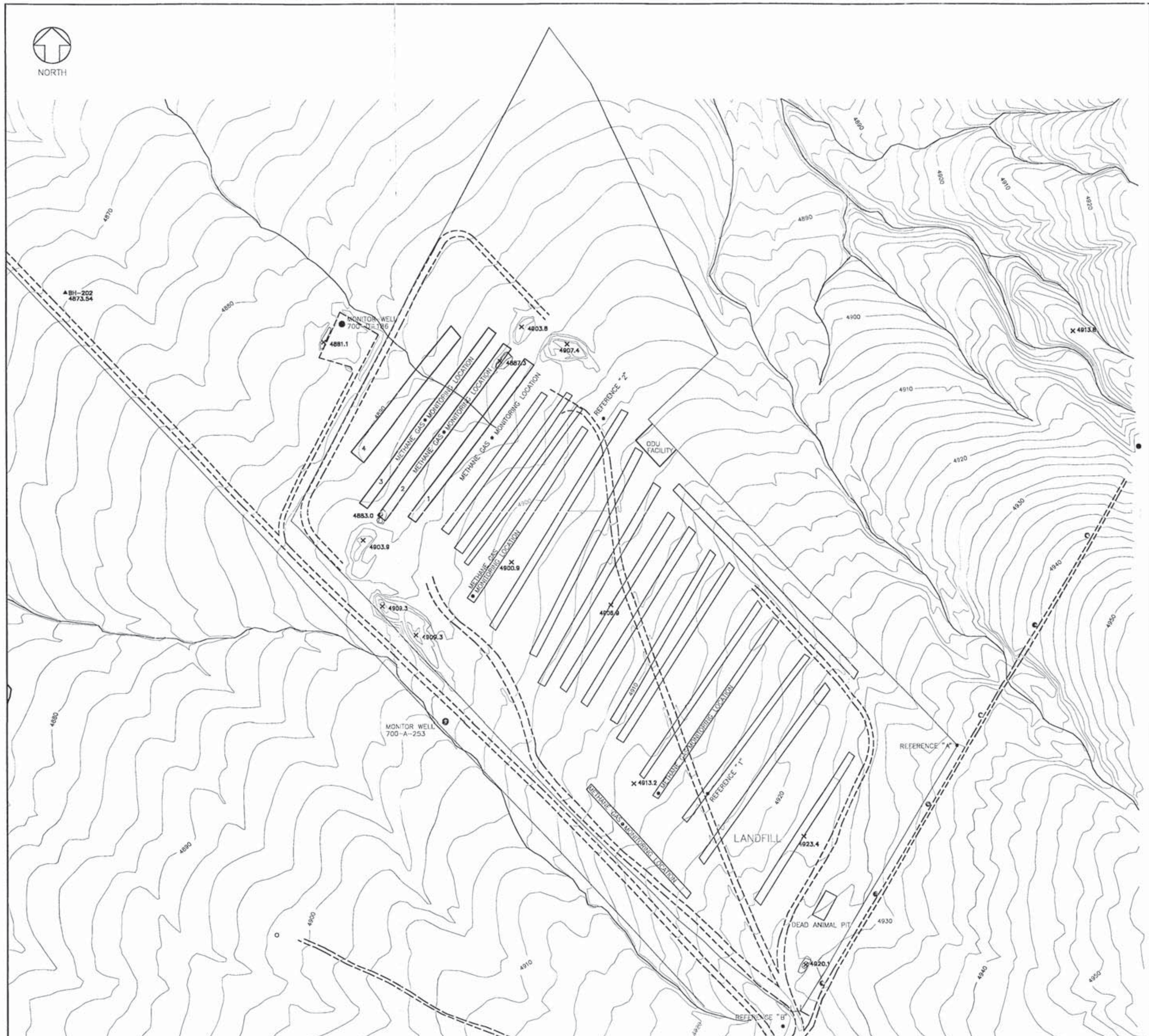


This photograph shows an aerial view of an open trench at the WSTF landfill (SWMU 49) in September 1993. Notice the heavy equipment used for landfill operations, including the newly purchased bulldozer and compactor. Also note that some closed and covered trenches are still visible due to some subsidence and vegetation growth.

Figure 6.4 29-Acre Boundary and Supplemental Methane Gas Sample Locations

(SEE NEXT PAGE)

SYMBOL	LETTER	ZONE	DESCRIPTION	DATE	APPROVAL
	A		REVISED PER DCN A-3 1-15-92 G.P.M.	1-21-92	D. TRUE T. CONDON R. MONJARAS
	B		REVISED PER DCN B-1, 3-10-93, R.E.M. REVISED PER DCN B-2, 4-19-93, R.E.M.		



NOTES:

1. OPEN 5/30/89 CLOSED 12/26/90 — 75,600 CU.FT. 15% GROUND FILL
2. OPENED 12/21/90 CLOSED 10/21/91 — 75,600 CU.FT. 15% GROUND FILL
3. OPENED 10/19/91 CLOSED 10/16/92 — 75,600 CU.FT. 15% GROUND FILL
4. OPENED 10/13/92

BH-208
4986.51

REQ'D PER ASS'Y	ITEM NO.	PART NO.	DESCRIPTION	MATERIAL	SPECIFICATION	SHT. NO.

NEXT ASS'Y / RELATED DWG'S

DIMENSIONAL TOLERANCE UNLESS NOTED OTHERWISE
.0± ANGLES ±
.00± FRACTIONS ±
.000±
DIMENSIONS ARE IN INCHES.

SURFACE FINISH IN MICRO INCHES RMS UNLESS OTHERWISE NOTED. √

UNLESS NOTED OTHERWISE REMOVE ALL SHARP EDGES AND BURRS.

DRAWN BY	GPM/REM	3-11-93
ENGINEER	J.B. HOSSLEY	11-18-87
DESIGNED BY		
CHECKED BY	J.B. HOSSLEY	11-18-87
APPROVAL	J. B. HOSSLY	11-18-87
APPROVAL	R. MITCHELL	11-18-87
AUTHORIZED	K. FARRAH	11-18-87
RELEASE	B. MELENDEZ	11-18-87

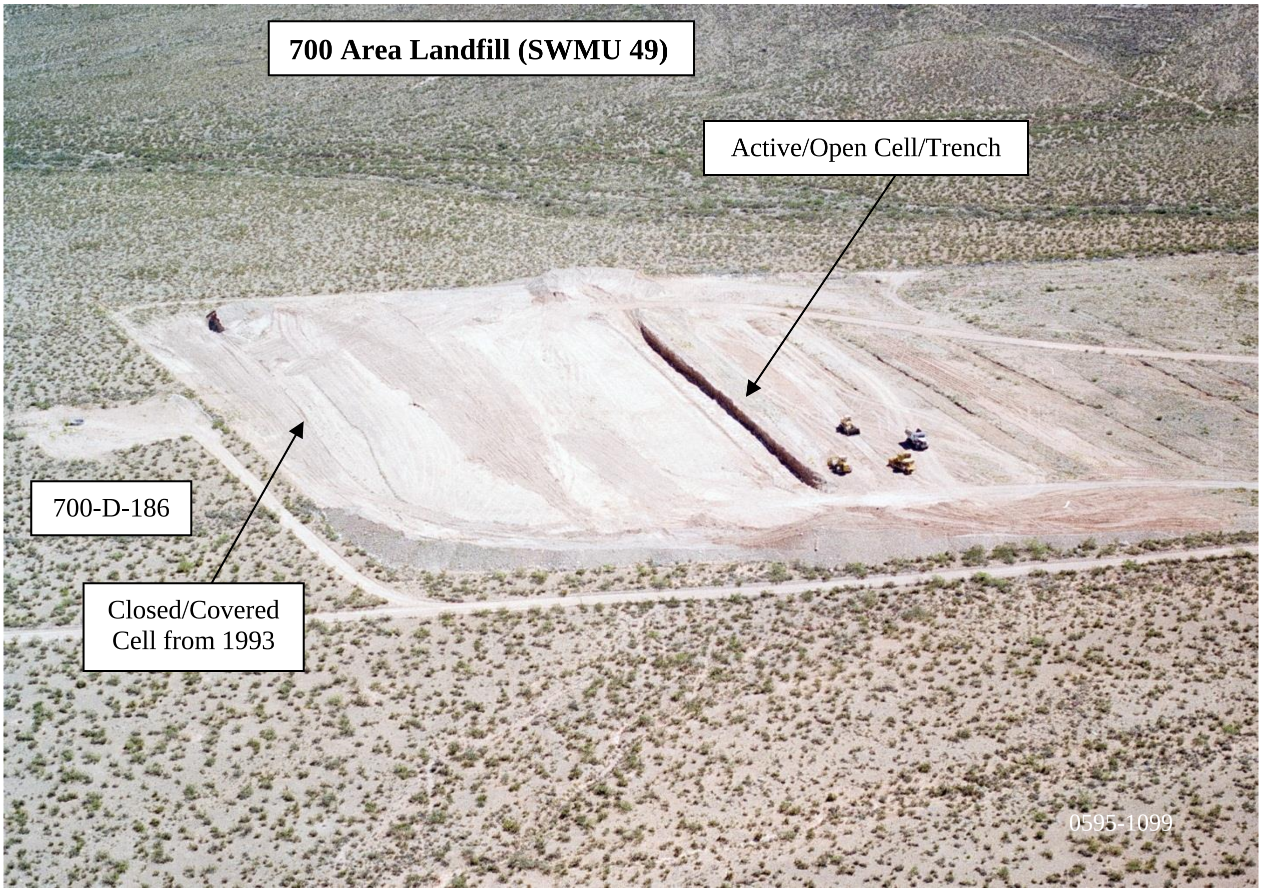
National Aeronautics and Space Administration NASA
Lyndon B. Johnson Space Center
White Sands Test Facility

SANITARY LANDFILL DETAIL SITE MAP

A.B. DWG. NO. | SCALE 1"=100' | SHEET 1 OF 1
CODE IDENT. | SIZE F | DWG. NO. 019-13998 | REV B

Figure 6.5 **WSTF Landfill-SWMU 49 (1995)**

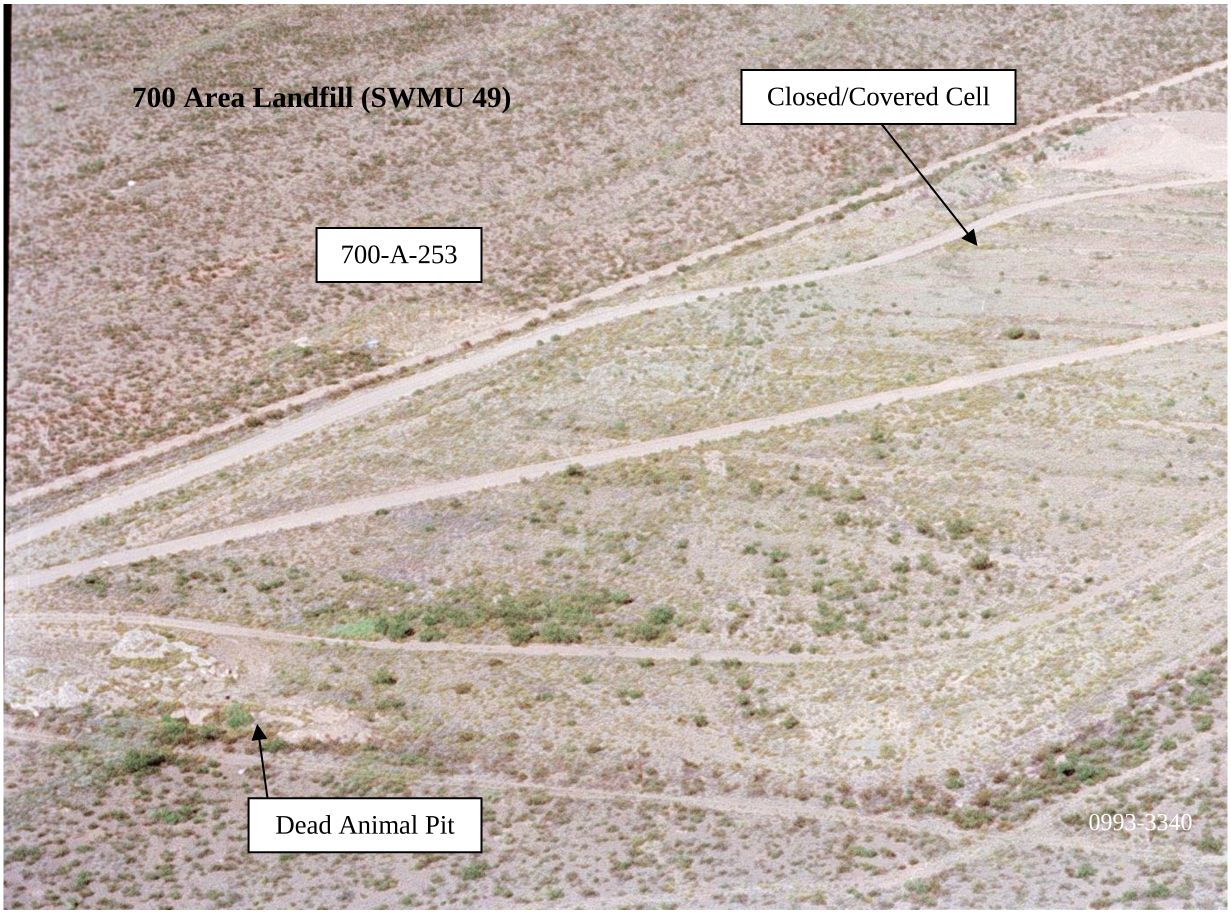
(May 1995 – view to the northeast)



This photograph shows an aerial view of an open trench at the WSTF landfill (SWMU 49) in May 1995. Notice the location of the trench is not adjacent to the cell from 1993, and this cell is located between older previously existing closed/covered cells. (Refer to Figure 6.3.)

Figure 6.6 **Dead Animal Pit (1993)**

(September 1993 – view to the west)



This photograph shows an aerial view of the dead animal pit at the WSTF landfill (SWMU 49) in September 1993. Note the white caliche layer around and within the dead animal pit. Groundwater monitoring well pad 700-A-253 and some previously closed and covered cells are visible as well.

Figure 6.7 700 Area Landfill and Monitoring Wells

(SEE NEXT PAGE)


700 Area Landfill Area
Methane Gas Monitoring Well
Conventional Groundwater Well
Multiport Groundwater Well
Graded Roads
WSTF Boundary
Sections
Buildings
Drainage Ditch
Berms
Cells
N
W
E
S
0 200 400 800 Feet
December 2017
Section 22, T20S, R3E
Section 23, T20S, R3E
Section 27, T20S, R3E
Section 26, T20S, R3E
700-F-455
STGT Firing Range SWMU 29
STGT Wastewater Lagoon AOC 51
STGT
700-B-510
700-H
BW-6-355
700-E-458
700-D-186
MW-6
MW-5
MW-7
MW-4
MW-3
MW-8
MW-9
MW-10
MW-2
MW-1
700-A-253
700-J-200
700 Area Open Detonation Unit
700 Area Landfill SWMU 49
Dead Animal Pit
Cereus Drive
700 AREA

Figure 6.8 Geosynthetic Clay Liner Cover (1998)

(March 1998 – view to the west)

This photograph shows the installation of the Geosynthetic Clay Liner cover at the WSTF landfill (SWMU 49) in March 1998.

Figure 6.9 Final Landfill Closure Diagram August 1998

(SEE NEXT PAGE)

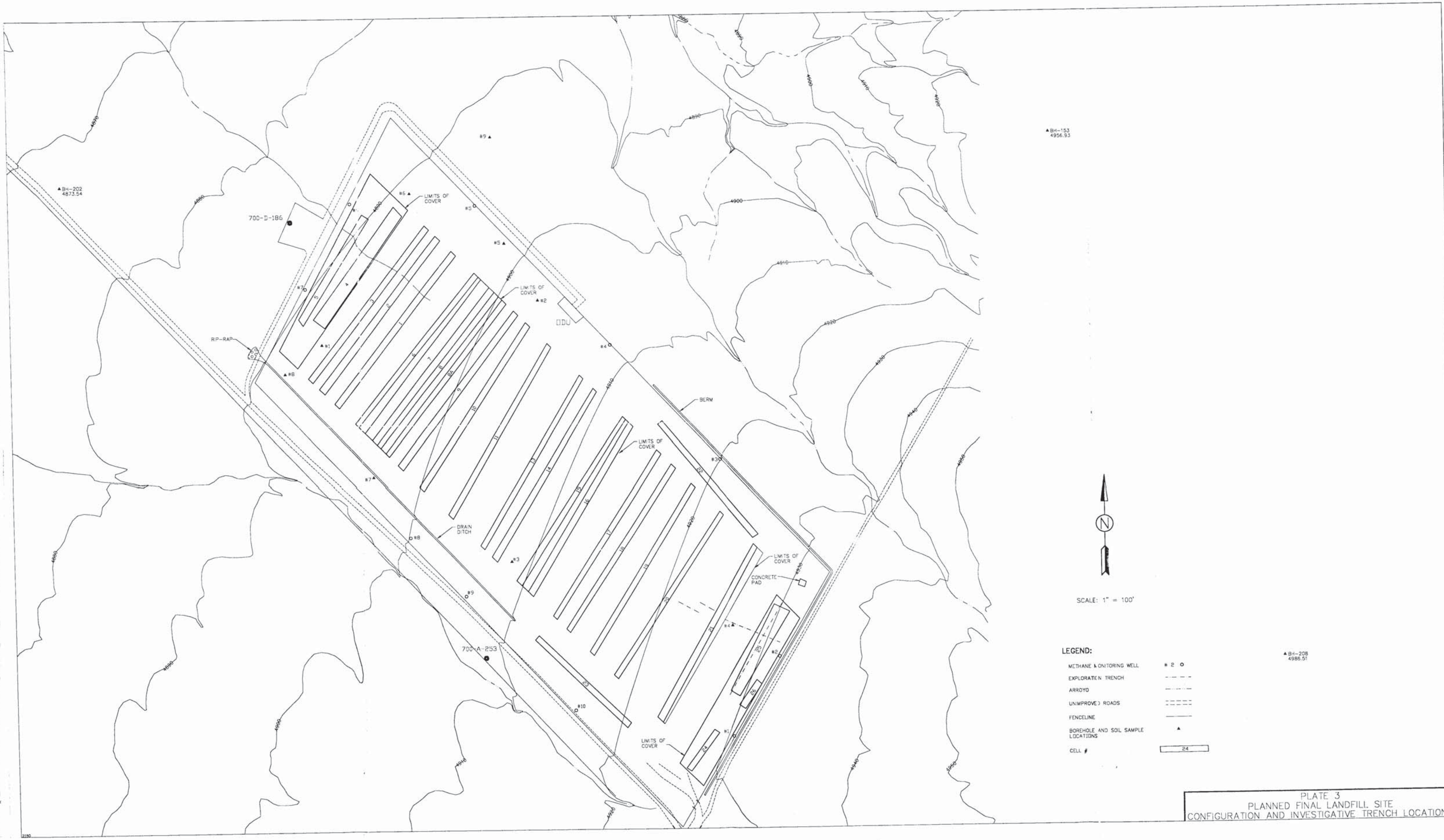
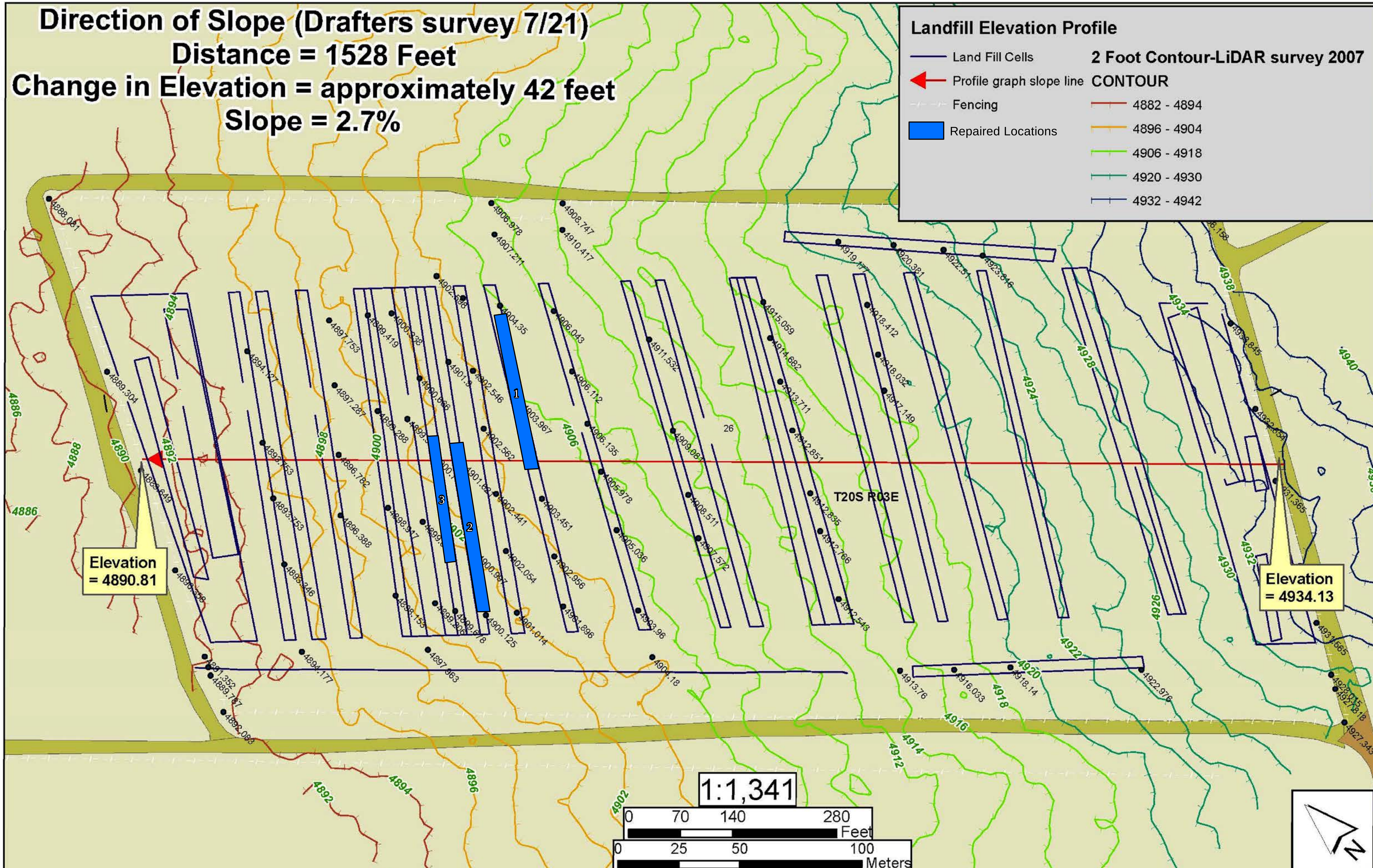


PLATE 3
PLANNED FINAL LANDFILL SITE
CONFIGURATION AND INVESTIGATIVE TRENCH LOCATIONS

Figure 6.10 **Landfill Elevation Profile**

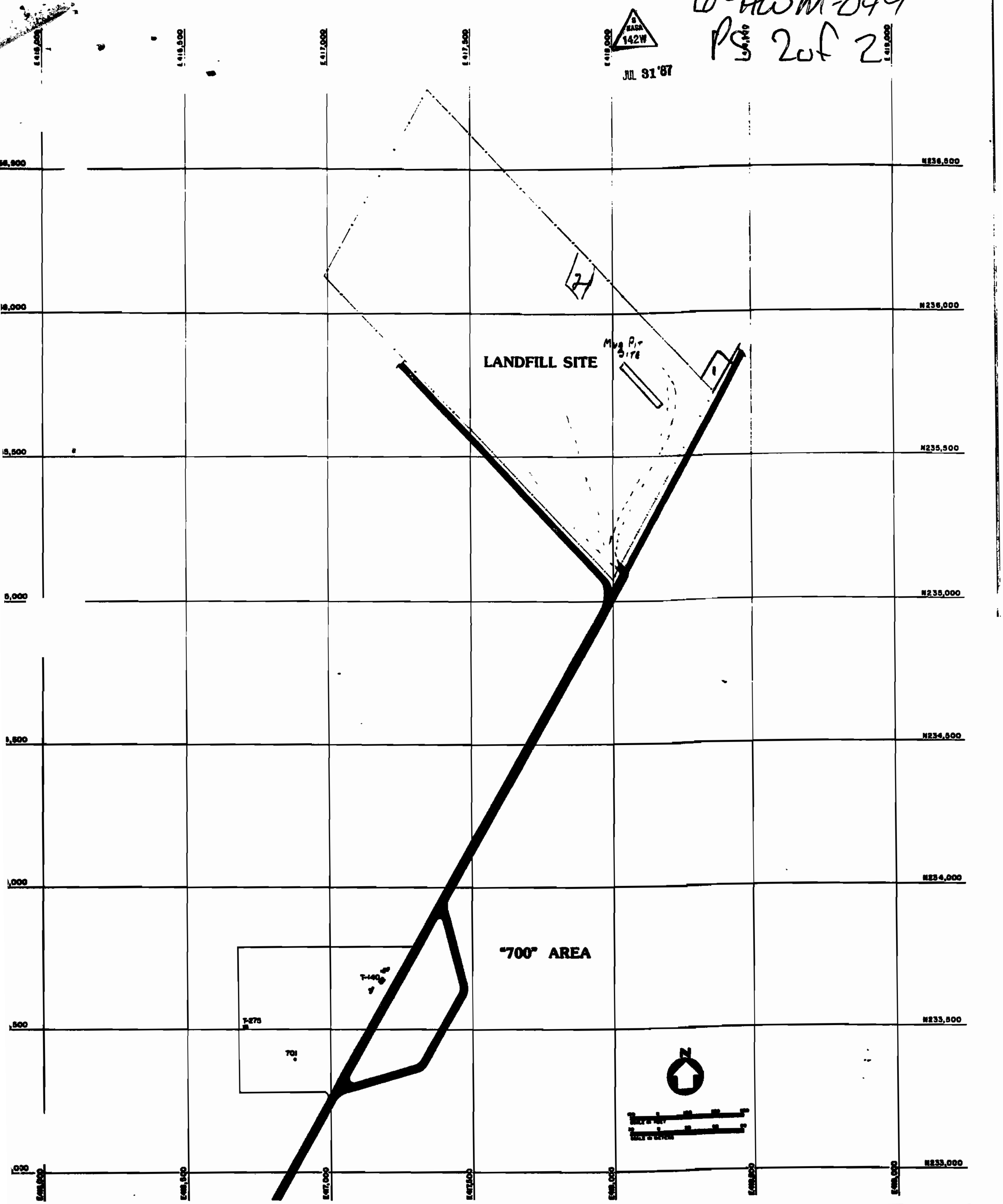
(SEE NEXT PAGE)



Direction of Slope (Drafters survey 7/21)
Distance = 1528 Feet
Change in Elevation = approximately 42 feet
Slope = 2.7%
Landfill Elevation Profile
Land Fill Cells
Profile graph slope line
Fencing
Repaired Locations
2 Foot Contour-LiDAR survey 2007
CONTOUR
4882 - 4894
4896 - 4904
4906 - 4918
4920 - 4930
4932 - 4942
Elevation = 4890.81
Elevation = 4934.13
T20S R03E
1:1,341
0 70 140 280 Feet
0 25 50 100 Meters
N

(SEE NEXT PAGE)

6-HWM-049
PS 2 of 2



WSTF "700" REMOTE TEST AREA

FACILITIES MASTER PLAN

DRAWING FMP 113

Tables

Table 6.1 Maximum Freon 113 Detections in Groundwater (µg/L)

Freon 113 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	~~Reporting Limit (~~RL~~)~~	700-D-186	RL	~~700-J-200~~	~~RL~~	700-H	RL
Jan-90	NI	NI	4	0.5	84	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Apr-90	NI	NI	2	0.5	61	5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jul/Aug-90	NI	NI	1	0.5	46	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Oct-90	NI	NI	0.6	0.5	64	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jan-91	NI	NI	1	0.5	75	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Apr-91	NI	NI	NA	NA	79	0.5			NI	NI
Jul-91	NI	NI	1	0.5	88	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Nov-91	NI	NI	NA	NA	84/210 QD	5			NI	NI
Jan-92	NI	NI	2	0.5	110	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Apr-92	NI	NI	3	0.5	83	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jul-92	NI	NI	0.8	0.5	110	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Oct/Nov-92	NI	NI	1	0.5	110	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jan/Feb-93	NI	NI	2	0.5	98 AD	5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Apr/May-93	NI	NI	3	0.5	68	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jul/Aug-93	NI	NI	3	0.5	76	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Nov-93	NI	NI	1	0.5	97	5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Feb-94	NI	NI	2	0.5	60	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Apr/May-94	NI	NI	2	0.5	62	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Aug-94	NI	NI	3	0.5	65	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Oct/Nov-94	NI	NI	2	0.5	67	5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jan/Feb-95	NI	NI	3	0.5	79	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Apr/May-95	NI	NI	4	0.5	84	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Aug-95	NI	NI	3	0.5	46	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~

Freon 113 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	~~Reporting Limit (~~RL~~)~~	700-D-186	RL	~~700-J-200~~	~~RL~~	700-H	RL
Nov-95	NI	NI	2	0.5	67	5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jan-96	NI	NI	2~~NA~~	0.5~~NA~~	70	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
May-96	NI	NI	3 J	5	73	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jul-96	NI	NI	3.4	0.5	61	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Aug-96	NI	NI	1.9	0.5	73	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Oct-96	NI	NI	2.7	0.5	73	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Nov-96	NI	NI	3.9	0.5	77	2.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Feb-97	NI	NI	2.8	0.5	42	10	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Apr-97	NI	NI	2.6	0.5	76	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jul-97	NI	NI	1.3	0.5	NA	NA	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Sep-97	NI	NI	0.9	0.5	38	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Oct-97	NI	NI	1.1	0.5	66	5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jan/Feb-98	NI	NI	0.32 J	0.5	41	0.5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
May-98	NI	NI	1.2 J	5	48	1	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Oct-98	NI	NI	2.2	0.5	75	3	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jan-99	NI	NI	0.96	0.5	44	1	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Jul-99	NI	NI	3.8	0.5	62	5	~~NA~~	~~NA~~	NI~~NA~~	NI ~~NA~~
Oct-99	2.1	0.5	NA	NA	NA	NA	~~2.1~~	~~0.5~~	ND	0.5
Dec-99	20.9	0.5	NA	NA	NA	NA	~~20.9~~	~~0.5~~	ND	0.5
Jan/Feb-00	ND	0.5	2.8	0.5	81	1.2	~~NA~~	~~NA~~	0.64	0.5
Apr-00	ND	0.5	NA	NA	NA	NA	~~NA~~	~~NA~~	ND	0.5
Jun-00	ND	0.5	NA	NA	NA	NA			ND	0.5
Jul-00	ND	0.5	NA	NA	NA	NA			ND	0.5
Aug-00	ND	0.5	2.6	1	52 Q	1	~~NA~~	~~NA~~	ND	0.5
Nov-00	ND	0.5	NA	NA	NA	NA			ND	0.5
Jan-01	0.46 J	0.5	2.3	0.5	120	1.2	~~0.46J~~	~~0.5~~	ND	0.5
Apr-01	0.32 J	0.5	NA	NA	NA	NA	~~0.32J~~	~~0.5~~	ND	0.5

Freon 113 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	~~Reporting Limit~~ ~~(~~RL~~)~~	700-D-186	RL	~~700-J-200~~	~~RL~~	700-H	RL
Jul-01	ND	0.5	1.7	1	58	1	~~NA~~	~~NA~~	ND	0.5
Jan-02	ND	0.5	2	0.5	65	0.5	~~NA~~	~~NA~~	ND	0.5
Apr-02	ND	0.5	NA	NA	NA	NA			ND	0.5
Jul-02	ND	0.5	2.6	1	75	1	~~NA~~	~~NA~~	ND	0.5 ~~1~~
Oct-02	ND	0.5	NA	NA	NA	NA			ND	0.5
Jan-03	ND	0.5	3	0.5	61	0.5	~~NA~~	~~NA~~	ND	0.5
Feb-03	ND	1	3.9	1	57	1	~~NA~~	~~NA~~	ND	1
Apr-03	ND	0.5	NA	NA	NA	NA			ND	0.5
Jul-03	ND	0.5	3.6	1	67	1	~~NA~~	~~NA~~	1.4	1
Oct-03	ND	0.5	NA	NA	NA	NA	~~NA~~	~~NA~~	ND	0.5
Jan-04	ND	0.5	1.7	1	59	0.5	~~NA~~	~~NA~~	ND	0.5 ~~1~~
May/Jun-04	ND	0.5	NA	NA	NA	NA			ND	0.5
Jul-04	ND	0.5	1.8	1	66	1	~~NA~~	~~NA~~	ND	1
Sep/Oct-04	ND	0.5	NA	NA	NA	NA			ND	0.5
Dec-04	ND	1	1.9	1	66	1	~~NA~~	~~NA~~	ND	0.5
Jan-05	1.2	1	0.72~~1.9~~	0.5~~1~~	57	0.5	~~1.2~~	~~1~~	NA~~ND~~	NA ~~0.5~~
Mar/Apr-05	ND	0.5	NA	NA	NA	NA			ND	0.5
Oct-05	0.45 J	0.5	NA	NA	NA	NA	~~0.45J~~	~~0.5~~	ND	0.5
Jan-06	1.1	1	1 J	1	61	1	~~1.1~~	~~1~~	ND	0.5
Apr-06	0.68	0.5	NA	NA	NA	NA	~~0.68~~	~~0.5~~	ND	0.5
Jul-06	1.8	1	6.3	0.5	50	0.5	~~1.8~~	~~1~~	ND	0.5
Oct/Nov-06	ND	0.5	NA	NA	NA	NA	~~0.78J~~	~~1~~	ND	0.5
Jan-07	1.6	1	2	1	49	0.5	~~1.6~~	~~1~~	ND	0.5
Apr-07	0.39 J	1	NA	NA	NA	NA	~~0.39J~~	~~1~~	ND	0.5
Jul-07	0.73 J	1	1	0.5	48	0.5	~~0.73J~~	~~1~~	ND	0.5
Oct-07	ND AD	0.5	NA	NA	NA	NA			ND A	0.5
Jan-08	0.7 J	1	1.3	0.5	39	1	~~0.7J~~	~~1~~	ND	0.5
Apr-08	0.7 J	1	NA	NA	NA	NA	~~0.7J~~	~~1~~	ND	0.5
Jul-08	0.69 J	1	3.2	0.5	27	0.5	~~0.69J~~	~~1~~	ND	0.5
Oct-08	0.95 J	1	NA	NA	NA	NA	~~0.95J~~	~~1~~	ND	0.5
Feb-09	1.4 J	5	1.8 J	5	20	0.5	~~1.4J~~	~~5~~	ND	0.5 ~~1~~
May/Jun-09	0.65 J	1	NA	NA	NA	NA	~~0.65J~~	~~1~~	ND	0.5
Jul-09	0.74 J	1	2.6	0.5	24	0.5	~~0.74J~~	~~1~~	ND	0.5
Oct-09	0.85 J	1	NA	NA	NA	NA	~~0.85J~~	~~1~~	ND	0.5
Feb-10	0.98 J	1	1.7	0.5	26	0.5	~~0.98J~~	~~1~~	ND	0.5 ~~1~~
May-10	ND	0.5	NA	NA	NA	NA			ND	0.5
Jul-10	0.83 J	1	1.7	0.5	24	0.5	~~0.83J~~	~~1~~	ND	0.5 ~~1~~

Freon 113 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	~~Reporting Limit (~~RL~~)~~	700-D-186	RL	~~700-J-200~~	~~RL~~	700-H	RL
Oct-10	0.7 J	1	NA	NA	NA	NA	~~0.7J~~	~~1~~	ND	0.5 ~~1~~
Feb-11	0.5 J	1	2.4	1	35	1	~~0.5J~~	~~1~~	ND	1
Jul-11	0.67 J	1	1.8	1	37	1	~~0.67J~~	~~1~~	ND	1~~5~~
Feb-12	0.58 J	1	NA	NA	NA	NA	~~0.58J~~	~~1~~	ND	1
Aug-12	0.58 J	1	1.4	1	39	1	~~0.58J~~	~~1~~	ND	1
Mar-13	0.67	0.5	1.3	0.5	39	0.5	~~0.67~~	~~0.5~~	ND	0.5
Sep-13	0.54 J	1	1.5	1	44	1	~~0.54J~~	~~1~~	ND	1
Mar-14	0.73 J	1	0.76 J	1	33	1	~~0.73J~~	~~1~~	ND	1
Sep-14	0.57 J	1	1.3	1	43	1	~~ND~~	~~1~~	ND	1
Mar-15	0.67 J	1	0.48 J~~ND~~	1~~0~~	33	10	~~ND~~	~~10~~	ND	1~~0~~
Oct-15	0.54 J	1	0.58 J~~ND~~	1~~0~~	27~~6~~	1~~0~~	~~ND~~	~~10~~	ND	1~~0~~
Mar-16	0.49 J	1	0.55 J~~ND~~	1~~5~~	33	5	~~ND~~	~~5~~	ND	1~~5~~
Oct-16	0.76 J	1	0.62 J	1	28	0.5	~~0.76~~	~~1~~	ND	0.5
Mar-17	0.53 J	1	1	1	36	1	~~0.53~~	~~1~~	ND	1~~5~~
Sep~~Dec~~-17	0.61 J	1	0.58 J	1	28	1	~~0.61~~	~~1~~	ND	1~~5~~
Mar/Apr-18	0.73 J	1	0.67 J	1	26	1			ND	1
Oct-18	0.69 J	1	0.34 J	1	27	1			ND	1

A = The result of an analyte for a laboratory control sample, initial calibration verification or continuing calibration verification was outside standard limits.
AD = Relative percent difference for analyst (laboratory) duplicates was outside standard limits.
J = The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA = Not Applicable.~~nalyzed~~ The well was not sampled for that event.
ND = Not Detected
NI = Not Installed. The event was prior to the installation of the well.
Q = The result for a blind control sample was outside standard limits.
QD = The relative percent difference for a field duplicate was outside standard limits.

Table 6.2 Bis(2ethylhexyl)phthalate (BEHP) Detections in Groundwater (µg/L)

Bis(2ethylhexyl) phthalate Date Sampled	700-J-200	Detection Limit	700-A-253	Detection Limit	700-D-186	Detection Limit	~~700-J-200~~	~~Detection Limit~~	700-H	Detection Limit
May-96	NI	NI	15	2[a]	NA	NA	~~NA~~	~~NA~~	NI~~NA~~	NI~~NA~~
Jul-96	NI	NI	33	2[a]	17	2[a]	~~NA~~	~~NA~~	NI~~NA~~	NI~~NA~~
Aug-96	NI	NI	37	2[a]	9.6	2[a]	~~NA~~	~~NA~~	NI~~NA~~	NI~~NA~~
Oct-96	NI	NI	32	2[a]	24	2[a]	~~NA~~	~~NA~~	NI~~NA~~	NI~~NA~~
Apr-97	NI	NI	24	2[a]	23	2[a]	~~NA~~	~~NA~~	NI~~NA~~	NI~~NA~~
Sep-97	NI	NI	10	10[a]	3.5	10[a]	~~NA~~	~~NA~~	NI~~NA~~	NI~~NA~~
Oct-98	NI	NI	8.0 J	10[a]	4.4 J	10[a]	~~NA~~	~~NA~~	NI~~NA~~	NI~~NA~~
Jan-99	NI	NI	5.96~~44~~	0.441~~206~~	4.8	0.441	~~NA~~	~~NA~~	NI~~NA~~	NI~~NA~~
Jul-99	NI	NI	ND	0.441	ND	2.9	~~NA~~	~~NA~~	NI~~NA~~	NI~~NA~~
Oct-99	3.8 J	2.9	NA	NA	NA	NA	~~3.8J~~	~~2.9~~	ND	2.9
Dec-99	ND	2.9	NA	NA	NA	NA	~~ND~~	~~2.9~~	ND	2.9
Jan/Feb-00	ND	2.9	ND	2.9	ND	2.9	~~ND~~	~~2.9~~	ND	2.9
Apr-00	1.8	0.441	NA	NA	NA	NA	~~1.8~~	~~0.441~~	0.58 J	0.441
Jul-00	ND	2.9	NA	NA	NA	NA	~~ND~~	~~2.9~~	ND	2.9
Aug-00	ND	2.9	ND	2.9	ND	2.9	~~ND~~	~~2.9~~	ND	2.9
Jan-01	ND	2.9	ND	2.9	ND	2.9	~~ND~~	~~2.9~~	ND	2.9
Jul-01	ND	2.9	ND	2.9	ND	2.9	~~ND~~	~~2.9~~	ND	2.9
Jan-02	ND	0.0019	ND	0.0019~~1.9~~	ND	0.0019~~1.9~~	~~ND~~	~~1.9~~	0.005 J	0.0019~~1.9~~
Mar-02	NA	NA	NA	NA	NA	NA	~~NA~~	~~NA~~	ND	0.441
Jul-02	ND	0.0031	ND	0.0031~~3.1~~	ND	0.0031~~3.1~~	~~ND~~	~~3.1~~	ND	0.0031~~3.1~~
Feb-03	ND	1.57	ND	1.57	ND	1.57	~~ND~~	~~1.57~~	1.3 J	1.57
Apr-03	ND	1.57	ND	1.57	ND	1.57	~~ND~~	~~1.57~~	ND	1.57
Jul-03	ND	1.57	ND	1.57	ND	1.57	~~ND~~	~~1.57~~	ND	1.57
Jan-04	ND	1.04	ND	1.04	ND	1.04	~~ND~~	~~1.04~~	0.3 J	1.04
Jul-04	ND	1.04	0.55 J	1.04	ND	1.04	~~ND~~	~~1.04~~	1.6 J	1.04
Dec-04	ND	1.04	ND	1.04	ND	1.04	~~ND~~	~~1.04~~	ND	1.04
Jan-06	ND	1	ND	1	ND	1	~~ND~~	~~1~~	ND	1
Jul-06	ND	1.67	ND	1.67	ND	1.67	~~ND~~	~~1.67~~	1.8~~J~~	1.67
Jan-07	ND	1	66	1	ND	1	~~ND~~	~~1~~	ND	1
Jul-07	ND	1	ND	1	ND	1	~~ND~~	~~1~~	ND	1
Jan-08	ND	1	ND	1	ND	1	~~ND~~	~~1~~	ND	1

Table 6.2 Bis(2ethylhexyl)phthalate (BEHP) Detections in Groundwater (µg/L)

Bis(2ethylhexyl) phthalate Date Sampled	700-J-200	Detection Limit	700-A-253	Detection Limit	700-D-186	Detection Limit	~~700-J-200~~	~~Detection Limit~~	700-H	Detection Limit
Jul-08	ND	1	1.3 J	1	ND	1	~~ND~~	~~1~~	17	1
Sep-08	NA	NA	NA	NA	NA	NA	~~NA~~	~~NA~~	ND	1
Feb-09	ND	1	ND	1	ND	1	~~ND~~	~~1~~	ND	1
Jul-09	ND	1	1.1 J	1	ND	1	~~ND~~	~~1~~	ND	1
Feb-10	ND	1	ND	1	ND	1	~~ND~~	~~1~~	ND	1
Jul-10	ND	1	ND	1	ND	1	~~ND~~	~~1~~	ND	1
Feb-11	ND	3.7	ND	3.5	ND	3.5	~~ND~~	~~3.7~~	ND	3.5
Jul-11	ND	1	ND	1	ND	1	~~ND~~	~~1~~	ND	1
Feb-12	ND	0.5	NA	NA	NA	NA	~~ND~~	~~0.5~~	1.8	0.5
Aug-12	ND	2	ND	2	ND	2	~~ND~~	~~2~~	ND	2
Mar-13	ND	1.2	ND	1.2	ND	1.2	~~ND~~	~~1.2~~	ND	1.2
Sep-13	ND	1	ND	1	ND	1	~~ND~~	~~1~~	ND	0.5
Mar-14	ND	2	ND	2	ND	2	~~ND~~	~~2~~	ND	2
Sep-14	ND	2	ND	2	ND	2	~~ND~~	~~2~~	ND	2
Mar-15	ND	2	ND	2	ND	2	~~ND~~	~~2~~	ND	2
Oct-15	0.55	0.50	14	0.50	ND	0.50	~~0.55~~	~~0.50~~	0.28	0.50
Mar-16	ND	2	ND	2	ND	2	~~ND~~	~~2~~	ND	2
Oct-16	ND	0.1	1.1 FB	0.1~~5~~	ND	0.1~~5~~	~~ND~~	~~0.5~~	ND	0.1~~5~~
Mar-17	4	0.1	ND	0.1~~5~~	ND	0.1~~5~~	~~4~~	~~0.5~~	0.63	0.1~~5~~
Sep~~Dec~~-17	ND	0.1	ND	0.1~~5~~	ND	0.1~~5~~	~~ND~~	~~0.5~~	0.85 RB	0.1~~5~~
Apr-18	ND	0.2	ND	0.2	ND/3.8 QD	0.2			ND	0.2
Oct-18	ND	0.2	ND	0.2	14	0.2			1.3	0.2

Notes:

[a] = No detection limit was reported. The value listed is a reporting limit.
FB = The analyte was detected in the field blank.
J = The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA = Not ~~Analyzed~~Applicable. The well was not sampled for that event.
ND = Not Detected
NI = Not Installed. The event was prior to the installation of the well.
QD = The relative percent difference for a field duplicate was outside standard limits.
RB = The analyte was detected in the method blank.

Table 6.3 Maximum Freon 11 Detections in Groundwater (µg/L)

Freon 11 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-90	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND Q	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Apr-90	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jul/Aug-90	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Oct-90	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Jan-91	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Apr-91	NI~~NA~~	NI~~NA~~	NA	NA	ND FB	0.5	NI~~NA~~	NI~~NA~~
Jul-91	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Nov-91	NI~~NA~~	NI~~NA~~	NA	NA	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan-92	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Apr-92	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Jul~~/Aug~~-92	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Oct/Nov-92	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan/Feb-93	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Apr/May-93	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Jul/Aug-93	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Nov-93	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Feb-94	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Apr/May-94	NI~~NA~~	NI~~NA~~	ND	0.5	0.5	0.5	NI~~NA~~	NI~~NA~~
Aug-94	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Oct/Nov-94	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan/Feb-95	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Apr/May-95	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Aug-95	NI~~NA~~	NI~~NA~~	ND	0.5	1	0.5	NI~~NA~~	NI~~NA~~
Nov-95	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan-96	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
May-96	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Jul-96	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Aug-96	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Oct-96	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Nov-96	NI~~NA~~	NI~~NA~~	ND	1	1.2 J FB	5	NI~~NA~~	NI~~NA~~
Feb-97	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Apr-97	NI~~NA~~	NI~~NA~~	ND	0.5~~/1/5~~	ND	0.5~~1~~	NI~~NA~~	NI~~NA~~
Jul~~/Aug~~-97	NI~~NA~~	NI~~NA~~	ND	0.5	NA	NA	NI~~NA~~	NI~~NA~~
Sep-97	NI~~NA~~	NI~~NA~~	ND	0.5	0.27 J	0.5	NI~~NA~~	NI~~NA~~
Oct-97	NI~~NA~~	NI~~NA~~	0.25 J	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan/Feb-98	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
May-98	NI~~NA~~	NI~~NA~~	0.3 J	0.5	4.6	0.5	NI~~NA~~	NI~~NA~~
Oct-98	NI~~NA~~	NI~~NA~~	ND	0.5~~/10~~	ND	0.5~~/10~~	NI~~NA~~	NI~~NA~~
Jan-99	NI~~NA~~	NI~~NA~~	ND	0.5~~/1~~	0.58	0.5	NI~~NA~~	NI~~NA~~
Jul-99	NI~~NA~~	NI~~NA~~	2.8	0.5	ND	5~~/10~~	NI~~NA~~	NI~~NA~~
Oct-99	ND	10	NA	NA	NA	NA	ND	10
Dec-99	ND	0.5~~/2/10~~	NA	NA	NA	NA	ND	10
Jan/Feb-00	ND Q	0.5~~/2/10~~	0.9	0.5	1	0.5	ND	0.5~~/2/10~~
Apr-00	ND	10	NA	NA	NA	NA	ND	10
Jun-Aug-00	ND	0.5~~/2/5/10~~	ND	0.5~~/2/10~~	0.4 J	2	ND	0.5~~/2/5/10~~
Nov-00	ND	0.5~~/2~~	NA	NA	NA	NA	ND	0.5~~/2~~
Jan-01	0.22 J	0.5	ND	0.5~~/10~~	0.6 J	10	ND Q	0.5~~/2/10~~
Apr-01	ND	0.5~~/2/10~~	NA	NA	NA	NA	ND	0.5~~/2~~
Jul-01	ND	0.5~~/2/10~~	ND Q	0.5~~/2/10~~	0.43 J	2	ND	0.5~~/2/10~~
Oct-01	ND	0.5~~/2~~	NA	NA	NA	NA	ND	0.5~~/2~~

Freon 11 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-02	ND~~-Q~~	0.5~~/2~~	ND	0.5~~/2~~	0.66	0.5	ND	0.5~~/2~~
Apr-02	ND	0.5~~/2~~	NA	NA	NA	NA	ND	0.5~~/2~~
Jul-02	ND~~-Q~~	0.5~~/2~~	ND	0.5~~/2~~	0.5	0.5	ND	0.5~~/2~~
Oct-02	ND	0.5~~/2~~	NA	NA	NA	NA	ND	0.5~~/2~~
Jan/Feb-03	ND	0.5~~/2~~	ND	0.5~~/2~~	0.54	0.5	ND	0.5~~/2~~
Apr-03	ND	0.5~~/2~~	NA	NA	NA	NA	ND~~-T~~	0.5~~/2~~
Jul-03	ND	0.5~~/2~~	0.5	0.5	1.1	0.5	ND	0.5~~/2~~
Oct-03	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Jan-04	ND	0.5~~/1/2~~	ND	0.5~~/2~~	0.62	0.5	ND	0.5~~/1/2~~
~~Jun/~~May-Jul-04	ND	0.5~~/1/2~~	ND	0.5~~/1/2~~	0.81 J	1	ND	0.5~~/1.2~~
Sep/Oct-04	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Dec-04	ND	2	ND	2	0.61 J	2	ND	0.5~~/1/2~~
Jan-05	ND~~A~~	0.5~~NA~~	ND	0.5	0.5	0.5	NA~~D~~	NA~~0.5/1~~
Mar/Apr-05	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Oct-05	ND	0.5	NA	NA	NA	NA	ND	0.5
Jan-06	ND	0.5~~/1~~	ND	0.5~~/1~~	0.8 J	1	ND	0.5~~/1~~
Apr-06	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Jul-06	ND	0.5~~/1/10~~	ND	0.5~~/10~~	2.2 J	10	ND	0.5~~/1/10~~
Oct/Nov-06	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Jan-07	ND	0.5~~/10~~	ND	0.5~~/10~~	0.56 J	10	ND	0.5~~/10~~
Apr-07	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Jul-07	ND	0.5~~/1/10~~	ND	0.5~~/10~~	0.52	0.5	ND	0.5~~/1/10~~
Oct-07	ND	1	NA	NA	NA	NA	ND~~-AD~~	0.5~~/1~~
Jan-08	ND	0.5~~/1/10~~	ND	0.5~~/10~~	1.2 J	10	ND	0.5~~/1/10~~
Apr-08	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Jul-08	ND	0.5~~/1/10~~	ND	0.5~~/10~~	1.8	0.5	ND	0.5~~/1/10~~
Oct-08	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Feb-09	ND	0.5~~/1/10~~	ND	0.5~~/10~~	1.2	0.5	ND	0.5~~/1/10~~
May/Jun-09	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Jul-09	ND	0.5~~/1/10~~	ND	0.5~~/10~~	1.6	0.5	ND	0.5~~/1/10~~
Oct-09	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Feb-10	ND	0.5~~1~~	ND	0.5~~/1~~	1.2	0.5~~/1~~	ND	0.5~~/1~~
May-10	ND~~A~~	0.5~~NA~~	NA	NA	NA	NA	ND	0.5~~/1~~
Jul-10	ND	0.5~~1~~	ND	0.5~~/1~~	1.1	0.5	ND	0.5~~/1~~
Oct-10	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~/1~~
Feb-11	ND	1	ND	1	1.5	1	ND	1
Jul-11	ND	1	ND	1	1.1	1	ND	1
Feb-12	ND	1	NA	NA	NA	NA	ND	1
Aug-12	ND	1	ND	1	0.83 J	1	ND	1
Mar-13	ND	0.5~~/1~~	ND	0.5~~/1~~	0.67	0.5	ND	0.5~~/1~~
Sep-13	ND	1	ND	1	0.67 J	1	ND	1
Mar-14	ND	1	ND	1	0.56 J	1	ND	1
Sep-14	ND	1	ND	1	0.61 J	1	ND	1
Mar-15	ND	1	ND	1	0.54 J	1	ND	1
~~Sep/~~Oct-15	ND	1	ND	1	0.57 J	1	ND	1
Mar-16	ND	1	ND	1	0.63 J	1	ND	1
Oct-16	ND	1	ND	1	0.44 J	0.5~~/1~~	ND	0.5~~/1~~
Mar-17	ND	1	ND	1	0.74 J	1	ND	1
Sep-17	ND	1	ND	1	0.63 J	1	ND	1
Mar/Apr-18	ND	1	0.26 J	1	0.6 J	1	ND	1

Freon 11 Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Aug-Oct-18	ND	1	ND	1	0.51 J	1	ND	1

Notes:

~~AD = Relative percent difference for analyst (laboratory) duplicates was outside standard limits.~~

FB = The analyte was detected in the field blank.

J = The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.

NA = Not ~~Analyzed~~Applicable. The well was not sampled for that event.

ND = Not Detected

NI = Not Installed. The event was prior to the installation of the well.

Q = The result for a blind control sample was outside standard limits.

~~T = The sample was analyzed outside the specified holding time or temperature.~~

Table 6.4 Maximum TCE Detections in Groundwater (µg/L)

TCE Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-90	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Apr-90	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jul/Aug-90	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Oct-90	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Jan-91	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Apr-91	NI~~NA~~	NI~~NA~~	NA	NA	ND	0.5	NI~~NA~~	NI~~NA~~
Jul-91	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Nov-91	NI~~NA~~	NI~~NA~~	NA	NA	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan-92	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Apr-92	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Jul-92	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Oct/Nov-92	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan/Feb-93	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Apr/May-93	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Jul/Aug-93	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Nov-93	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Feb-94	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Apr/May-94	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Aug-94	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Oct/Nov-94	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan/Feb-95	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Apr/May-95	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Aug-95	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Nov-95	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan-96	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
May-96	NI~~NA~~	NI~~NA~~	0.2	0.1	0.3	0.1	NI~~NA~~	NI~~NA~~
Jul-96	NI~~NA~~	NI~~NA~~	0.1	0.1	0.2	0.1	NI~~NA~~	NI~~NA~~
Aug-96	NI~~NA~~	NI~~NA~~	0.2	0.1	0.2	0.1	NI~~NA~~	NI~~NA~~
Oct-96	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Nov-96	NI~~NA~~	NI~~NA~~	ND A	0.5~~-A~~	0.3 J A FB	0.5	NI~~NA~~	NI~~NA~~
Feb-97	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Apr-97	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Jul-97	NI~~NA~~	NI~~NA~~	ND	0.5	NA	NA	NI~~NA~~	NI~~NA~~
Sep-97	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Oct-97	NI~~NA~~	NI~~NA~~	ND	0.5	1.1	0.5	NI~~NA~~	NI~~NA~~
Jan/Feb-98	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
May-98	NI~~NA~~	NI~~NA~~	0.27 J	0.5	3	0.5	NI~~NA~~	NI~~NA~~
Oct-98	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	ND	0.5~~/5~~	NI~~NA~~	NI~~NA~~
Jan-99	NI~~NA~~	NI~~NA~~	ND	0.5	0.27 J	0.5	NI~~NA~~	NI~~NA~~
Jul-99	NI~~NA~~	NI~~NA~~	ND	0.5~~/5~~	0.8	0.5	NI~~NA~~	NI~~NA~~
Oct-99	ND	1	NA	NA	NA	NA	ND	1
Dec-99	0.21 J	0.5	NA	NA	NA	NA	ND	1
Jan/Feb-00	ND	0.5~~/1~~	ND	0.5~~/1~~	0.53	0.5	ND	0.5~~/1~~
Apr-00	ND	1	NA	NA	NA	NA	ND	1
Jun-Aug-00	ND	0.5~~/1~~	ND	0.5~~/1~~	0.34 J	1	ND	0.5~~/1~~
Nov-00	0.68	0.5	NA	NA	NA	NA	ND	0.5~~/1~~
Jan-01	0.54 J	1	ND	0.5~~/1~~	0.22 J	0.5	ND	0.5~~/1~~
Apr-01	0.39 J	1	NA	NA	NA	NA	ND ~~EB~~	0.5~~/1~~
Jul-01	0.38 J	1	ND	0.5~~/1~~	0.39 J	1	ND	0.5~~/1~~
Oct-01	ND	0.5~~/1~~	NA	NA	NA	NA	ND	0.5~~/1~~

TCE Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-02	0.38 J	1	ND	0.5~~1~~	0.44 J	1	ND	0.5~~1~~
Apr-02	0.54	0.5	NA	NA	NA	NA	ND	0.5~~1~~
Jul-02	0.38 J	1	ND	0.5~~1~~	0.45 J	~~1~~0.5	ND	0.5~~1~~
Oct-02	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jan/Feb-03	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Apr-03	ND	0.5~~1~~	NA	NA	NA	NA	ND ~~J~~	0.5~~1~~
Jul-03	ND	0.5~~1~~	ND	0.5~~1~~	0.75	0.5	ND	0.5~~1~~
Oct-03	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jan-04	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
May-Jul-04	ND	0.5~~1~~	ND	0.5~~1~~	0.58	0.5	ND	0.5~~1~~
Sep/Oct-04	0.56 J	1	NA	NA	NA	NA	ND	0.5~~1~~
Dec-04	ND	1	ND	1	0.65 J	1	ND	0.5~~1~~
Jan-05	4.1	0.5	ND	0.5	ND	0.5	NA	NA
Mar/Apr-05	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Oct-05	1.8	0.5	NA	NA	NA	NA	ND	0.5
Jan-06	2	1	ND	0.5~~1~~	0.8 J	1	ND	0.5~~1~~
Apr-06	1.8	1	NA	NA	NA	NA	ND	0.5~~1~~
Jul-06	1.9	0.5	ND	0.5~~1~~	0.67	0.5	ND	0.5~~1~~
Oct/Nov-06	1.2	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jan-07	1	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Apr-07	0.85	0.5	NA	NA	NA	NA	ND	0.5~~1~~
Jul-07	0.81 J	1	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Oct-07	0.7 RB A	0.2	NA	NA	NA	NA	ND A	0.2/~~0.5~~
Jan-08	0.67	0.5	ND	0.5~~1~~	0.59 J	0.5~~1~~	ND	0.5~~1~~
Apr-08	0.85	0.5	NA	NA	NA	NA	ND	0.5~~1~~
Jul-08	0.75	0.5	ND	0.5~~1~~	0.87	0.5	ND	0.5~~1~~
Oct-08	0.75	0.5	NA	NA	NA	NA	ND	0.5~~1~~
Feb-09	0.61 J	1	ND	0.5~~1~~	0.51	0.5	ND	0.5~~1~~
May/Jun-09	0.65	0.5	NA	NA	NA	NA	ND	0.5~~1~~
Jul-09	0.65	0.5	ND	0.5~~1~~	0.68	0.5	ND	0.5~~1~~
Oct-09	0.47 J	0.5	NA	NA	NA	NA	ND	0.5~~1~~
Feb-10	0.47 J	0.5	ND	0.5~~1~~	0.57	0.5	ND	0.5~~1~~
May-10	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jul-10	0.49 J	1	ND	0.5~~1~~	0.44 J	0.5	ND	0.5~~1~~
Oct-10	0.49 J	1	NA	NA	NA	NA	ND	0.5~~1~~
Feb-11	0.38 J	1	ND	1	0.53 J	1	ND	1
Jul-11	0.56 J	1	ND	1	0.6 J	1	ND	1
Feb-12	0.41 J	1	NA	NA	NA	NA	ND	1
Aug-12	0.31 J	1	ND	1	0.5 J	1	ND	1
Mar-13	0.35 J	0.5	ND	0.5~~1~~	0.44 J	0.5	ND	0.5~~1~~
Sep-13	0.35 J	1	ND	1	0.53 J	1	ND	1
Mar-14	0.33 J	1	ND	1	0.41 J	1	ND	1
Sep-14	0.34 J	1	ND	1	0.41 J	1	0.23 J	1
Mar-15	0.32 J	1	ND	1	0.45 J	1	ND	1
Oct-15	0.23 J	1	ND	1	0.37 J	1	ND	1
Mar-16	0.27 J	1	ND	1	0.42 J	1	ND	1
Oct-16	0.27 J	1	ND	1	0.54	0.5	ND	0.5~~1~~
Mar-17	0.25 J	1	ND	1	0.57 J	1	ND	1
Sep-17	0.26 J	1	ND	1	0.44 J	1	ND	1
Mar/Apr-18	0.17 J	1	ND	1	0.47 J	1	ND	1
Oct-18	ND	1	ND	1	0.36 J	1	ND	1

A = The result of an analyte for a laboratory control sample, initial calibration verification or continuing calibration verification was outside standard limits.
~~EB = The analyte was detected in the equipment blank.~~
FB = The analyte was detected in the field blank.
J = The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA = Not ~~Analyzed~~Applicable. The well was not sampled for that event.
ND = Not Detected
NI = Not Installed. The event was prior to the installation of the well.
RB = The analyte was detected in the method blank.
~~T = The sample was analyzed outside the specified holding time or temperature.~~

Table 6.5 Maximum PCE Detections in Groundwater (µg/L)

PCE Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-90	NI~~NA~~	NI~~NA~~	ND	1/~~5~~	ND	1/~~5~~	NI~~NA~~	NI~~NA~~
Apr-90	NI~~NA~~	NI~~NA~~	ND	1	ND	1/~~5~~	NI~~NA~~	NI~~NA~~
Jul/Aug-90	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Oct-90	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Jan-91	NI~~NA~~	NI~~NA~~	ND	1/~~5~~	ND	1	NI~~NA~~	NI~~NA~~
Apr-91	NI~~NA~~	NI~~NA~~	NA	NA	ND	1	NI~~NA~~	NI~~NA~~
Jul-91	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Nov-91	NI~~NA~~	NI~~NA~~	NA	NA	ND	1/~~5~~	NI~~NA~~	NI~~NA~~
Jan-92	NI~~NA~~	NI~~NA~~	ND	1/~~5~~	ND	1	NI~~NA~~	NI~~NA~~
Apr-92	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Jul-92	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Oct/Nov-92	NI~~NA~~	NI~~NA~~	ND	1	ND	1/~~5~~	NI~~NA~~	NI~~NA~~
Jan/Feb-93	NI~~NA~~	NI~~NA~~	ND	1/~~5~~	ND	1/~~5~~	NI~~NA~~	NI~~NA~~
Apr/May-93	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Jul/Aug-93	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Nov-93	NI~~NA~~	NI~~NA~~	ND	1	ND	1/~~5~~	NI~~NA~~	NI~~NA~~
Feb-94	NI~~NA~~	NI~~NA~~	ND	1/~~5~~	ND	1	NI~~NA~~	NI~~NA~~
Apr/May-94	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Aug-94	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Oct/Nov-94	NI~~NA~~	NI~~NA~~	ND	1	ND	1/~~5~~	NI~~NA~~	NI~~NA~~
Jan/Feb-95	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Apr/May-95	NI~~NA~~	NI~~NA~~	ND	1/~~5~~	ND	1	NI~~NA~~	NI~~NA~~
Aug-95	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Nov-95	NI~~NA~~	NI~~NA~~	ND	1	ND	1/~~5~~	NI~~NA~~	NI~~NA~~
Jan-96	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
May-96	NI~~NA~~	NI~~NA~~	ND	0.2/~~1/5~~	ND	0.2/~~1~~	NI~~NA~~	NI~~NA~~
Jul-96	NI~~NA~~	NI~~NA~~	ND	0.2	ND	0.2	NI~~NA~~	NI~~NA~~
Aug-96	NI~~NA~~	NI~~NA~~	ND	0.2/~~1~~	ND	0.2/~~1~~	NI~~NA~~	NI~~NA~~
Oct-96	NI~~NA~~	NI~~NA~~	ND	1	ND	1	NI~~NA~~	NI~~NA~~
Nov-96	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5/~~5~~	NI~~NA~~	NI~~NA~~
Feb-97	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Apr-97	NI~~NA~~	NI~~NA~~	ND	0.5/~~5~~	ND	0.5/~~1~~	NI~~NA~~	NI~~NA~~
Jul-97	NI~~NA~~	NI~~NA~~	ND	0.5	NA	NA	NI~~NA~~	NI~~NA~~
Sep-97	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
Oct-97	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5/~~5~~	NI~~NA~~	NI~~NA~~
Jan/Feb-98	NI~~NA~~	NI~~NA~~	ND	0.5	ND	0.5	NI~~NA~~	NI~~NA~~
May-98	NI~~NA~~	NI~~NA~~	ND	0.5/~~5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Oct-98	NI~~NA~~	NI~~NA~~	ND	0.5/~~5~~	ND	0.5/~~5~~	NI~~NA~~	NI~~NA~~
Jan-99	NI~~NA~~	NI~~NA~~	ND	0.5/~~1~~	ND	0.5/~~1~~	NI~~NA~~	NI~~NA~~
Jul-99	NI~~NA~~	NI~~NA~~	ND	0.5/~~5~~	ND	0.5	NI~~NA~~	NI~~NA~~
Oct-99	ND	0.5	NA	NA	NA	NA	ND	0.5
Dec-99	ND	0.5/~~1~~	NA	NA	NA	NA	ND	0.5
Jan/Feb-00	ND ~~Q~~	0.5/~~1~~	ND	0.5	ND	0.5	0.21 J	0.5
Apr-00	ND	0.5	NA	NA	NA	NA	ND	0.5
Jun-Aug-00	ND	0.5/~~1~~	ND	0.5/~~1~~	0.51	0.5	ND	0.5/~~1~~
Nov-00	ND	0.5/~~1~~	NA	NA	NA	NA	ND	0.5/~~1~~
Jan-01	ND	0.5/~~1~~	ND	0.5	ND	0.5	ND ~~Q~~	0.5/~~1~~
Apr-01	ND	0.5/~~1~~	NA	NA	NA	NA	ND	0.5/~~1~~
Jul-01	ND	0.5/~~1~~	ND	0.5/~~1~~	ND	0.5/~~1~~	ND	0.5/~~1~~
Oct-01	ND	0.5/~~1~~	NA	NA	NA	NA	ND	0.5/~~1~~

PCE Date Sampled	700-J-200	Reporting Limit (RL)	700-A-253	RL	700-D-186	RL	700-H	RL
Jan-02	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Apr-02	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jul-02	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Oct-02	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jan/Feb-03	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Apr-03	ND	0.5~~1~~	NA	NA	NA	NA	ND ~~J~~	0.5~~1~~
Jul-03	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Oct-03	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jan-04	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
May-Jul-04	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Sep/Oct-04	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Dec-04	ND	1	ND	1	ND	1	ND	0.5~~1~~
Jan-05	ND	0.5~~1~~	ND	0.5	ND	0.5	NA	NA
Mar/Apr-05	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Oct-05	ND	0.5	NA	NA	NA	NA	0.06 J	0.5
Jan-06	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Apr-06	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jul-06	ND	0.5~~1~~	0.24 J	0.5	0.33 J	0.5	0.25 J	0.5
Oct/Nov-06	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jan-07	ND	0.5	ND	0.5	ND	0.5	ND	0.5
Apr-07	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jul-07	ND	0.5~~1~~	ND	0.5	ND	0.5	ND	0.5~~1~~
Oct-07	ND A AD SP	0.5	NA	NA	NA	NA	ND ~~A~~	0.5~~1~~
Jan-08	ND	0.5~~1~~	ND	0.5	ND	0.5	ND	0.5~~1~~
Apr-08	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jul-08	ND	0.5~~1~~	ND	0.5	ND	0.5	ND	0.5~~1~~
Oct-08	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Feb-09	ND	0.5~~1~~	ND	0.5	ND	0.5	ND	0.5~~1~~
May/Jun-09	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jul-09	ND	0.5~~1~~	ND	0.5	ND	0.5	ND	0.5~~1~~
Oct-09	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Feb-10	ND	0.5~~1~~	ND	0.5	ND	0.5	ND	0.5~~1~~
May-10	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Jul-10	ND	0.5~~1~~	ND	0.5	ND	0.5	ND	0.5~~1~~
Oct-10	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Feb-11	ND	1	ND	1	ND	1	ND	1
Jul-11	ND	0.5~~1~~	ND	0.5~~1~~	0.28 J	0.5	ND	0.5~~1~~
Feb-12	ND	0.5~~1~~	NA	NA	NA	NA	ND	0.5~~1~~
Aug-12	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Mar-13	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Sep-13	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Mar-14	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~	ND	0.5~~1~~
Sep-14	ND	1	ND	1	ND	1	ND	1
Mar-15	ND	1	ND	1	ND	1	ND	1
Oct-15	ND	1	ND	1	ND	1	ND	1
Mar-16	ND	1	ND	1	ND	1	ND	1
Oct-16	ND	1	ND	1	ND	0.5~~1~~	ND	0.5~~1~~
Mar-17	ND	1	ND	1	ND	1	ND	1
Sep-17	ND	1	ND	1	ND	1	ND	1
Mar/Apr-18	ND	1	ND	1	ND	1	ND	1
Oct-18	ND	1	ND	1	ND	1	ND	1

A = The result of an analyte for a laboratory control sample, initial calibration verification or continuing calibration verification was outside standard limits.
AD = Relative percent difference for analyst (laboratory) duplicates was outside standard limits.
J = The result is an estimated value less than the quantitation limit, but greater than or equal to the detection limit.
NA = Not ~~Analyzed~~Applicable. The well was not sampled for that event.
ND = Not Detected
NI = Not Installed. The event was prior to the installation of the well.
~~Q = The result for a blind control sample was outside standard limits.~~
SP = The matrix spike recovery and/or the relative percent difference for matrix spike duplicates was outside standard limits.
~~T = The sample was analyzed outside the specified holding time or temperature.~~

Appendix A
Interview Summary

Appendix A
WSTF 700 Area Landfill (SWMU 49) Summary of Findings from Employee Interviews or Questionnaires

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
Aerospace Data Facility-Southwest (ADF-SW) 1995-present (2014)	• No waste documentation or history was available prior to the employee beginning work in 1995, and there was "no specific data available on any chemical used prior to 1997…" • Buildings at ADF-SW are used for data processing. "There are no hazardous wastes, only domestic and universal wastes. Used oil/batteries for fire alarms, lights are all 'green' and shipped off-site for disposal." • "Very little maintenance is performed by ADF-SW personnel on site. Government Services Administration maintains vehicles" (at WSTF). "The only maintenance performed at ADF-SW involves changing oil in generators. At most, there would be 4-5 ounces of used oil absorbed with rags. The rags are then disposed of off-site. Batteries used at ADF-SW are sealed gel cells that require no maintenance. When they need service, they are disposed of off-site and new ones obtained." • "Any paints used were historically latex [water-based]. Currently items arrive painted, and no painting is done at ADF-SW." • ADF-SW originally had 56 employees; currently, approximately 800 employees work 24 hours per day, 365 days per year, 2-3 shifts per day. • All transformers at ADF-SW were sampled for Polychlorinated biphenyls (PCBs) in 1997/1998 with no PCBs detected. No other potential PCB-containing items were identified at ADF-SW. • Waste generation has been the same since the employee began working at ADF-SW in 1995. • The facility was constructed in 1983/1984. Building 10 addition was added in 1991, along with the gymnasium and warehouse. In 2004, another addition was constructed onto Building 10.	• Interviewed in 2012
Tracking and Data Relay Satellite System (TDRSS) 1989-present (2014) and Second TDRSS Ground Terminal (STGT) 1997-present (2014)	• At STGT, "Degreasers and oils were always containerized and shipped off-site for disposal." [since 1997, when the employee began working at STGT] • Currently paint and paint brushes used at STGT are shipped off site for disposal. • The only solvent ever used was "Virginia 10", but it was always containerized and disposed of off-site [since 1997]. • STGT transformers never contained any oil, so no PCBs. There were never any other PCB type components at STGT due to the recent age of the facility (1988/1989). • All TDRSS transformers were (and are) dry and contained no PCBs. There were light ballasts containing PCBs historically, but they all were replaced by 2010. There were never any spills of PCBs to the employee's knowledge.	• Interviewed in 2012

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• Wastes included solvents, oils, and latex (water-based) paints and debris (rags, gloves, etc.).	
TDRSS and STGT 1997-present (2014)	• The only solvent used at STGT was "Virginia 10". It was containerized and shipped off-site for disposal. • STGT transformers never contained any oil, so there were no PCBs within them.	• Interviewed in 2012
TDRSS 1989-present (2014) and STGT mid 1990s-present (2014)	• Wastes for TDRSS and STGT included "non leaded paint" and "mineral spirits."	• Interviewed in 2012
WSTF 200 Area 1981-1987; Environmental Department 1987-present (2014)	• The dead animal pit was located by the entrance road and was for the disposal of dead animals hit on WSTF roads or found on WSTF property. • Wastes the employee remembers seeing in the 700 Area landfill were: o "Empty bottles of every chemical known to man" at WSTF, o Metal 5-gal drums of acetone, solvents, and other chemicals, o Cleaning debris, such as wipes, gloves, rags o Decontaminated self-contained atmospheric protection ensemble (SCAPE) suits, o Old negatives and etching plates, o Vegetable oil, o Cafeteria waste, o Aerosol cans (partially full and empty), o Resins, o Stainless steel tubings, o Hard hats and other PPE, o Pressurized canisters (rarely), o Titanium tanks (~2 ft diameter), o Automotive materials (brake parts, tires, filters, rags with antifreeze, used oil, o Construction wastes (including floor tiles, ceiling tiles, piping, "anything thrown away in remodels") • Automotive battery cores were recycled off-site and liquids from batteries were placed in the 600 Area Hazardous Waste Management Unit (HWMU). • Control of environmental wastes at WSTF began in 1985, but did not immediately change all procedures and personnel behaviors.	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• Drums of chemicals were stored in the Drum Storage Facility (DSF) to await shipment off-site for disposal.	

WSTF 200 Area 1978-late 1980s; Environmental Department late 1980s-present (2014)	• No shipments of wastes off-site occurred prior to 1985.
	• Liquid wastes were stored in the 300, 400, and 600 Area impoundments. Solid wastes were disposed of in the 700 Area landfill.
	• The proactive management of wastes began at WSTF in 1985, when a permanent Environmental Department was established. This was a gradual process of waste management and reduction.
	• Hazardous wastes after 1985 were stored in a special facility (DSF) and shipped off-site for disposal.
	• Small quantities of laboratory wastes had been disposed of in the 700 Area landfill prior to 1985.
	• Empty drums, mostly, were disposed of in the landfill; however, the employee recalled approximately half-full small cylinders (5 gal) of chemicals/wastes being discarded in the 700 Area landfill between approximately 1980 and 1985, when Environmental Protection Agency (EPA) inspections prompted a site cleaning initiative.
	• Only a small volume of waste liquids were placed in the landfill because full drums of waste oils/liquids were delivered to the WSTF Fire Department for fire-fighting practice.
	• Drums were made of steel or fiberboard (a hard pressed cardboard).
	• Other material the employee remembered seeing in the 700 Area landfill were:
	  ○ Debris contaminated with wastes (gloves, wipes, rags),
	  ○ Glass bottles,
	  ○ Old negatives,
	  ○ Personal protective equipment (PPE),
	  ○ Spill dry, oils,
	  ○ Solvent-contaminated rags,
	  ○ Trash,
	  ○ Paper,
	  ○ Cafeteria wastes,
	  ○ Landscape materials,
	  ○ Organics,
	  ○ Weeds,
		• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	○ Toner Cartridges, ○ Type writer ribbons, ○ Correction fluid bottles, ○ Chemical containers, ○ Metal parts from buildings, ○ Paint cans (with lead paint), ○ Minor amounts of liquid paint, ○ Dried paint, ○ Epoxies, ○ Lab contaminated wastes (rags, gloves, aprons) contaminated with solvents, Trichloroethene (TCE), Freons (Trichlorofluoromethane [Freon 11] and 1,1,2-Trichloro-1,2,2-trifluoroethane [Freon 113], acetone, isopropyl alcohol (IPA), Tetrachloroethene (PCE), etc., ○ Automotive wastes (rags with oil, greases, antifreeze; tires), ○ Construction wastes (including asbestos-containing wastes), • The employee did not believe that bulk hazardous wastes had been disposed of in the 700 Area landfill.	
WSTF 100, 200, 800, 300, and 400 Areas; over 25 years	• The employee was not aware of any 700 Area landfill operational documents. "They [supervisors] would tell me what to dump and I would take it to the 700 Area and dump it." • When the employee began working at WSTF, there was no [off-site] trash service for the site. "There was no need for it, since WSTF had its own landfill for disposal." • The employees stated that most wastes were taken to the landfill until an off-site trash service began. • "Any operation on-site that was conducted at the time the landfill was open that generated waste would use the landfill for disposal purposes." • The employee recalled seeing the following materials in the 700 Area landfill: ○ "Plenty of liquids were placed into the landfill either directly poured or were in a container of some sort." Liquids included: ▪ Decontamination liquids such as MF and TF Freon (Freon 11 and Freon 113), ▪ Spent automotive liquids such as hydraulic fluids, engine oil, and diesel fluids, ▪ Spent oakites (Oakite 33, Oakite 126,	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	▪ Spent methyl ethyl ketone (MEK), and ▪ Spent Brulin (solutions). o Some tires (The employee recalled vehicle batteries and most tires being recycled) o Small automotive wastes (vehicle filters, oil filters, contaminated rags) o All disposable PPE (including gloves, SCAPE gear, splash gear, face-protection gear). No PPE was decontaminated prior to disposal. o Bottles and containers of Freons (Freon 11 and Freon 113), TCE, acetone, alcohol, PCE, MEK, o Paints (both water-based and oil-based, some containing lead, o Epoxies (liquid and dried), o “Plenty of primer,” o All metal components (such as 306 stainless steel, carbon steel, titanium, Tygon tubing, aluminum, wire insulation). The employee recalled specifically spools of 1-in., 1.5-in., and 2-3-in. lines of 306 stainless steel were disposed of in the landfill. o Other metals (chromium, mercury) o Large 1,200-gal to small 75 to 100-gal tanks were decontaminated with MEK and disposed of in the 700 Area landfill. o “small flashlight-type batteries” [alkaline] o Empty aerosol cans (occasionally full or partially full when the “nozzle broke”) o Adhesives, Teflon, Tygon, Kevlar, and gasket materials o Fuel-contaminated debris (contaminated with unsymmetrical dimethylhydrazine [UDMH], A-50, Monomethylhydrazine [MMH], and hydrazine) and oxidizer-contaminated debris (contaminated with nitrogen tetroxide-N_2O_4). Debris included: ▪ Tubing, ▪ Valves, ▪ Soft goods, ▪ A large number of O-rings, ▪ Teflon gaskets, ▪ Splash gear, ▪ “Anything on an aerospace panel”	

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• The employee recalled personally disposing of 55-gal drums full of acetone and IPA in the 700 Area landfill. "Most drums were unmarked, but MEK and Freons were definitely placed in the landfill" (since they were decontamination agents). • "Most engine-cleaning solutions were placed into the landfill." • Wooden pallets were used to transport multiple drums at a time. When the load was added to the 700 Area landfill, the wood pallet was also added. • "There was a time when wood was separated and placed in a scrap wood pile." • The employee stated that there had been an asbestos abatement initiative, possibly in 1983, where asbestos-lined piping was removed from buildings and placed in drums. The employee did not know the disposition of the drums of asbestos. • During the "shuttle build-up" (when the test stands in the 300 and 400 Areas were being modified from Apollo program testing to configurations for space shuttle testing), there had been a lot of construction and building modifications. This construction debris "most likely" was disposed of in the 700 Area landfill. Concrete and asphalt had been placed in arroyos within the WSTF site. (Another employee [Lela Hunnicutt-Mack] stated that the concrete and asphalt was removed from arroyos in 2012). • The employee witnessed one fire at the 700 Area landfill "due to spontaneous combustion of rags" in the early 1980s or late 1970s. • The employee believed that when sludge was removed from a WSTF wastewater (sewage) lagoon, the sludge was disposed of in the 700 Area landfill. • Since there was no shipment of wastes off-site and no off-site trash service early on, the employee suspected that photographic wastes, and spent fluorescent lights were also disposed of in the landfill. • No K-bottles or pressurized canisters were placed in the landfill because a company in Las Cruces provided an exchange service where empty tanks would be exchanged for full tanks. • "There was no organization with how the material was placed into the landfill. The trenches were really high."	
WSTF Environmental Department summers 1987 and 1989; 1990-2010	• When the employee was hired at WSTF, the DSF was already being used to store hazardous wastes prior to shipment off-site for disposal. • The employee stated that by the time the employee was hired full-time (in 1990), nothing hazardous was being disposed of in the 700 Area landfill.	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments

	• The employee remembered seeing the following materials in the 700 Area landfill:
	  ○ Paper,
	  ○ Cafeteria wastes,
	  ○ Office supply items,
	  ○ Alkaline batteries,
	  ○ Empty paint cans (with less than 2.5 cm of paint remaining).
	• There are two trenches at the landfill that are along the long edge of the landfill and all the others are perpendicular and located within.
	• The employee stated that there had been many fires at the 700 Area landfill. The employee recalled seeing smoke when he was first hired, and many burned items within the trenches. The employee was unsure of the cause of the fires, but believed WSTF personnel were burning sensitive documents.
	• Earlier trenches were covered by the fill (rock/soil) from digging later trenches.
	• There was a dead animal pit located near the gate, immediately to the right, approximately 50 yards to the northeast.
	• Approximate dimensions of the dead animal pit were 20 ft long by 14 ft wide by 5 or 6 ft deep (by 1990).
	• The same dead animal pit had been used, at least from when the employee was hired until landfill closure.
	• During the closure process for the 700 Area landfill, a backhoe had been used to dig through the landfill to locate trenches.
	• The employee reported that many of the trenches located contained char (burned material).
	• The reason for landfill closure was new and more stringent regulation requirements. The landfill was closed in the late 1990s.
	• Refuse had been compacted at the 700 Area landfill by using a caterpillar to "take the mound of rocks/soil at the end of the trench and cover the area up, then driving the caterpillar over the area many times to compact it. Dump trucks on either end of the trench assisted."
	• The employee stated that on many occasions, "they had trouble compacting the landfill."
	• The employee stated that when banned items were discovered in the landfill, the items were removed and disposed of properly. Paint was shipped off-site for disposal due to lead and solvents within the paint.	

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• Copper wire, conduit, electrical equipment were recycled. • The employee stated that there was only one waste disposal transport truck at WSTF, and the driver was trained to recognize unpermitted items. "When the driver saw something that he knew should not be in the trash/landfill, he would tell me, and also the person who threw the thing away (if he knew). If not, then he would tell the supervisor for the building/area that the trash had been picked up from." • There were ramps located on either end of active trenches as part of the way the trenches were excavated; however, the ramps were not for driving into the trench for waste disposal. Wastes were "dumped from the sides, usually on the south side." • "A Cell Allis Chalmers cat [caterpillar] blade was used to dig out across and push dirt out on either end." • The WSTF Quality Assurance department conducted landfill inspections "early on". Then the WSTF Environmental Department "took over." • The employee was asked to explain why NASA referred to the 700 Area landfill as "modified" in the 1978 landfill registration form to the New Mexico Environmental Improvement Division. The employee was unsure but stated that the likely explanation was that the word 'modified' was referring to the difference in the wastes the 700 Area landfill disposed of than most landfills. (The WSTF 700 Area landfill never accepted commercial or residential wastes, but accepted only wastes generated at WSTF.)	

WSTF 400 Area 1985-1992; Environmental Manager 1992-2001	• The employee guessed that prior to shipping wastes off-site for disposal (beginning in 1985), any solid wastes, including types of materials shipped off-site currently, were disposed of in the 700 Area landfill.
	• The employee only remembered "the usual office wastes" being disposed of at the landfill, including:
	    o "The usual office wastes",
	    o Cardboard,
	    o Cafeteria wastes.
	• The employee clarified information regarding exploding small propulsion engines in the 700 Area landfill trenches.
	    o One of the descriptions of engine type were discussing disposal of Orbital Maneuvering System engines for the space shuttle program. "It was a matter of proprietary engine designs and the engine designer did not want any other engine designer to see their design.
		• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	○ BATES engines were associated with the Ballistic Missile Defense Organization. ○ When discussing engines, a 50-lb engine refers to the amount of thrust the engine can produce. ○ The liquid propellant engines would have been purged of fuel and oxidizer prior to being exploded in the landfill, "so very little to no contamination would be expected." ○ The solid propellant motors would likely have contained hydrochloric acid and aluminum oxide or aluminum and ammonium perchlorate. If the latter could possibly result in perchlorate contamination.	
WSTF Facilities 1985-1995; 2000-present (2014)	• The employee remembers seeing: ○ Trash, ○ Papers, ○ Tree/weed trimmings, ○ Paint cans (both water and oil-based), ○ 55-gal drums, ○ Respirators, ○ Protective suits, ○ Metal flashing, ○ Alkaline batteries, ○ Fluorescent light bulbs, ○ Construction wastes. • No vehicle batteries would be present because the cores were exchanged for working batteries. • The employee assisted with constructing the closure cap at the 700 Area landfill. "It was fabric on top of a clay layer."	• No additional information or comments
WSTF Facilities 1978-present (2014)	• Sludge had been removed once from the 100 Area wastewater lagoon (both cells) in 1979-1980. The sludge was placed in a pile along the WSTF well road (the BLM or Off-Site Soil Pile). • No sludge was ever removed from the 200 or 600 Area wastewater lagoons. Sludge was placed on plastic sheeting and "wind-rolled" to let it dry. Facilities personnel would turn the sludge occasionally until it was dry. • Only very small amounts of liquids were disposed of in the 700 Area landfill. • Prior to 1985, except for vehicle batteries, no wastes were shipped off-site for	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	disposal. • The dead animal pit was a separate, smaller trench located right next to the fence on the southeast side of the landfill. There was only one pit in the life of the landfill. Dimensions of the dead animal pit were approximately 10 ft deep by 20 ft long by 8-10 ft wide. • The employee recalled seeing the following items in the 700 Area landfill: ○ Tires, ○ 55-gal drums, ○ PPE. • The employee remembered seeing WSTF Fire Department personnel burning sensitive documents in the active trenches of the landfill. This may have been in the early 1980s.	
28 years in WSTF Facilities	• Sludge taken from a wastewater (sewage) lagoon were allowed to air dry prior to disposal. • The employee stated that all sludge was taken to a disposal facility in Utah (in the mid-1980s), including sludge from the 300, 400, and 600 Area HWMUs, was allowed to dry on plastic, then shipped off site for disposal. • The employee remembered the landfill receiving: ○ Metals (machine shop tubings, carbon steel, stainless steel), ○ Automotive materials (oil filters, air filters, used rags, tires), ○ Boxes (cardboard), ○ Paint cans, ○ Lights, maybe ballasts.	• No additional information or comments
32 Years in WSTF 200 Area	• The employee stated, “The old dump…was used for general trash and disposal.” • “The old dump. Everything went into it.”	• No additional information or comments
WSTF 200 Area Calibration Laboratory and later Office Chief 1969-1990	• The employee stated that most things were thrown away. “Very few things were taken to Holloman [Air Force Base].” • The employee recalled discarding (for disposal in the landfill): ○ Meters, parts to volt meters (meters contained aluminum, copper, tin, gold, silver, chrome decorations), ○ Rags, soft goods, gloves (contained lubricating oils, WD-40, petroleum), ○ Perhaps video tapes from high speed cameras, ○ Photo paper, ○ Burned paper,	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	○ Trans-circuit boards (the employee could not recall exact chemicals, but mentioned sodium persulfate, aluminum persulfate, and ferric oxide) ○ "Freons were dumped in arroyos" at the landfill. ○ "Old parts from the Cal. Lab. ended up in the landfill." ○ Plastic, meter cases, steel or aluminum cabinets, ○ Inductors, ○ Capacitors, ○ Resistors (iron, insulated wires paint), ○ Epoxies, ○ Batteries, ○ Loose floor and ceiling tiles (containing asbestos), ○ Mercury (manometer broke and mercury was cleaned up with a cloth that was discarded in the landfill). ○ Fragments left from 800 Area testing (metals, fabrics, plastics, burned material), ○ Rags containing grease, acetone, alcohol, Krytox lubricant (an oxygen compatible lubricant), and Teflon grease. • Later, (mid-1980s?), "if it was salvageable, it could go to Holloman, if workers took the time. Sometimes they just threw things away because it was easier." • The employee stated that the mindset of employees during the Apollo program was that if you had something to dispose of, you just went out and did it. There was no concern for the environment at that time. When items were recycled, it was only because they could provide money or there was no place to throw the item away. • "There was no environmental control until later in the Shuttle program." • Wastes were not shipped off-site prior to a full-time Environmental Department. • Personnel were always concerned with safety of the workers, avoiding physical harm to workers, not the environment.	
WSTF Propulsion Areas (300/400) 1963/1964-1986 (consultant to present)	• The employee stated that items disposed of in the 700 Area landfill included: ○ Bottles of chemicals from the 200 labs (like phosphorus). • The employee had personally exploded many engines within the trenches of the landfill over time. For the 1960s (Apollo program), early 1970s (Shuttle program), and then in 1985 (solid propellant engines). For several liquid propellant engines, the designs were proprietary, and the designers/contractors did not want the engines returned after testing. Therefore, the employee used C4 explosives to destroy the	• No additional information or comments

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	engines at the landfill. • A bulldozer was present at the landfill all the time. When the employee needed to destroy an engine, the employee would supervise the excavation of a new trench, then conduct the explosions, and then cover the area again. • The employee stated that the engines would have contained a small residual amounts of fuels and oxidizer. • Solid propellant engines with "trident propellant" and "BATES" (Ballistic Test and Evaluation System) motors for the Army and Navy were tested at WSTF. These engines "had a habit of blowing up." • To ensure the engines were safe for testing, engines were routinely x-rayed upon arrival at WSTF. If there were any voids or abnormalities evident in the x-rays, then the employee would destroy these engines with C4 in the landfill trenches. • Approximately 50 engines would arrive at WSTF at a time, and the employee remembered one time when 5 of the 50 needed destroying. The same procedures applied to destroying the solid propellant engines as destroying the liquid propellant engines; however, the solid propellant/oxidizer was fully loaded in these engines, not small residuals. • The employee did not specify the propellant/oxidizer used in the BATES motors.	
WSTF Engineer 1974-2003	• No wastes were shipped off-site prior to 1985. • Chemicals and liquids were generally disposed of in the surface impoundments (300, 400, and 600 HWMUs), not the 700 Area landfill. • Vehicle batteries were always recycled through HAFB. • Materials the employee remembers being disposed of in the landfill included: ○ Photographic solid wastes, ○ Paints, epoxies, aerosol cans, ○ Anything that was thrown away, ○ Oils and contaminated soils (loose, not in drums), ○ Small amounts of liquids left in cans, drums, ○ Broken equipment, furniture. • The WSTF warehouse had a recycling program for electric motors, computer parts • "In the early days, no one paid attention to what went into the landfill."	• No additional information or comments
Various positions 1976-1990	• There were no written records, only verbal procedures for the 700 Area landfill early on. The employee stated that paper records were developed in the early 1990s.	• No additional information or comments

Appendix A
WSTF 700 Area Landfill (SWMU 49) Summary of Findings from Employee Interviews or Questionnaires

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	• Only vehicle batteries were shipped off-site prior to the mid-1980s. • "In 1987, we were just starting to establish written records." • The employee stated that "things were taken to the landfill that should not have been, but there were no environmental policies at that time." • Environmental protection was not the mentality of the employees at WSTF. • Hazardous wastes were disposed of at the landfill and in dumpsters prior to the Environmental Department. It was not considered a safety hazard back then. • May have had some hazardous wastes disposed of improperly up to perhaps 1989. • "Garbage was just thrown away." • "There were educational battles," trying to change employee attitudes and habits.	

200 Area 1966-1992	• The employee did not have much information regarding the 700 Area landfill.
	• Waste disposed of in the landfill included:
	    o Trash, garbage,
	    o 800 Area test remnants (some were retained for the client or in the 800 Area for "future inspection.")
	• There was no effort at WSTF to develop any knowledge of solid waste streams to the landfill.
	• Liquid wastes were not disposed of in the landfill as a usual process. There were other areas at WSTF for liquid disposal/storage.
		• No additional information or comments

WSTF Facilities Department 1965-at least 1993	• The employee stated that the 700 Area landfill opened in October 1965. • "The waste was being transferred to the first cell on the SW end when I started delivering site waste." • Hazardous waste was likely disposed of in the landfill. The employee stated "…at the time, we were not aware of hazardous waste and now almost everything is hazardous." • Small quantities of liquids were added to the landfill, "A little bit of everything, but not a lot of anything."	• Interviewed in 1993 as part of the landfill site assessment
WSTF Environmental Department 1985-2005	• Prior to establishment of a full-time Environmental Department at WSTF, no chemicals/hazardous wastes were shipped off site. • "There seemed to be no historical procedure to deal with occasional extra, leftover, or off-specification liquids/chemicals." • There were at least three waste shipments to ENSCO in 1985. "the waste shipments were PCB's and haz[ardous] waste to the best of my recall."	• Interviewed in 1993 as part of the landfill site assessment; also interviewed in May 2014 as part of the investigation for this HIS

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments

	• The employee recalled long-term 200 Area clean room employee statements:
	  ○ Prior to 1985, items contaminated with hydrazine, oxidizer, all 200 Area laboratory chemicals (such as Freons [Freon 11 and Freon 113], TCE, PCE, alcohol, acetone, MEK, etc.) were disposed of in the landfill.
	  ○ Small quantities of gold and other metals from aerospace parts.
	  ○ Fluorescent light ballasts (containing PCBs).
	  ○ Contaminated items included:
	    ▪ Software (gloves, cloths, PPE),
	    ▪ Hardware (tubing, piping, plastic).
	• The employee assisted in destroying the off-specification solid propellant engines in the 700 Area landfill trenches in the mid-1980s.
	• Five lbs of C4 were used per explosion.
	• The engines were small enough to be carried by a person.
	• When interviewed in 1993:
	  ○ The landfill opened in the mid-1960s "subsequent to the commencement of site operations."
	  ○ "Previous discussions with long time site employees indicate that the following wastes were probably placed in the landfill"
	    ▪ Paints (oil and water based),
	    ▪ Adhesives,
	    ▪ Fillers,
	    ▪ Batteries (mercury, NiCad, lead acid),
	    ▪ Glassware and soft goods contaminated with fuel (primarily MMH and solvents."
	  ○ Liquids ("paints, solvents, electrolytes from batteries") were disposed of in the landfill "in tens to hundreds of gal annually"	

Facilities Department (overseeing landfill operations) 1978-1994	• "Anything thrown away would have ended up in the landfill." • Wastes were not shipped prior to having an Environmental Department (except for vehicle batteries). • Personnel attempted to ensure no hazardous wastes were added to the landfill. • The employee did not remember the details of what was disposed of in the landfill (recalled construction wastes and spill dry). • The employee recalled the WSTF recycling and waste reduction programs more clearly:	• Interviewed in 1993 as part of the landfill site assessment; also interviewed in August 2014 as part of the investigation for this HIS

Position/ Location	Significant White Sands Test Facility (WSTF) Wastewater Lagoon Information	Other Information or Comments
	○ wood was placed in a pile in the 100 Area for fire-fighting practice, ○ electrical equipment was shipped for recycling to Holloman (HAFB), ○ Vehicle batteries were shipped to HAFB for core trade-in, ○ Metal was accumulated in the 150 Yard and sold as scrap, ○ Most drums were also shipped to HAFB for recycling. • When interviewed in 1993: ○ The landfill opened in 1964 or 1965 ○ "In the early years there was no hazardous waste distinction; therefore, most probably we did [dispose of hazardous wastes in the landfill]". ○ Liquids were disposed of at the landfill "some, before I got here (1978)." ○ Liquids included: "off-specification paints from paint locker clean outs" and were "small quantities."	
WSTF Fire Department 1963-1996	• When interviewed in 1993: ○ The landfill opened in late 1964. ○ "Prior to the hazardous waste laws, the landfilled materials would surely have exhibited current hazardous waste characteristics." ○ Liquids were disposed of in the landfill: "Off-specification paints and epoxies. Residues from cleaning operations and drums that were landfilled."	• Interviewed in 1993 as part of the landfill site assessment; also interviewed in May 2014 as part of this HIS
WSTF Propulsion 1965-1971	• Large quantities of Freon (Freon 11 and Freon 113) were used • "Also Trich [TCE] was primarily used. Most evaporated." • "Landfilled most of waste" • "The landfill site north of the usage areas was used to dispose of drums of Freon waste." (700 Area landfill)	• Interviewed in 1990
WSTF 300 Area 1965-1968; "All Areas" 1975-1990	• There was "no limit on the type of stuff that went into the landfill."	• Interviewed in 1990

Appendix B
Well Information

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

Location ID: **700-A-253** | Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 NW 1/4 SE 1/4 Sec 26, T20S, R3E**
NM State Plane Coordinates (NAD 83): **170655.79N 467020.93E**
Elevation (Brass Cap): **1496.62 m AMSL**
Elevation (Top of Casing): **1497.35 m**
Drilling Contractor: **Larjon Drilling Company**
Driller: **T. Crawford**
Total Depth of Borehole (bgs): **287' (87.5 m)**
Borehole Diameter: **9 7/8" (reamed 16") 0-60'; 9 7/8" 60-155'; 9" 155-287'**
Depth to Bedrock (bgs): **149' (45.4 m); Andesite**
Depth to Groundwater: **183.71' (56 m) TOC (11/9/89)**
Total Depth Surface Casing (bgs): **60' (18.3 m)**
Diameter and Type Surface Casing: **Nominal 10" Steel**

Date(s) Well Installed: **11/6/89 - 11/8/89**
Date(s) Well Developed: **11/9-13/89 (bailing); 11/17-27/89 (pumping)**
Field Representative(s): **G. Contaldo**
Total Depth Well Casing (bgs): **268.7' (80.9 m)**
Type of Casing: **PVC and Stainless Steel**
Diameter Well Casing: **Nominal 4" (~4 1/2" OD; ~3 3/4" ID)**
Casing Schedule: **40 PVC to 161.8'; 5 Stainless Steel to 268.7'**
Screened Zone (bgs): **253.0' - 263.4' (77.1 - 80.3 m)**
Comments: **bgs = below ground surface**
TOC = Top of Casing
AMSL = Above Mean Sea Level

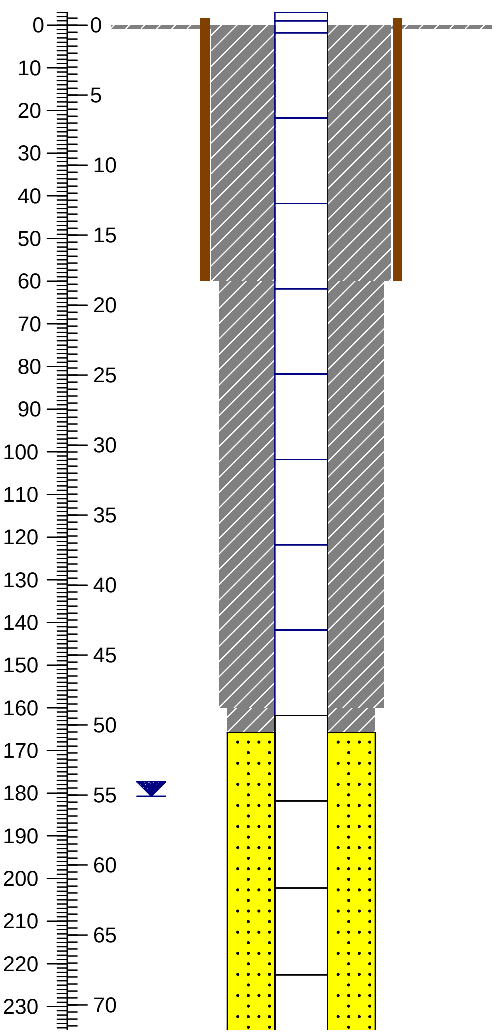
Casing Explanation:

- Surface Casing **Nominal 10" Steel**
- Conventional Casing **Nominal 4" PVC**
- Conventional Casing **Nominal 4" Stainless Steel**
- Conventional Screen **Nominal 4" Stainless Steel 0.020"-Slot (Regular Strength)**
- Conventional End Cap **Nominal 4" Stainless Steel**
- **Welded Stainless Steel Centralizers**
- Water Table

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 10/20 Sand/ Bentonite Mix
- Slough
- 8/20-16/40 Sand Mix
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Conventional Well Stick-Up = 2.4' (0.73 m); 3' (0.9 m) at installation. 2.0' stainless steel riser and locking cap top casing.

Surface Casing Stick-Up = ~1.7' (0.5 m)

Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface

Nominal 10" Steel Surface Casing Depth = 60' (18.3 m)

All Casing Above 161.8' (49.3 m) = Schedule 40 PVC

All Casing and Screen Below 161.8' (49.3 m) = Schedule 5 Stainless Steel

Water Table = 183.71' TOC (56 m); measured 11/9/89 during annular materials installation.

Annular/Borehole Descriptions
All depths listed are bgs

Top of Neat Cement (with 5% bentonite) = 0'

Santa Fe Group Alluvium from surface to 149' (45.4 m)

16" Borehole TD = 60' (18.3 m). Pilot hole: 12 1/4" (per Driller) or 9 7/8" (per Geologist).

Andesite (Orejon) Bedrock Depth = 149' (45.4 m)

9 7/8" Borehole TD = 155' (47.24 m) per Driller; 160' (48.8 m) per Geologist.

Top of 8/20 & 16/40 Silica Sand (~1:1 ratio) = 166' (50.6 m)

Micritic Limestone and Calcareous Siltstone (Panther Seep Formation) Bedrock Depth = 206' (62.8 m)

Top of Upper Bentonite Seal = 239.8' (73.1 m)

Top of Upper 16/40 Silica Sand = 243.2' (74.1 m)

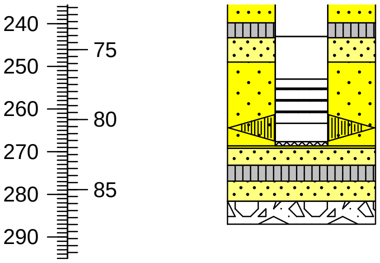
Top of 8/20 Silica Sand = 249' (75.9 m)

Surface Casing **Nominal 10" Steel**		**Casing Explanation:**
Conventional Casing **Nominal 4" PVC**	Conventional End Cap **Nominal 4" Stainless Steel**	
Conventional Casing **Nominal 4" Stainless Steel**	**Welded Stainless Steel Centralizers**	
Conventional Screen **Nominal 4" Stainless Steel 0.020"-Slot (Regular Strength)**	Water Table	

Annular Materials Explanation:

Cement	8/20-16/40 Sand Mix	
Bentonite (Grout Well DF)	4/8 Sand	10/20 Sand
Bentonite Seal	6/9 Sand	16/40 Sand
Slough	8/12 Sand	20/40 Sand
1/8 Gravel	8/20 Sand	30/70 Sand

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs
Top of Screen (Regular Strength) = 253.0' (77.1 m) Bottom Screen (Regular Strength) = 263.4' (80.3 m) Four steel plates (centralizers) welded to casing at ~264' (80.5 m) Sump consists of 5' blank riser and end cap Nominal 4" Schedule 5 Stainless Steel Casing TD = 268.7' (81.9 m)	Top of Lower 16/40 Silica Sand = 269.2' (82.1m) Top of Lower Bentonite Seal = 273.2' (83.3 m) Top of 16/40 Silica Sand = 276.9' (84.4 m) Top of Slough = 281.5' (85.8 m; Sounded 11/6/89) 9" Borehole TD = 287' (87.5 m)

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

Location ID: **700-B-510** | Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NW 1/4 NW 1/4 SW 1/4 Sec 26, T20S, R3E**
NM State Plane Coordinates (NAD 83): **170874.82N 465851.50E**
Elevation (Brass Cap): **1465.39 m AMSL**
Elevation (Top of Casing): **1466.00 m AMSL**
Drilling Contractor: **Larjon Drilling Company**
Driller: **J. Gower**
Total Depth of Borehole (bgs): **550' (167.6 m)**
Borehole Diameter: **7 7/8" (reamed 16") (0-80'); 9 7/8" (80-226'); 9" (226-550')**
Depth to Bedrock (bgs): **285' (86.9 m); Andesite**
Depth to Groundwater: **468.65' (142.84 m) TOC (7/23/90)**
Total Depth Surface Casing (bgs): **80' (24.4 m)**
Diameter and Type Surface Casing: **Nominal 10" Steel**

Date(s) Well Installed: **7/23/90 - 7/25/90**
Date(s) Well Developed: **7/25/90-7/26/90 (bailing); 7/27/90-8/13/90 (pumping)**
Field Representative(s): **M. Canavan, J. Rogers, G. Contaldo**
Total Depth Well Casing (bgs): **536.3' (163.5 m)**
Type of Casing: **Stainless Steel**
Diameter Well Casing: **Nominal 4"**
Casing Schedule: **SCD 5 0-399.3'; SCD 10 399.3-536.3'**
Screened Zone (bgs): **510.0' - 530.8' (155.4 - 161.8 m)**
Comments: **AMSL = Above Mean Sea Level bgs = below ground surface**
TOC = Top of Casing

Casing Explanation:

Surface Casing
Nominal 10" Steel

Conventional Casing
Nominal 4"
Stainless Steel

Conventional Screen
Nominal 4"
Stainless Steel 0.020"-Slot

Conventional End Cap
Nominal 4"
Stainless Steel

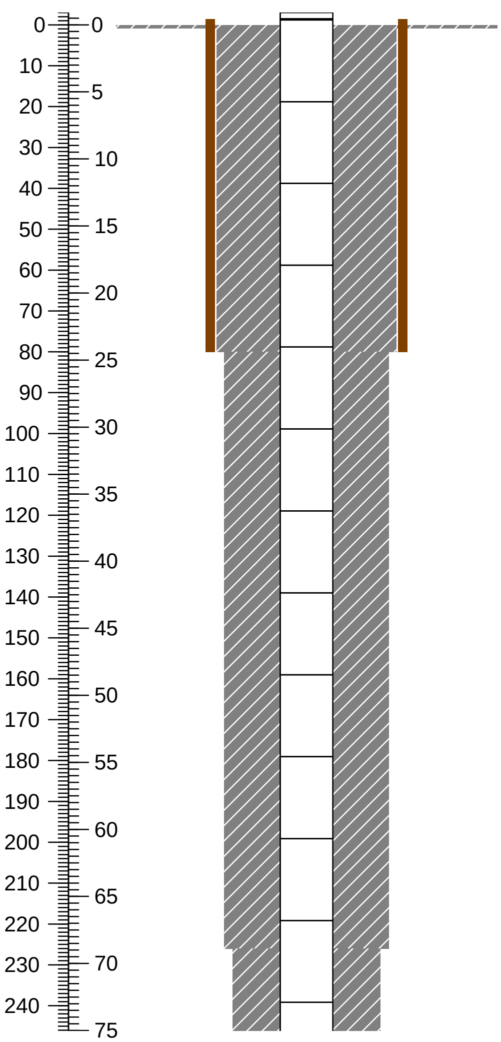
Welded Steel Centralizers

Water Table

Annular Materials Explanation:

Cement
Bentonite (Grout Well DF)
Bentonite Seal
10/20 Sand/ Bentonite Mix
Slough
8/20-16/40 Sand Mix
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand
10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	Annular/Borehole Descriptions All depths listed are bgs
Conventional Well Stick-Up = 2.0' (0.61 m) (3.2' (1.0 m) measured at installation) Stick-up consists of a 1.73' riser and 0.27' adapter plus 1.2' well casing stick-up. Surface Casing Stick-Up = ~1.4' (0.4 m) Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface. Well casing is schedule 5 stainless steel 0-399.3' (0-121.7 m). Water not detected during drilling; however, after drilling to 550' (total depth), water was present the next day.	Top of Neat Cement (with 5% bentonite) = 0' The formation is Santa Fe Group Alluvium from surface to 255' (77.7 m). 16" Borehole TD = 80' (24.4 m) (originally drilled 7 7/8" with tricone bit) 9 7/8" Borehole TD = 226' (68.9 m)

Surface Casing
Nominal 10" Steel

Conventional Casing
Nominal 4"
Stainless Steel

Conventional Screen
Nominal 4"
Stainless Steel 0.020"-Slot

Casing Explanation:

Conventional End Cap
Nominal 4"
Stainless Steel

Welded Steel Centralizers

Water Table

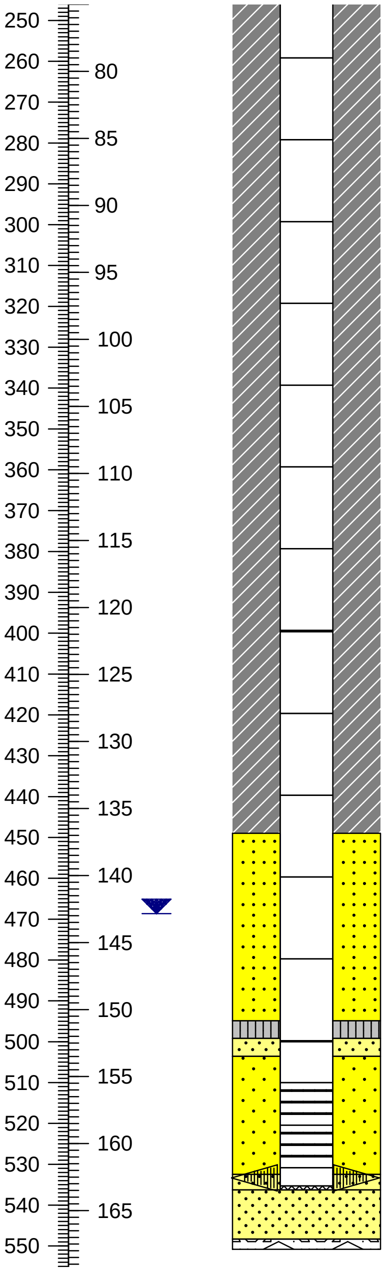
Cement
Bentonite (Grout Well DF)
Bentonite Seal
10/20 Sand/ Bentonite Mix
Slough

8/20-16/40 Sand Mix
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand

Annular Materials Explanation:

10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Well casing is schedule 10 stainless steel 399.3-536.3' (121.7-163.5 m)

Water Table = 468.65.92' (142.84 m) (measured 7/23/90 before well installation; TOC surface casing)

Adaptor at 499.7' (152.3 m)

Top of Screen (Extra Strength) = 510.0' (155.4 m)

Bottom of Screen (Extra Strength) = 530.8' (161.8 m)

Four steel plates (centralizers) welded to casing at ~533.3' (~162.5 m)

Sump consists of 5.0' blank riser and stainless steel end cap.

Nominal 4" Schedule 10 Stainless Steel Casing TD = 536.3' (163.5 m)

Annular/Borehole Descriptions
All depths listed are bgs

Volcanic Alluvium Depth = 255' (77.7 m)

Volcanic Andesite (Orejon) Bedrock Depth = 285' (86.9 m)

Top of 8/20 & 16/40 Silica Sand = 450' (137.2 m)

Top of Bentonite Seal = 495' (150.9 m)

Top of Upper 16/40 Silica Sand = 499' (152.1 m)

Top of 8/20 Silica Sand = 504' (153.6 m)

Top of Lower 16/40 Silica Sand = 533' (162.5 m)

Top of Slough = 548' (167.0 m) before casing installation (7/23/90)

9" Borehole TD = 550' (167.6 m)

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

Location ID: **700-D-186** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NW 1/4 SW 1/4 NE 1/4 Sec 26, T20S, R3E**
NM State Plane Coordinates (NAD 83): **170984.32N 466879.24E**
Elevation (Brass Cap): **1489.57 m AMSL**
Elevation (Top of Casing): **1490.20 m AMSL**
Drilling Contractor: **Larjon Drilling Company**
Driller: **T. Crawford**
Total Depth of Borehole (bgs): **205' (62.5 m)**
Borehole Diameter: **12 1/4" (reamed 16") 0-54'; 9 7/8" 54-194'; 9" 194-205'**
Depth to Bedrock (bgs): **180' (54.9 m); Limestone**
Depth to Groundwater: **175.' (53.55 m) TOC (11/20/89)**
Total Depth Surface Casing (bgs): **54' (16.5 m)**
Diameter and Type Surface Casing: **Nominal 10" Carbon Steel**

Date(s) Well Installed: **11/17/89 - 11/27/89**
Date(s) Well Developed: **11/28/89 - 12/21/89**
Field Representative(s):**R. Cooper**
Total Depth Well Casing (bgs): **201.6' (61.4 m)**
Type of Casing: **PVC and Stainless Steel**
Diameter Well Casing: **Nominal 4" (~4.5" OD; ~3.75" ID)**
Casing Schedule: **SCD 40 PVC 0-145.7'; SCD 5 Stainless Steel to 201.6'**
Screened Zone (bgs): **186.0' - 196.3' (56.7 - 59.8 m)**
Comments: **AMSL = Above Mean Sea level**
TOC = Top of Casing
SCD = Schedule
bgs = below ground surface

Casing Explanation:

Surface Casing
Nominal 10" Carbon Steel

Conventional Casing
Nominal 4" PVC

Conventional Casing
Nominal 4" Stainless Steel

Conventional Screen
Nominal 4" Stainless Steel
0.020"-Slot (Regular Strength)

Conventional End Cap
Nominal 4" Stainless Steel

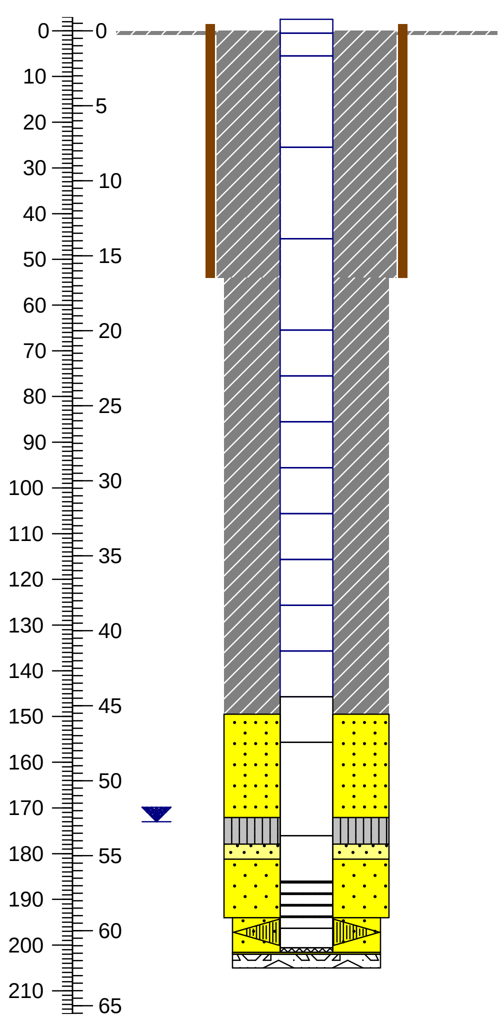
Welded Stainless Steel Centralizers

Water Table

Annular Materials Explanation:

Cement
Bentonite (Grout Well DF)
Bentonite Seal
10/20 Sand/ Bentonite Mix
Slough
8/20-16/40 Sand Mix
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand
10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs
Conventional Well Stick-Up = 2.1' (0.64 m) (2.5' (0.8 m) at installation) 3.0' (0.91 m) Stainless steel riser and locking cap tops casing. Surface Casing Stick-Up = ~1.5' (0.5 m) Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface.	Top of Neat Cement (with 5% bentonite) = 0' Santa Fe Group Alluvium from surface to 180' (54.9 m)
Nominal 10" Carbon Steel Surface Casing Depth = 54' (16.5 m)	16" Borehole TD = 54' (16.5 m) (12 1/4" pilot hole)
All casing 0.5-145.7' (44.4 m) bgs = SCD 40 PVC	
All casing and screen below145.7' (44.4 m) = SCD 5 Stainless Steel	Top of 8/20 & 16/40 Silica Sand = 150' (45.7 m) Top of Upper Bentonite Seal = 172' (52.4 m) Top of Upper 16/40 Silica Sand = 178' (54.3 m)
Water Table = 172.9' (52.7 m) bgs (11/16/89) in open borehole Top of Screen (Regular Strength) = 186.0' (56.7 m) Bottom of Screen (Regular Strength) = 196.3' (59.8 m)	Limestone (Hueco Formation) Bedrock Depth = 180' (54.9 m) Top of 8/20 Silica Sand = 181' (55.2 m) 9 7/8" Borehole TD = 194' (59.1 m)
Four steel plates (centralizers) welded to casing at ~197' (60.0 m) Sump consists of 5' blank riser and end cap.	Top of Slough = 202' (61.6 m) (11/18/89) before casing installation
Nominal 4" SCD 5 Stainless Steel Casing TD = 201.6' (61.4 m)	9" Borehole TD = 205' (62.5 m) (air hammer bit)

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

Location ID: **700-E-458** | Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NW 1/4 SE 1/4 SW 1/4 Sec 27, T20S, R3E**
NM State Plane Coordinates (NAD 83): **170316.63N 464666.64E**
Elevation (Brass Cap): **1438.73 m AMSL**
Elevation (Top of Casing): **1439.36 m AMSL**
Drilling Contractor: **Larjon Drilling Company**
Driller: **J. Gower, M. Clanton**
Total Depth of Borehole (bgs): **515' (157.0 m)**
Borehole Diameter: **12 1/4" 0-65'; reamed 16" to 69'; 9 7/8" 69-515'**
Depth to Bedrock (bgs): **285' (86.9 m); Andesite**
Depth to Groundwater: **354.9' (108.16 m) TOC (3/15/90)**
Total Depth Surface Casing (bgs): **69' (21.0 m)**
Diameter and Type Surface Casing: **Nominal 10" Steel**

Date(s) Well Installed: **3/2/90 - 3/6/90**
Date(s) Well Developed: **3/7/90-3/15/90 (bailing); see comments**
Field Representative(s): **R. Cooper**
Total Depth Well Casing (bgs): **484.2' (147.6 m)**
Type of Casing: **Stainless Steel**
Diameter Well Casing: **Nominal 4"**
Casing Schedule: **Sch 5 +2.7-392.9'; Sch 10 392.9-484.2'**
Screened Zone (bgs): **458.1'-478.9' (139.6 - 146.0 m)**
Comments: **bgs = below ground surface**
TOC = Top of Casing
AMSL = Above Mean Sea Level
Lockheed techs completed development (no records).

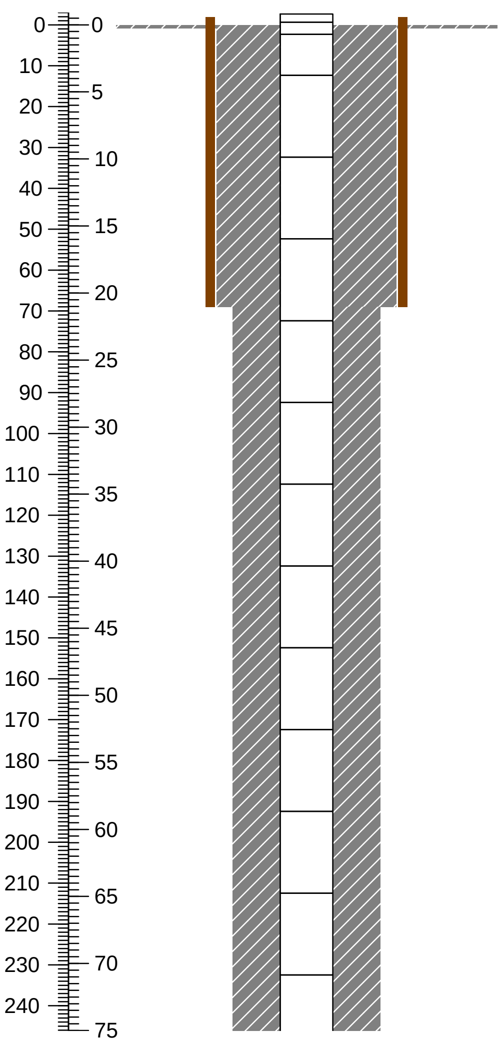
Casing Explanation:

- Surface Casing **Nominal 10" Steel**
- Conventional Casing **Nominal 4" Stainless Steel**
- Extra Strength Screen **Nominal 4" Stainless Steel 0.020" Slot**
- Conventional End Cap **Nominal 4" Stainless Steel**
- **Welded Steel Centralizers**
- Water Table

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 10/20 Sand/ Bentonite Mix
- Slough
- 8/20-16/40 Sand Mix
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Conventional Well Stick-Up = 2.1' (0.63 m) (2.7' (0.8 m) at installation)

Surface Casing Stick-Up = ~1.9' (0.6 m)

Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface.

Well casing is schedule 5 stainless steel 0-392.9' (0-119.8 m)

Annular/Borehole Descriptions
All depths listed are bgs

Top of Neat Cement (with 5% bentonite) = 0'

Santa Fe Group Alluvium from surface to 285' (86.9 m)

16" Borehole TD = 69' (21.0 m) (Originally Drilled 12 1/4" with Tricone Bit)

Surface Casing
Nominal 10" Steel

Conventional Casing
Nominal 4"
Stainless Steel

Conventional Screen
Nominal 4"
Stainless Steel 0.020" Slot

Casing Explanation:

Conventional End Cap
Nominal 4"
Stainless Steel

Welded Steel Centralizers

Water Table

Cement

Bentonite (Grout Well DF)

Bentonite Seal

10/20 Sand/ Bentonite Mix

Slough

8/20-16/40 Sand Mix

4/8 Sand

6/9 Sand

8/12 Sand

8/20 Sand

Annular Materials Explanation:

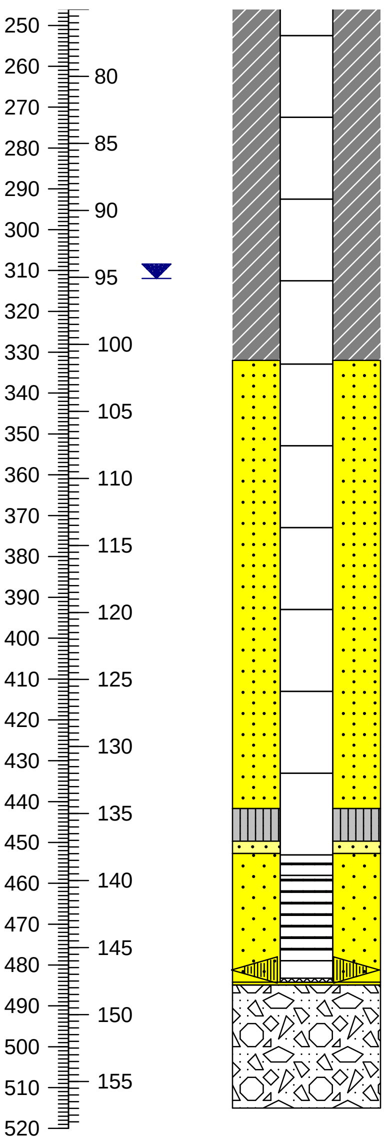
10/20 Sand

16/40 Sand

20/40 Sand

30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Water Table = 354.9' (108.16 m) (measured 3/15/90 during development; TOC)

Well casing is schedule 10 stainless steel (blanks) 392.9-458' (119.8-139.6 m)

Top of Screen (Extra Strength) = 458.0' (109.1 m)

Bottom of Screen (Extra Strength) = 478.9' (146.0 m)

Four steel plates (centralizers) welded to casing at ~481.2' (~146.7 m)

Sump consists of 5.0' blank riser and stainless steel end cap

Nominal 4" Schedule 10 Stainless Steel Casing TD = 484.2' (147.6 m)

Annular/Borehole Descriptions
All depths listed are bgs

Volcanic Andesite (Orejon) Bedrock Depth = 285' (86.9 m)

Top of 8/20 & 16/40 Silica Sand = 332' (101.2 m)

Top of Upper Bentonite Seal = 442' (134.7 m)

Top of Upper 16/40 Silica Sand = 450' (137.2 m)

Top of 8/20 Silica Sand = 453' (138.1 m)

Top of Slough = 484.9' (147.8 m)(Measured 3/2/90 before casing installation)

9 7/8" Borehole TD = 515' (157.0 m) (Drilled with Tricone Bit)

JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

WELL COMPLETION DIAGRAM

WESTBAY® MONITORING WELL

Location ID: **700-H** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 SE 1/4 NW 1/4 Sec. 26, T20S, R3E**
NM State Plane Coordinates (NAD 83 in meters): **170800.46N 466572.04E**
Elevation (Brass Cap): **1484.3 m AMSL**
Elevation (Top of Casing): **1484.58 m AMSL**
Drilling Contractor: **Stewart Brothers Drilling Company**
Driller: **J. Aguilar**
Total Depth of Borehole (bgs): **730' (222.5 m)**
Borehole Diameter: **7 5/8" 0-170'; 4 1/2" 170-730'**
Depth to Bedrock (bgs): **200' (61.0 m); Andesite**
Depth to Groundwater: **258.58' (78.81 m) TOSC (8/10/99; open borehole)**
Total Depth Surface Casing (bgs): **170' (51.8 m)**
Diameter and Type Surface Casing: **Nominal 5" Steel**
Date(s) Well Installed: **8/10/99 - 8/18/99**

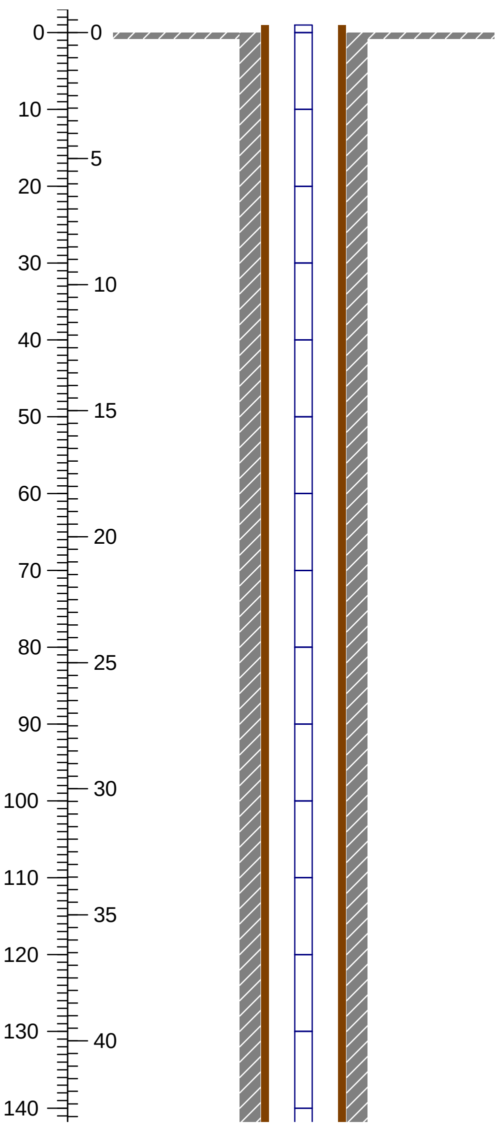
Date(s) Well Developed: **BH = 6/20/99, 7/12-15/99; WB = Not Recorded**
Field Representative(s): **M. Canavan, G. Giles, M. McClure, (see comments)**
Total Depth Well Casing (bgs): **695' (211.8 m)**
Type of Casing: **Westbay® MP 38 PVC**
Diameter Well Casing: **1.5" ID; 1.9" OD**
WB Sampling Zone(s)(bgs): **350' (107.56 m); 535' (163.88 m); and 670' (204.93 m)**
WB Packer Zone(s)(bgs): **345-360' (106.04-110.60 m); 525-545' (160.83-166.93 m); and 660-680' (201.88-207.97 m)**
Comments: **Depths (meters) for WB components and zones are a calculated value based on piezometric levels at MPs. AMSL = Above Mean Sea Level TOSC = Top of Surface Casing Field Reps, cont'd: J. Pearson, L. Hunnicutt-Mack, M. Rivera**

Casing Explanation:

Surface Casing **Nominal 5" Steel**
1.5" ID Westbay® MP38 Casing
1.5" ID Westbay® MP38 End Cap
Packer
Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)
Magnetic Collar
Water Table
Cement
Slough

Feet/Meters

Well Descriptions All depths listed are bgs (unless noted)	Annular/Borehole Descriptions All depths listed are bgs
Westbay® Well Stick-Up = 1.0' (0.298 m) Surface Casing Stick-Up = ~1.01' (0.3 m) Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface	



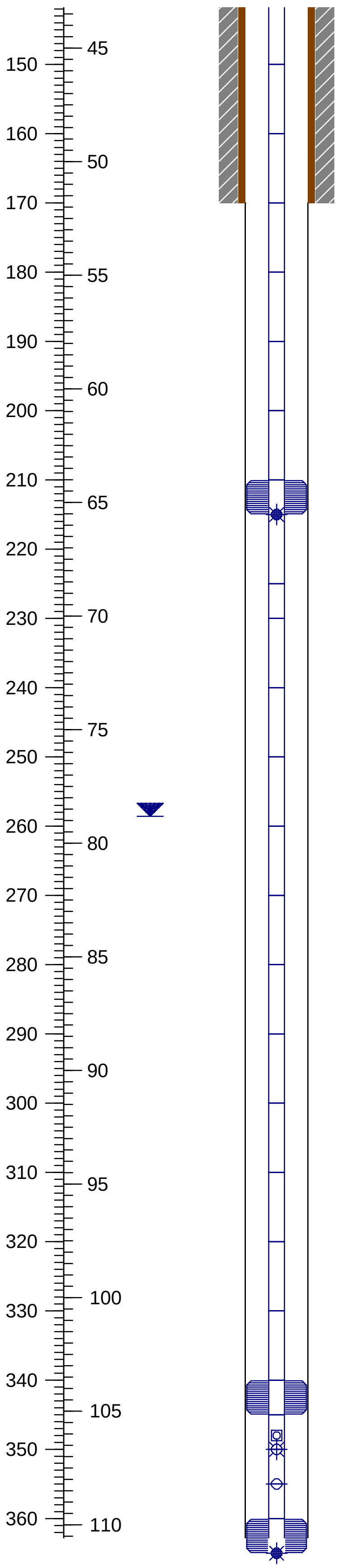
Surface Casing
Nominal 5" Steel

1.5" ID Westbay® MP38 Casing

Casing Explanation:
1.5" ID Westbay® MP38 End Cap
Packer

Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)
Magnetic Collar
Water Table
Cement
Slough

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	Annular/Borehole Descriptions All depths listed are bgs
Nominal 5" Steel Surface Casing Depth = 170' (51.8 m)	7 5/8" Borehole cemented to 170' (51.8 m)
	Andesite (Orejon Andesite) Bedrock Depth = 200' (61.0 m)
Packer Depth = 210'-215' (64.01-65.53 m)	
MP Depth (with Filter Sock) = 215' (65.53 m)	
Depth to Water = 258.58' (78.81 m)(Borehole; measured 8/10/99 (Top of Surface Casing) just before Westbay® well casing installation)	
Packer Depth = 340'-345' (104.51-106.04 m)	
Magnetic Collar Depth = 349' (107.26 m)(Exact Location Not Recorded)	
Sampling MP Depth = 350' (107.56 m)	
PP Depth = 355' (109.08 m)	
Packer Depth = 360'-365' (110.60-112.12 m)	

Surface Casing
Nominal 5" Steel

1.5" ID Westbay® MP38 Casing

Casing Explanation:

1.5" ID Westbay® MP38 End Cap

Packer

Measurement Port (MP)

MP with Filter Sock

Mechanical Pumping Port (PP)

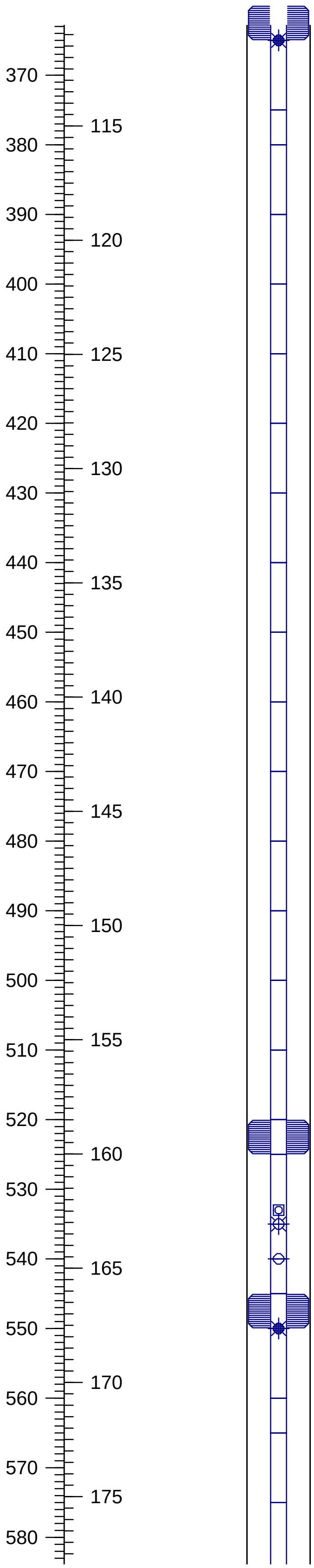
Magnetic Collar

Water Table

Cement

Slough

Feet/Meters	**Well Descriptions** All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs



MP Depth (with Filter Sock) = 365' (112.12 m)

Packer Depth = 520'-525' (159.31-160.83 m)

Magnetic Collar Depth = 534' (163.58 m)(Exact Location Not Recorded)

Sampling MP Depth = 535' (163.88 m)

PP Depth = 540' (165.40 m)

Packer Depth = 545'-550' (166.93-168.45 m)

MP Depth (with Filter Sock) = 550' (168.45 m)

Surface Casing
Nominal 5" Steel

1.5" ID Westbay® MP38 Casing

Casing Explanation:

1.5" ID Westbay® MP38 End Cap

Packer

Measurement Port (MP)

MP with Filter Sock

Mechanical Pumping Port (PP)

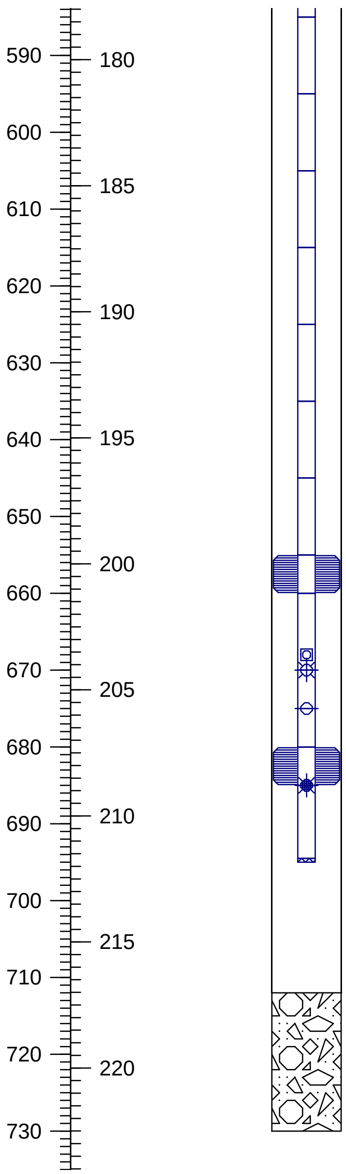
Magnetic Collar

Water Table

Cement

Slough

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs
Packer Depth = 655'-660' (200.36-201.88 m)	
Magnetic Collar Depth = 669' (204.63 m)(Exact Location Not Recorded)	
Sampling MP Depth = 670' (204.93 m)	
PP Depth = 675' (206.45 m)	
Packer Depth = 680'-685' (207.97-209.49 m)	
MP Depth (with Filter Sock) = 685' (209.49 m)	
Westbay® MP 38 Casing TD = 695' (211.8 m)	
	Top of Slough = 712' (217.0 m). Borehole sloughed. Total depth was measured 8/10/99 prior to Westbay® casing installation.
4 1/2" Borehole TD = 730' (222.5 m)	

NASA JSC - White Sands Test Facility
Las Cruces, New Mexico, USA

WELL COMPLETION DIAGRAM
CONVENTIONAL MONITORING

Location ID: **700-J-200** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **NE 1/4 NE 1/4 SE 1/4 Sec 26, T20S, R3E**	Date(s) Well Installed: **6/6/99 - 6/7/99**
NM State Plane Coordinates (NAD 83): **170653.39N 467353.49E**	Date(s) Well Developed: **8/3/99 - 8/10/99 (Bennett pump)**
Elevation (Brass Cap): **1508.74 m AMSL**	Field Representative(s): **M. Canavan, G. Giles, J. Pearson, (see comments)**
Elevation (Top of Casing): **1508.96 m AMSL**	Total Depth Well Casing (bgs): **230' (70.1 m)**
Drilling Contractor: **Stewart Brothers Drilling Company**	Type of Casing: **304 Stainless Steel**
Driller: **J. Aguilar**	Diameter Well Casing: **4" ID; 4 1/2" OD**
Total Depth of Borehole (bgs): **240' (73.2 m)**	Casing Schedule: **10**
Borehole Diameter: **11 3/4" Drive Casing 0-70'; 9 7/8" Hammer Bit 70-240'**	Screened Zone (bgs): **199.6' - 219.7' (60.8 - 67.0 m)**
Depth to Bedrock (bgs): **110' (33.5 m); Limestone**	Comments: **bgs = below ground surface AMSL = Above Mean Sea Level**
Depth to Groundwater: **121.65' (37.08 m) TOC (2/25/00)**	**TOC = Top of Casing**
Total Depth Surface Casing (bgs): **70' (removed)**	**This well is upgradient of the 700 Area Landfill**
Diameter and Type Surface Casing: **11 3/4" Temporary Drive Casing**	**Field Reps, cont'd: M. McClure, L. Hunnicutt-Mack, M. Rivera**

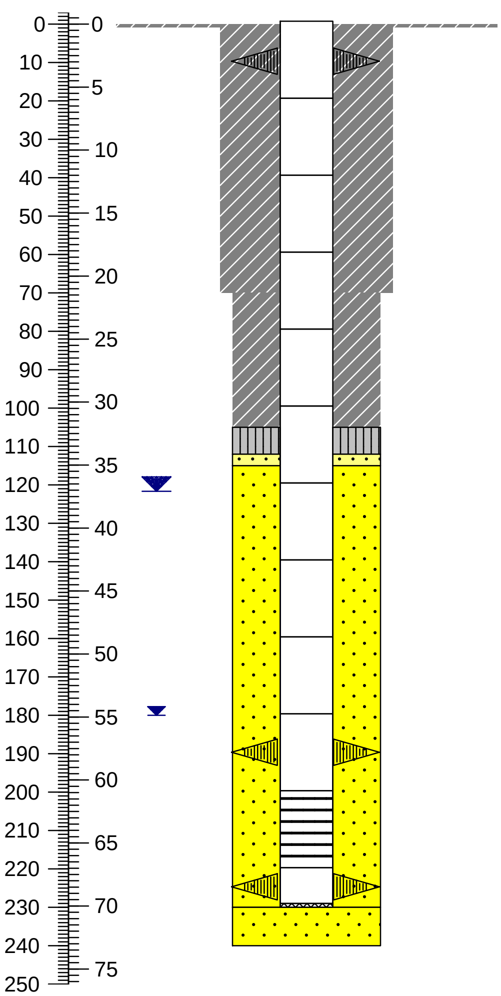
Casing Explanation:

- Surface Casing **11 3/4" Temporary Drive Casing**
- Conventional Casing **4" ID; 4 1/2" OD 304 Stainless Steel**
- Conventional Screen **4" ID; 4 1/2" OD 304 Stainless Steel 0.020"-Slot**
- Conventional End Cap **4" ID; 4 1/2" OD 304 Stainless Steel**
- **Welded Steel Centralizers**
- Water Table

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 10/20 Sand/ Bentonite Mix
- Slough
- 8/20-16/40 Sand Mix
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions All depths listed are bgs (unless noted)	**Annular/Borehole Descriptions** All depths listed are bgs
Conventional Well Stick-Up = 0.70' (0.21 m) (0.8' (0.2 m) at installation)	Top of Cement = 0'
Well completed with ~4' x ~4' cement pad, barrier posts, and locking steel well cap surrounding the casing at ground surface	
NOTE: Number and locations of centralizers were not recorded at installation. Locations and depths were taken from camera log.	The formation is Santa Fe Group Alluvium from surface to 110' (33.5 m)
Three steel plates (centralizers) welded to casing at ~9.7' (~3.0 m)	11 3/4" Borehole TD = 70' (21.3 m) (Drilled with Drive Casing)
	Top of Upper Bentonite Seal = 105' (32.0 m)
	Limestone Bedrock Depth = 110' (33.5 m)
Water Table = 121.65' (37.08 m) (measured 2/25/00 post-development)	Top of Upper 16/40 Silica Sand = 112' (34.1 m)
	Top of 8/20 Silica Sand = 115' (35.1 m)
First Occurrence of Groundwater During Drilling = 180' (54.9 m)	
Three steel plates (centralizers) welded to casing at ~189.6' (~57.8 m)	
Top of Screen (Regular Strength) = 199.6' (60.8 m)	
Bottom of Screen (Regular Strength) = 219.7' (67.0 m)	
Three steel plates (centralizers) welded to casing at ~224.7' (~68.5 m)	
Sump consists of 10.0' blank riser and stainless steel end cap	
4.5" OD (4" ID) Schedule 10 Stainless Steel Casing TD = 230' (70.1 m)	9 7/8" Borehole TD = 240' (73.2 m) (Drilled with Hammer Bit)

QA 17 APR 0 3 1996

WSTF / SKETCH

TITLE: Methane Well Design

CONTRACTOR AUTH. SIGNATURES: [illegible] 3/28/96; [illegible] 4-1-96; [illegible] 04/03/96

NASA AUTH. SIGNATURES: [illegible] 4/3/96

TPS NO. 6-GHWM-960243

PAGE 5 OF 5

MOD. NO. DATE: 3-28-96

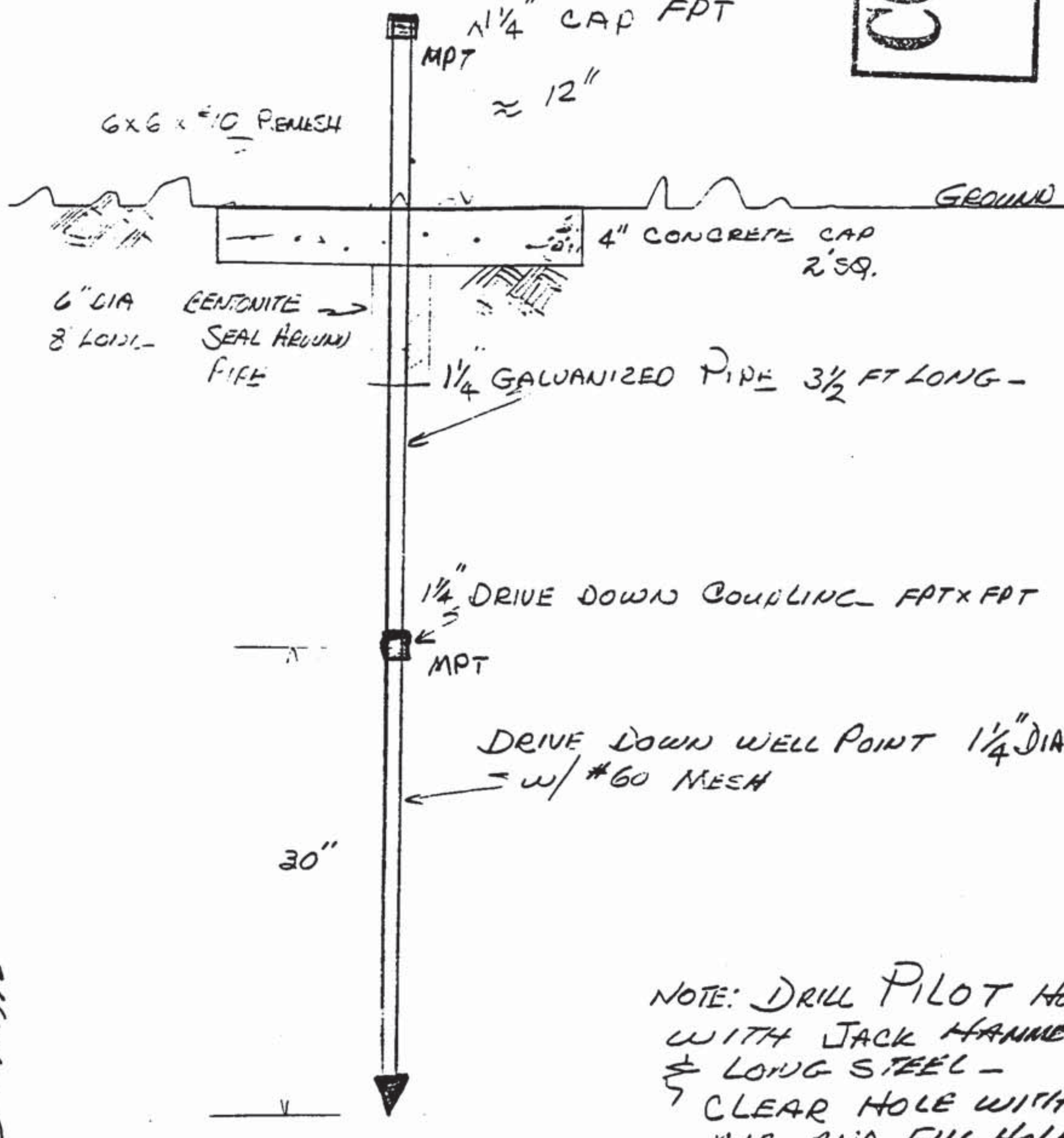
SKETCH NO. 2

SK -

BY: G. Hackler

DATE: 3-28-96

METHANE MONITERING WELL (TYP) 10EA



NOTE: DRILL PILOT HOLE WITH JACK HAMMER & LONG STEEL - CLEAR HOLE WITH AIR AND FILL HOLE w/ SAND

SK–

Appendix C
SDS

MATERIAL SAFETY DATA SHEET **CODE: M/L 1138**

This Material Safety Data Sheet complies with the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200

PRODUCT: LENOX GENERAL PURPOSE SOFT SOLDERING LIQUID FLUX (Inorganic Acid Soldering Flux)

NFPA/HMIS HAZARD CODES: HEALTH: 3 FIRE: 0 REACTIVITY: 0 SPECIAL: N/A

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0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

SECTION I IDENTIFICATION

SUPPLIER NAME: LENOX
1690 Lowery Street
Winston-Salem, NC 27101

ISSUE DATE: May, 2007

INFORMATION PHONE: 336-777-8600

SECTION II COMPOSITION INFORMATION

INGREDIENT	CAS NO.	US OSHA PEL	%
Ammonium Chloride	12125-02-9	NA	4-15
Hydrochloric Acid	7647-01-0	5.0 PPM	3-15
Zinc Chloride	7646-85-7	1PPM	30-45

PEL = PERMISSABLE EXPOSURE LIMIT
Unlisted percentages are non-hazardous stabilizers, activators, and water.
None of the materials in this product are listed in NTP, IARC, or OSHA as carcinogens.

SECTION III HEALTH HAZARDS

EYES: Flush with water for 10 minutes. Obtain immediate medical attention.
SKIN: Wash thoroughly with water. If irritation develops, obtain medical attention.
ACUTE INHALATION: Remove to fresh air. Obtain immediate medical attention.
INGESTION: If patient is fully conscious, give two glasses of water and induce vomiting. Obtain immediate medical attention.
PRIMARY ROUTES OF ENTRY: Fume inhalation, ingestion, skin and eyes.
SYMPTOMS OF OVEREXPOSURE: Pulmonary edema, abdominal pain, vomiting, eye damage and skin burn.
MEDICAL CONDITIONS GENERALLY AGGRAVATED BY OVEREXPOSURE: None presently known.
CHEMICAL LISTED AS A CARCINOGEN OR POTENTIAL CARCINOGEN: None
OSHA Permissible Exposure Limit (PEL): 1 PPM
ACGIH Threshold Limit Value (TLV): 1 PPM

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: N/A
FLAMMABLE LIMITS: N/A
EXTINGUISHING MEDIA: Dry chemical, CO2 foam
AUTO IGNITION TEMPERATURE: None
SPECIAL FIRE FIGHTING PROCEDURES: Normal cautious when dealing with chemicals.
UNUSUAL FIRE & EXPLOSION HAZARDS: Will release small amounts of HC1 upon decomposition.

SECTION V ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IN CASE MATERIAL IS SPILLED: First neutralize with Soda Ash or Sodium Bicarbonate; dilute with water and dispose of in accordance with EPA Regulations.

SECTION VI HANDLING AND STORAGE

STORAGE REQUIREMENT:	Store in plastic containers in cool area, away from heat. Do not store in glass or porcelain container. Wash thoroughly after use.
HANDLING PRECAUTIONS:	Safe precautionary practices - avoid spills and exposure to skin and fumes.

SECTION VII CONTROL MEASURES

RESPIRATORY PROTECTION (TYPE):	NIOSH approved respirator
MECHANICAL (GENERAL):	Yes
EYE PROTECTION:	Safety glasses/goggles
PROTECTIVE GLOVES:	Recommended, NIOSH approved
OTHER PROTECTIVE CLOTHING OR EQUIPMENT:	Rubber apron, or equivalent
VENTILATION:	Yes
LOCAL EXHAUST:	Yes

SECTION VIII PHYSICAL AND CHEMICAL CHARACTERISTICS

BOILING POINT:	104°C/220°F	**SPECIFIC GRAVITY (WATER=1)**:	1.32
VAPOR PRESSURE (mm Hg):	N/A	**PERCENT VOLATILE BY VOLUME**:	64%
VAPOR DENSITY (AIR=1):	N/A	**EVAPORATION RATE (BUTYL ACETATE=1)**:	0.6
MELTING POINT:	0°C/32°F	**SOLUBILITY IN WATER**:	Unlimited
REACTIVITY IN WATER:	None	**APPEARANCE AND ODOR**:	Clear, odorless liquid

SECTION IX STABILITY AND REACTIVITY

STABILITY:	Product is stable
(CONDITIONS TO AVOID):	Metals
INCOMPATIBILITY:	Alkaline, Strong Oxidizing or Reducing Materials, Cyanides or Combustible Materials.
HAZARDOUS DECOMPOSITION PRODUCTS:	HC1, Zinc Chloride, Zinc Oxide, Ammonium
HAZARDOUS POLYMERIZATION:	Will not occur
(CONDITIONS TO AVOID):	Excessive heat or cold

SECTION X TRANSPORTATION AND DISPOSAL CONSIDERATIONS

D.O.T. PROPER SHIPPING NAME:	Corrosive Liquid, Acidic, Inorganic, N.O.S. Contains Zinc Chloride, Hydrochloric Acid
HAZARD CLASS:	8
IDENTIFICATION NUMBER:	UN3264
PACKING GROUP:	III
TYPE DOT LABEL REQUIRED INFO:	Corrosive
WASTE DISPOSAL METHOD:	Dispose of in accordance with EPA regulations

SECTION XI OTHER INFORMATION

VOC CONTENT: None

MATERIAL SAFETY DATA SHEET

Chemical Product and Company Identification

LABEL IDENTIFIER: DuPont® Krytox ® performance lubricants, 240 AC

PRODUCT IDENTIFIER: P/N 601593 Lubricant, Fluorinated Grease, “Krytox”, 2 oz. Tube

COMPANY IDENTIFICATION: MINE SAFETY APPLIANCES COMPANY
1100 Cranberry Woods Drive
Cranberry Township, PA 16066
CUSTOMER SERVICE: 1-800-MSA-2222 (8:30 a.m. – 5:00 p.m., USA local time)
EMERGENCY: 1-800-255-3924 (CHEM-TEL, INC.)

Vendor Information

A Material Safety Data Sheet as furnished by DuPont for “Krytox” 240 Series Fluorinated Grease is attached (6 Pages).

DuPont Chemicals MSDS REVISION DATE: 5/5/95

Other Information

WARNING: This is a hazardous chemical product. By following the directions and warnings provided with this product, the hazards associated with the use of this product can be greatly reduced but never entirely eliminated. Mine Safety Appliances Company makes no warranties, expressed or implied, with respect to this product and EXPRESSLY DISCLAIMS THE WARRANTY OF MERCHANTABILITY AND ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE. Users assume all risks in handling, using or storing this product.

DuPont Chemicals

MSDS MATERIAL SAFETY DATA SHEET

3886PP

Revised 5-MAY-1995 Printed 15-DEC-1998

"KRYTOX" 240 Series Fluorinated Grease

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification
"KRYTOX" is a registered trademark of DuPont.

Corporate MSDS Number	DU008138
Grade	AA,AB,AC,AD, & AZ

Company Identification
MANUFACTURER/DISTRIBUTOR
DuPont
1007 Market Street
Wilmington, DE 19898

PHONE NUMBERS

Product Information	1-800-441-7515
Transport Emergency	CHEMTREC 1-800-424-9300
Medical Emergency	1-800-441-3637

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	**CAS Number**	**%**
PERFLUOROALKYLETHER	60164-51-4	73-82
PTFE	9002-84-0	18-27

HAZARDS IDENTIFICATION

Potential Health Effects

Skin contact may cause skin irritation with discomfort or rash. Prolonged skin contact may cause redness and inflammation of the hair follicles without skin sensitization.

Eye contact may cause eye irritation with discomfort, tearing or blurring of vision.

(Continued)

HAZARDS IDENTIFICATION(Continued)

Inhalation of fluorine compounds released as decomposition products above 290 degC (554 degF) may cause lung irritation and pulmonary edema which require medical treatment. Inhalation of fumes or smoke from overheated or burning grease may cause polymer fume fever, a temporary flu-like illness accompanied by fever, chills, and sometimes cough, of approximately 24 hours duration. Repeated episodes of polymer fume fever may cause lung damage.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

Flush skin with water after contact. Wash contaminated clothing before reuse.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, do not induce vomiting. Immediately give 2 glasses of water. Never give anything by mouth to an unconscious person. Call a physician.

Notes to Physicians

Activated charcoal mixture may be administered. To prepare activated charcoal mixture, suspend 50 grams activated charcoal in 400 mL water and mix thoroughly. Administer 5 mL/kg, or 350 mL for an average adult.

(Continued)

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point	Does not ignite
Method	PMCC

Non-combustible.

Extinguishing Media
As appropriate for combustibles in area

Fire Fighting Instructions
Wear self-contained breathing apparatus. Wear full protective equipment.

Decomposition at flame temperatures may form toxic fluorine compounds. Avoid breathing decomposition products.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)
NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures
Place in container for disposal. Remove source of heat and flame.

HANDLING AND STORAGE

Handling (Personnel)
Avoid contact with eyes. Avoid contact with skin. Wash thoroughly after handling. Do not store or consume food, drink or tobacco in areas where they may become contaminated with this material.

Storage
Keep container tightly closed. Do not store or consume food, drink or tobacco in areas where they may become contaminated with this material.

Keep away from heat and flames to avoid decomposition product.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls
Keep container tightly closed.

Keep away from heat and flames.

(Continued)

EXPOSURE CONTROLS/PERSONAL PROTECTION(Continued)

Personal Protective Equipment

EYE/FACE PROTECTION

Wear safety glasses or coverall chemical splash goggles.

RESPIRATOR

Where the potential exists for exposure to decomposition products due to heating or elevated temperatures, wear NIOSH/MSHA approved respiratory protection as appropriate.

PROTECTIVE CLOTHING

Where there is potential for skin contact have available and wear as appropriate, impervious gloves, apron, pants, and jacket.

Exposure Guidelines

Applicable Exposure Limits

PTFE

PEL (OSHA)	None Established
TLV (ACGIH)	None Established
AEL * (DuPont)	10 mg/m3, 8 Hr. TWA, total dust
	5 mg/m3, 8 Hr. TWA, respirable dust

* AEL is DuPont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Melting Point	320 C (608 F)
Solubility in Water	Negligible WT%
pH	Neutral
Odor	Odorless
Form	Solid, waxy grease
Color	White
Specific Gravity	1.89-1.93 @ 24 deg C (75 deg F)

STABILITY AND REACTIVITY

Chemical Stability

Stable.

Incompatibility with Other Materials

None reasonably foreseeable.

Polymerization

Polymerization will not occur.

Other Hazards

Decomposition: Heating above 260-290 deg C (500-554 deg F) may form potentially toxic fluorine compounds.
Depolymerization may occur in the presence of some metal oxides at temperatures above 288 deg C (550 deg F).
Decomposition occurs at increasing rates as temperature is raised above 355 deg C (670 deg F).

(Continued)

TOXICOLOGICAL INFORMATION

Animal Data

Perfluoroalkylether:

Inhalation 4 hour ALC:	19.54 mg/l in rats
Skin absorption ALD:	>17,000 mg/kg in rats
Oral ALD:	>25,000 mg/kg in rats

The product contains a mild eye irritant. A single inhalation exposure to perfluoroalkylether caused nonspecific effects such as respiratory irritation. Toxic effects described in animals exposed to decomposition products of perfluoroalkylether formed above 260 degC (500 degF) include lung irritation, irregular respiration, tremors and increased liver weight. Pulmonary edema and death occurred in rats exposed to the decomposition products of perfluoroalkylether formed at around 290 degC (554 degF).

A single inhalation exposure to PTFE caused irritation of the lungs. A repeated ingestion exposure caused no significant toxicological effects. Long-term ingestion exposure caused altered white blood cell count.

DISPOSAL CONSIDERATIONS

Waste Disposal

Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations. Do not flush to surface water or sanitary sewer system.

TRANSPORTATION INFORMATION

Shipping Information

DOT

Proper Shipping Name   Not Regulated.

Shipping Containers:
2, 8 oz. polyethylene tubes
1 lb. double wall jars (polypropylene inner; polystyrene outer)
5-15 lb. polyethylene pails
50-75 lb. white high density polyethylene pails

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status   Reported/Included.

TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

Acute	: Yes
Chronic	: No
Fire	: No
Reactivity	: No
Pressure	: No

(Continued)

OTHER INFORMATION

NFPA, NPCA-HMIS

NPCA-HMIS Rating

Health	1
Flammability	0
Reactivity	0

Personal Protection rating to be supplied by user depending on use conditions.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS	MSDS Coordinator
Address	DuPont Chemicals Wilmington, DE 19898
Telephone	800-441-7515

End of MSDS

MATERIAL SAFETY DATA SHEET

Share Corporation
P.O. Box 245013
Milwaukee, WI 53224

GENERAL INFORMATION NUMBER: (414) 355-4000
EMERGENCY TELEPHONE NUMBER: (800) 776-7192
CHEMTREC: (800) 424-9300

REVISION DATE: September 4, 2002
DATE OF ISSUE: September 10, 2002

I - Product Identification

Diazinon 4E

PRODUCT CODE: 1501
CHEMICAL FORMULATION: Solvent based residual insecticide.
NFPA HAZARD IDENTIFICATION SYSTEM: **HEALTH:** 2 **FLAMMABILITY:** 2 **REACTIVITY**: 0
HAZARD RATING: 4 - Extreme; 3 - High; 2 - Moderate; 1 - Slight; 0 - Insignificant

II - Hazardous Ingredients

Values reported as TWA unless noted.

SUBSTANCE	APPROX %	OSHA PEL	ACGIH TLV	EPA 40 CFR: 302	EPA 40 CFR: 355	EPA 40 CFR: 372	CAS #
Diazinon	48.0	N/E	.1 mg/m^3 (skin)	N	N	N	333-41-5
Aromatic Hydrocarbon	< 35.0	N/E	435 mg/m^3 (skin)	N	N	N	64742-95-6
Xylene	< 2.00	100 ppm	100 ppm				1330-20-7
Cumene	< 1.00	50 ppm	50 ppm				98-82-8
Pseudocumene (1,2, 4-Trimethylbenzene)	10.0-20.0	25 ppm	25 ppm				95-63-6

Key: **PEL**: Permissible Exposure Limit **TLV:** Threshold Limit Value **C**: Ceiling level **STEL**: Short Term Exposure Limit
N/A: Not Applicable **N/D**: Not Determined **N/E**: Not Established **Y**: Yes **N**: No
302: CERCLA List of Hazardous Substances and Reportable Quantities (40 CFR 302.4).
355: SARA TITLE III / List of Extremely Hazardous Substances for Emergency Planning and Notification (40 CFR 355).
372: SARA TITLE III / List of Toxic Chemicals subject to Release Reporting (Community Right to Know) (40 CFR 372).

III - Physical Data

BOILING POINT (°F): > 200
VAPOR PRESSURE (mm Hg): 31.0 @ 100^{o}F
VAPOR DENSITY (AIR = 1): < 1.0
SOLUBILITY IN WATER: Emulsifiable
SPECIFIC GRAVITY (WATER = 1): 1.00
VOC CONTENT (% by weight): N/D
EVAPORATION RATE (WATER = 1): N/D
pH: N/A
APPEARANCE AND ODOR: Clear, yellow liquid; aromatic solvent odor..

IV - Fire and Explosion Hazard Data

FLASH POINT (°F): 145 **(TEST METHOD):** TCC
FLAMMABLE LIMITS IN AIR (VOLUME %) **UPPER:** N/D **LOWER:** N/D
EXTINGUISHING MEDIA: Carbon dioxide, dry chemical.
SPECIAL FIRE FIGHTING PROCEDURES: Cool fire exposed containers with water fog. Firefighters should be equipped with full protective gear including self-contained breathing apparatus.
UNUSUAL FIRE AND EXPLOSION HAZARD: Combustible liquid. Do not use, pour, spill or store near heat or open flame.

V - Reactivity Data

STABILITY: Stable.
INCOMPATIBILITY: Strong oxidizers
CONDITIONS TO AVOID: Excess heat and open flame.
HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition may produce oxides of carbon.
HAZARDOUS POLYMERIZATION: Will not occur.
CONDITIONS TO AVOID: None

VI - Health Hazard Data

ROUTES OF ENTRY **INHALATION:** X **EYE CONTACT:** X **SKIN CONTACT:** X **INGESTION:** X
INGREDIENTS THAT ARE CONSIDERED BY OSHA, NTP, IARC TO BE SUSPECTED HUMAN CARCINOGENS: None
EFFECTS OF OVEREXPOSURE
IF IN EYES: Causes moderate eye irritation.
IF ON SKIN: May be absorbed through skin. Avoid contact with skin and clothing.
IF SWALLOWED: Nausea, cramps, diarrhea.
IF INHALED: Irritation to upper respiratory tract. May be an aspiration hazard.
EMERGENCY AND FIRST AID PROCEDURES
IF IN EYES: Flush eyes and under eyelids with plenty of cool water for at least 15 minutes. If irritation persists, obtain medical attention.
IF ON SKIN: Wash with soap and water. Remove contaminated clothing and launder separately before reuse. If irritation persists, obtain medical attention.
IF SWALLOWED: Contact physician or poison control center immediately. Give affected person 1 to 2 glasses of water. Do not induce vomiting. Never give anything to an unconscious person.
IF INHALED: Remove person to fresh air.
NOTE TO PHYSICIAN: Gastric lavage may be indicated if product was taken internally. Diazinon is an organophosphate insecticide. If symptoms of cholinesterase inhibition are present, atropine sulfate by injection is antidotal. 2-PAM is also antidotal and may be administered, but only in conjunction with atropine.

VII - Spill or Leak Protection

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Ventilate area and remove all sources of ignition. Contain spill. Soak up spilled material with inert absorbent material and place in a properly marked closed container for proper disposal.
WASTE DISPOSAL METHOD: Consult local environmental authorities.

VIII - Special Protection Information

RESPIRATORY PROTECTION: Use with adequate ventilation. Do not breathe vapors or mists. If recommended Exposure Limits are exceeded wear a NIOSH approved respirator, following manufacturer's recommendations.
VENTILATION **LOCAL:** Recommended **MECHANICAL:** Not required
PROTECTIVE GLOVES: Chemical resistant.
EYE PROTECTION: None normally required otherwise protective goggles.
OTHER PROTECTIVE EQUIPMENT: Protective clothing.
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Store in a cool, dry place away from heat or open flame. Keep container tightly closed when not in use. Keep away from food and feed. Do not permit children or pets on sprayed grass until sprayed grass has completely dried. Do not contaminate ornamental fish ponds. Do not use on humans, household pets or livestock.
OTHER PRECAUTIONS: Keep out of reach of children.

IX - Transportation Information (ground transportation only)

DOT PROPER SHIPPING NAME: Consumer Commodity
DOT CLASS: ORM-D **DOT ID NUMBER:** N/A **DOT PACKING GROUP**: N/A

The shipping information listed above applies only to non-bulk (< 119 gallons) containers of this product. This product may have more than one proper shipping name depending on packaging, product properties, & mode of shipment. If any alteration of packaging, product, or mode of transportation is further intended, different shipping names and labeling may apply.

REVISION DATE: September 4, 2002 Prepared by: PMR DATE OF ISSUE: September 10, 2002

"DuPont" "HYVAR" X-L
M0000506 Revised 11-OCT-2008

Substance ID :130000023989

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

"HYVAR" is a registered trademark of DuPont.

"DuPont" is a trademark of DuPont.

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont
1007 Market Street
Wilmington, DE 19898

PHONE NUMBERS
Product Information : 1-800-441-7515 (outside the U.S. 302-774-1000)
Transport Emergency : CHEMTREC 1-800-424-9300(outside U.S. 703-527-3887)
Medical Emergency : 1-800-441-3637 (outside the U.S. 302-774-1000)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
*BROMACIL (LITHIUM SALT OF 5-BROMO-3-SEC-BUTYL-6-METHYLURACIL)	314-40-9	21.9
INERT INGREDIENTS (INCLUDES PERCENTAGES OF THE FOLLOWING:)		78.1
* ETHYLENE GLYCOL	107-21-1	30-35
ETHANOL	64-17-5	<10
* METHANOL	67-56-1	<5

* Disclosure as a toxic chemical is required under Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

HAZARDS IDENTIFICATION

Emergency Overview

CAUTION! Harmful if swallowed or absorbed through skin.

Causes moderate eye irritation. Avoid contact with eyes, skin or clothing.

Potential Health Effects

Based on animal studies, eye contact with "Hyvar" X-L may cause moderate corneal opacity.

Based on animal studies, skin contact with "Hyvar" X-L may cause skin irritation or rash.

Carcinogenicity Information

The following components are listed by IARC, NTP, OSHA or ACGIH as carcinogens.

Material	IARC	NTP	OSHA	ACGIH
BROMACIL				A3

FIRST AID MEASURES

First Aid

IF IN EYES: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

IF SWALLOWED: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

IF ON SKIN OR CLOTHING: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

IF INHALED: No specific intervention is indicated as the product is not likely to be hazardous by inhalation. Consult a physician if necessary.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-441-3637 for emergency medical emergencies involving this product.

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point : 44 C (111 F)
Method : Setaflash
Autoignition : 410 C (770 F)

Combustible. Heating can release vapors which can be ignited.

Do not store near heat or open flame.

Extinguishing Media

Water Spray, Foam, Dry Chemical, CO2.

Fire Fighting Instructions

Wear self-contained breathing apparatus. Wear full protective equipment. Use water spray. Cool tank/container with water spray. Runoff from fire control may be a pollution hazard.

If area is heavily exposed to fire and if conditions permit, let fire burn itself out since water may increase the area contaminated.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Initial Containment

Dike spill. Prevent material from entering sewers, waterways, or low areas.

Spill Clean Up

Soak up with sawdust, sand, oil dry or other absorbent material.

Accidental Release Measures

If spill area is on ground near valuable plants or trees, remove top 2 inches of soil after initial cleanup.

HANDLING AND STORAGE

Handling (Personnel)

USERS SHOULD: Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.

Users should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Handling (Physical Aspects)

Keep away from heat, sparks and flames.

Storage

Store product in original container only. Do not contaminate water, other pesticides, fertilizer, food or feed in storage Keep container closed when not in use.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use only with adequate ventilation. Keep container tightly closed.

When handlers use closed systems, enclosed cabs or aircraft in a manner that meets the requirements listed in the Workers Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4-6)]. The handler PPE requirements may be reduced or modified as specified in the WPS.

Personal Protective Equipment

Some materials that are chemical resistant to this product are listed below. If you want more options follow the instructions for Category C on the EPA chemical resistance category selection chart.

Applicators and other handlers must wear:
- Long-sleeved shirt and long pants.
- Shoes plus socks.
- Chemical Resistant Gloves, Category C (such as butyl rubber, neoprene rubber, or nitrile rubber) equal to or greater than 14 mils.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product’s concentrate. Do not reuse them.

Follow manufacturer’s instructions for cleaning and maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Exposure Guidelines

Applicable Exposure Limits

BROMACIL

PEL (OSHA)	: None Established
TLV (ACGIH)	: 10 mg/m3, 8 Hr. TWA, A3
AEL * (DuPont)	: 10 mg/m3, 8 & 12 Hr. TWA

ETHYLENE GLYCOL

PEL (OSHA)	: None Established
TLV (ACGIH)	: Ceiling: 39.4 ppm, 100 mg/m3, aerosol,A4
AEL * (DuPont)	: 50 ppm, 8 & 12 Hr. TWA, vapor 10 mg/m3, 8 & 12 Hr. TWA, particulate Aerosol

ETHANOL

PEL (OSHA)	: 1,000 ppm, 1,900 mg/m3, 8 Hr. TWA
TLV (ACGIH)	: 1,000 ppm, 1,880 mg/m3, 8 Hr. TWA, A4 Notice of Intended Changes (2008) STEL 1000 ppm, A3
AEL * (DuPont)	: 1000 ppm, 8 & 12 Hr. TWA

METHANOL

PEL (OSHA)	: 200 ppm, 260 mg/m3, 8 Hr. TWA
TLV (ACGIH)	: 200 ppm, 8 Hr. TWA, Skin STEL 250 ppm
AEL * (DuPont)	: 200 ppm, 8 & 12 Hr. TWA, Skin

* AEL is DuPont’s Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Solubility in Water	: Soluble
pH	: 11.2 - 12.2
Odor	: Alcoholic
Form	: Liquid
Color	: Amber
Density	: 1.12 g/cc

Physical Hazards

Combustible. Do not use or store near heat or open flame. Keep container tightly closed when not in use.

STABILITY AND REACTIVITY

Chemical Stability

Stable at normal temperatures and storage conditions.

Incompatibility with Other Materials

Incompatible with acids and amines, especially primary amines.

Decomposition

Decomposes with heat.

Polymerization

Polymerization will not occur.

TOXICOLOGICAL INFORMATION

Animal Data

```
Oral LD50           :  3927 mg/kg (male rats)
                       1414 mg/kg (female rats)
Dermal LD50         : >5000 mg/kg (rabbits)
Inhalation 4-hr LC50: >or= 4.3 mg/L (rats)
```

Based on animal testing, Hyvar X-L is an eye and skin irritant, but is not a skin sensitizer.

BROMACIL
Repeated exposure to Bromacil by ingestion resulted in incoordination, salivation, vomiting, weakness, tearing and dilated pupils. Repeated exposure caused liver changes, increased liver, adrenal, and heart weights, decreased kidney and spleen weights, and thyroid changes. Long-term exposure caused reduced weight gain, slight thyroid effects, and liver effects.

Repeated exposure to Bromacil by inhalation caused slightly increased platelet counts, lower serum cholesterol, and slightly increased liver weights. All remaining animals were normal after a 14-day recovery period.

Dogs fed Bromacil for one year had decreased body weight gain in the high dose group. Rats fed Bromacil for two years had reduced body weight gain, increased incidence of thyroid cysts, and enlargement of thymus at the high dose, and a dose-related increase in thyroid tumors. Mice fed Bromacil for 18-months had liver lesions in all male groups and an increase in liver tumors in the high dose males.

Animal testing indicates Bromacil does not have reproductive

effects. Bromacil is not considered to be a developmental toxicant. Any developmental effects occurred at maternally toxic doses. The weight of evidence suggests that Bromacil does not produce genetic damage in mammalian or bacterial cells cultures or animal studies.

METHANOL
Toxic effects that may result from excessive exposure to methanol include visual disturbances or blindness, narcosis and other CNS effects, liver effects, and acidosis.

Indivdiuals with preexisting diseases of the retina or liver may have increased susceptibility to methanol toxicity.

ETHYLENE GLYCOL
Immediate effects of overexposure to ethylene glycol by ingestion or inhalation may include non-specific effects such as headache, nausea and weakness. Gross overexposure may cause central nervous system depression with dizziness, confusion, incoordination, drowsiness or unconsciousness; altered kidney function which may be accompanied by abnormal urine volume, low back pain, discomfort or edema; kidney stones; liver abnormalities; high blood pressure; irregular heart beat with a strange sensation in the chest, "heart thumping"; apprehension; lightheadedness, feeling of fainting, dizziness, weakness, sometimes progressing to loss of consciousness; retention of acid in the blood, making oxygen less available in the blood stream and leading to symptoms of increased breathing rate, nausea, vomiting, confusion and weakness which may progress to loss of consciousness. Gross overexposure could lead to death. Skin permeation can occur in amounts capable of producing the effects of systemic toxicity. There are no reports of human sensitization. Individuals with preexisting diseases of the kidneys may have increased susceptibility to the toxicity of excessive exposures.

ETHANOL
Toxic effects described in animals include effects on the liver, reproductive system, and cardiovascular system along with CNS depression.

ECOLOGICAL INFORMATION

Ecotoxicological Information

AQUATIC TOXICITY
For the active ingredient Bromacil:

96 hr LC50 Rainbow trout	:	36 mg/L
96 hr LC50 Bluegill sunfish	:	127 mg/L
96 hr LC50 Fathead minnows	:	182 mg/L

AVIAN TOXICITY

For the active ingredient Bromacil:

Acute Oral LD50 Bobwhite quail	:	2250 mg/kg
Subacute Dietary LC50 Mallard duck	:	>10,000 ppm
Subacute Dietary LC50 Bobwhite quail	:	>10,000 ppm

DISPOSAL CONSIDERATIONS

Waste Disposal

Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations. Do not flush to surface water or sanitary sewer system.

Do not contaminate water, food, or feed by disposal. Waste resulting from the use of this product may be disposed of on the site or at an approved waste disposal facility.

ENVIRONMENTAL HAZARDS:
Do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment washwaters.

Container Disposal

Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

TRANSPORTATION INFORMATION

Shipping Information

DOT
Proper Shipping Name: Not regulated for domestic non-bulk shipments*

IMO/IATA
Proper Shipping Name: Flammable liquid, n.o.s., (Ethanol, Methanol)
Hazard Class : 3
UN No. : UN 1993
Special Information : Flashpoint 44 DEG C (for ocean transport only)
Packing Group : III

*For Domestic Bulk Shipments:
Proper shipping name: Combustible liquid, n.o.s., (Ethanol, Methanol)
NA No. : NA 1993
Packing Group : III

REGULATORY INFORMATION

U.S. Federal Regulations

TITLE III HAZARD CLASSIFICATIONS SECTIONS 311, 312

Acute : Yes
Chronic : Yes
Fire : Yes
Reactivity : No
Pressure : No

In the United States this product is regulated by the US Environmental Protection Agency under the Federal Insecticide, Fungicide and Rodenticide Act. It is a violation of federal law to use this product in a manner inconsistent with its labeling.

EPA Reg. No. 352-346

ADDITIONAL REGULATORY INFORMATION

SARA/CERCLA Reportable Quantity:
Methyl alcohol (5,000 lb)

******ATTENTION******

CALIFORNIA PROPOSITION 65

THIS PRODUCT CONTAINS LITHIUM SALT OF BROMACIL WHICH IS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE DEVELOPMENTAL EFFECTS AND MALE REPRODUCTION EFFECTS.

OTHER INFORMATION

NFPA, NPCA-HMIS

NFPA Rating
Health : 1
Flammability : 2
Reactivity : 0

NPCA-HMIS Rating
Health : 1
Flammability : 2
Reactivity : 0

(Continued)

Personal Protection rating to be supplied by user depending on use conditions.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : DuPont Crop Protection
Address : Wilmington, Delaware 19898
Telephone : 1-888-638-7668

# Indicates updated section.

MATERIAL SAFETY DATA SHEET

Douglas Products and Packaging Co.
1550 E. Old 210 Highway
Liberty, Mo. 64068
Phone :(816)-781-4250
Fax: (816)-781-1043

Manufacturer's Name:
Douglas Products and Packaging Co.
1550 E. Old 210 Highway
Liberty, MO. 64068

Emergency Telephone No.
1-800-424-9300 (Chemtrec)
Day Telephone: 1-816-781-4250
Night Telephone: 1-816-781-4650

SECTION I- GENERAL INFORMATION

Trade Name: Pyrethrin 5
EPA Registration No: 1015-67

The Chem Trec number is used only in the event of chemical emergencies involving a spill, leak. Fire, exposure, or accident involving chemicals.

SECTION II-INGREDIENTS

Labels

Material or Component	Cas#	%	Osha Pel	TLV	Hazard Data
Petroleum Distillate	647-42-95-6	96.83	-/-	100 ppm	-
*Piperonyl Butoxide, Technical	00051-03-6	01.00	-/-	-	-
Pyrethrins	08003-34-7	00.50	-/-	5 mg/m3	-

*Equivalent to 1.11% (Butylcarbityl) (6-Propylpiperonyl) Ether and 0.28% related compound.

HMIS: Health-2 Flammability-2 Reactivity-1 Personal Protection-B

SECTION III-PHYSICAL DATA

Physical properties	Liquid
Appearance	Straw Colored
Odor	N/A
Boiling Point	403 degrees F. to 509 degrees F.
Specific gravity	.8127
Vapor density	N/A
Melting point	N/A
Vapor pressure	N/A
Evaporation rate	1/430
Soluble in water	Negligible

SECTION IV- FIRE DATA

Flashpoint: 150 Degrees F
Flammable Limits: LOWER-N/A UPPER N/A
Extinguishing Media: NFPA Class B extinguisher CO2, Dry Chemical or Foam (For liquid fires)
Fire Fighting Techniques: None

Unusual fire and explosion hazards: Product will burn at elevated temperatures, keep away from heat and open flame.

SECTION V-REACTIVITY DATA

Heat and open flames are conditions that contribute to instability. Strong oxidizers such as permanganate are incompatible with product. Will produce carbon monoxide from burning. Conditions contributing to hazardous polymerization: N/A

SECTION VI-HEALTH HAZARD DATA

Principal Routes of Entry are inhalation and contact with skin.

Inhalation:	Acute toxicity LC (50) = 8.53 mg/L in air for 4 hours.
Skin:	N/A
Eye:	N/A
Ingestion:	Acute toxicity LD (50) = g/kg for rats
Effects of Exposure:	Irritation to skin, eyes, mucosa, hyperexcitability, uncoordination, chronic, convulsions and diarrhea.

SECTION VII- EMERGENCY PROCEDURES

Eye contact:	Flush with water thoroughly
Skin contact:	Wash with soap and water
Inhalation:	Remove patient to fresh air
Indigestion:	Call physician immediately. Do not induce vomiting, Antidote for cholinesterase inhibition antrophine

CARCINOGINICITY: **NPT: NO** **IARC: NO** **OSHA: NO**

SECTION VIII-SPILL OR LEAK PROCEDURES

Remove all sources of ignition, ventilate area, and soak up spillage with absorbent materials such as sawdust.

To dispose incinerate and dispose of empty containers according to local regulations. Do not incinerate in closed containers, avoid breathing vapors, do not bury waste close to water sources.

SECTION IX-SPECIAL PROTECTION INFORMATION

Eye Protection:	Safety glasses recommended
Ventilation Requirements:	Local exhaust is preferable, can use mechanical
Respiratory Protection:	None required if adequate ventilation
Skin Protection:	Solvent resistant gloves
Other:	None

SECTION X-SPECIAL PRECAUTIONS

Special Precautions/Storage

*Wash thoroughly after handling and before eating and smoking.

*****Do not store above 120 degrees F., Combustible, keep away from heat and open flame, do not store in open or unlabeled containers.

The information presented herein for consideration, while not guaranteed, is true and accurate to the best of our knowledge. No warranty, or guaranty is expressed or implied regarding the accuracy or reliability of such information and we shall not be liable for any loss or consequential damages arising out of the use thereof.

Revised 5-31-07

MATERIAL SAFETY DATA SHEET

Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

Effective Date: 11/15/99
Product Code: 75068
MSDS: 006667

SPIKE* 80 DF HERBICIDE

1. PRODUCT AND COMPANY IDENTIFICATION:

PRODUCT: Spike* 80 DF Herbicide

COMPANY IDENTIFICATION:
Dow AgroSciences
9330 Zionsville Road
Indianapolis, IN 46268-1189

2. COMPOSITION/INFORMATION ON INGREDIENTS:

Tebuthiuron: N-(5-(1,1-Dimethylethyl)-1,3,4-thiadiazol-2-yl)-N,N'-dimethylurea	CAS # 034014-18-1	80%
Other Ingredients, Total		20%

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

3. HAZARDOUS IDENTIFICATIONS:

EMERGENCY OVERVIEW
Hazardous Chemical. Tan solid granule with a mild odor. May cause eye irritation with corneal injury. LD_{50} for skin absorption in rabbits is >2000 mg/kg. Oral LD_{50} for rats is 488 mg/kg. Inhalation LC_{50} for rats is >4.84 mg/L for 4 hours (particulate aerosol).
EMERGENCY PHONE NUMBER: 800-992-5994

POTENTIAL HEALTH EFFECTS: This section includes possible adverse effects, which could occur if this material is not handled in the recommended manner.

EYE: May cause moderate eye irritation with corneal injury.

SKIN: Essentially non-irritating to skin. A single prolonged exposure is not likely to result in the material being absorbed through skin in harmful amounts. The LD_{50} for skin absorption in rabbits is >2000 mg/kg. Did not cause allergic skin reactions when tested in guinea pigs.

INGESTION:. Single dose oral toxicity is moderate. Small amounts swallowed incidental to normal handling operations are not likely to cause injury; however, swallowing larger amounts may cause serious injury, even death. The oral LD_{50} for rats is 488 mg/kg.

INHALATION: Single exposure to dust is not likely to be hazardous. The LC_{50} for rats is 4.84 mg/l for 4 hours (particulate aerosol).

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: Effects have been reported in the following organs: blood, kidney, and pancreas.

CANCER INFORMATION: Tebuthiuron did not cause cancer in laboratory animals.

TERATOLOGY (BIRTH DEFECTS): Birth defects are unlikely. Exposures having no adverse effects on the mother should have no effect on the fetus.

REPRODUCTIVE EFFECTS: Tebuthiuron did not interfere with reproduction in animal studies.

4. FIRST AID:

EYES: Irrigate with flowing water immediately and continuously for 15 minutes. Consult medical personnel.

SKIN: Wash off in flowing water or shower.

INGESTION: If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Consult medical personnel.

INHALATION: Remove to fresh air if effects occur. Consult a physician.

NOTE TO PHYSICIAN: No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

*Trademark of Dow AgroSciences

Emergency Phone: 800-992-5994
Dow AgroSciences LLC
Indianapolis, IN 46268

Dow AgroSciences

SPIKE* 80 DF HERBICIDE

Effective Date: 11/15/99
Product Code: 75068
MSDS: 006667

5. FIRE FIGHTING MEASURES:

FLASH POINT: Not applicable
METHOD USED: Not applicable

FLAMMABLE LIMITS
LFL: Not applicable
UFL: Not applicable

EXTINGUISHING MEDIA: Use water fog, foam, or CO_2 if product is involved in a fire.

FIRE AND EXPLOSION HAZARDS: Will emit toxic fumes when heated to decomposition.

FIRE-FIGHTING EQUIPMENT: Wear positive-pressure, self-contained breathing apparatus and full protective clothing.

6. ACCIDENTAL RELEASE MEASURES:

ACTION TO TAKE FOR SPILLS: Contain and sweep up material of small spills and dispose of waste. Report large spills to Dow AgroSciences at 800-992-5994. Prevent runoff.

7. HANDLING AND STORAGE:

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Keep out of reach of children. May be fatal if swallowed. Causes eye irritation. Harmful if absorbed through the skin. Avoid breathing dust or spray mist and contact with skin, eyes or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco. Wash exposed clothing before reuse. Store in original container in a dry area.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION:

These precautions are suggested for conditions where a potential for exposure exists. Emergency conditions may require additional precautions.

EXPOSURE GUIDELINES: None established.

ENGINEERING CONTROLS: Good general ventilation should be sufficient for most conditions. Local exhaust ventilation may be necessary for some operations.

RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS.

RESPIRATORY PROTECTION: In dusty atmospheres, use a NIOSH approved respirator for dust.

SKIN PROTECTION: No precautions other than clean body-covering clothing should be needed.

EYE/FACE PROTECTION: Use chemical goggles.

APPLICATORS AND ALL OTHER HANDLERS: Please refer to the product label for personal protective clothing and equipment.

9. PHYSICAL AND CHEMICAL PROPERTIES:

BOILING POINT: Not Determined
VAPOR PRESSURE: Not Determined
BULK DENSITY: 25-45 lb/cu. ft.
SOLUBILITY IN WATER: Not Determined
SPECIFIC GRAVITY: Not Determined
APPEARANCE: Tan solid granule
ODOR: Mild
pH: 5 - 8.5 (1% Aqueous)

10. STABILITY AND REACTIVITY:

STABILITY: (CONDITIONS TO AVOID) Stable under normal storage conditions.

INCOMPATIBILITY: (SPECIFIC MATERIALS TO AVOID) None known.

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of nitrogen and sulfur may be formed if product is involved in fire.

HAZARDOUS POLYMERIZATION: Not known to occur.

11. TOXICOLOGICAL INFORMATION:

MUTAGENICITY: For tebuthiuron, in-vitro mutagenicity studies were negative in some cases and positive in other cases. Animal mutagenicity studies were negative.

*Trademark of Dow AgroSciences

MATERIAL SAFETY DATA SHEET

Emergency Phone: 800-992-5994
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Effective Date: 11/15/99
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MSDS: 006667

SPIKE* 80 DF HERBICIDE

12. ECOLOGICAL INFORMATION:

ENVIRONMENTAL FATE:

MOVEMENT & PARTITIONING: Based largely or completely on information for tebuthiuron. Bioconcentration potential is low (BCF <100 or Log Pow <3).

DEGRADATION & PERSISTENCE: No relevant information found.

ECOTOXICOLOGY: Based largely or completely on information for tebuthiuron. Maximum acceptable toxicant concentration (MATC) in water flea (Daphnia magna) is 31.4 mg/L. Maximum acceptable toxicant concentration (MATC) in fathead minnow (Pimephales promelas) is 12.94 mg/L.

13. DISPOSAL CONSIDERATIONS:

DISPOSAL METHOD: Do not contaminate water, food or feed by storage or disposal. Open dumping is prohibited. Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility in accordance with all Federal, State, and local regulations.

14. TRANSPORT INFORMATION:

For DOT regulatory information, if required, consult transportation regulations, product shipping papers, or consult your Dow AgroSciences representative.

15. REGULATORY INFORMATION:

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.

U.S. REGULATIONS

SARA 313 INFORMATION: This product contains the following substances subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

CHEMICAL NAME	CAS NUMBER	CONCENTRATION
TEBUTHIURON	034014-18-1	80%

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An immediate health hazard
A delayed health hazard

TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

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STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in the composition section of the MSDS.

CHEMICAL NAME	CAS NUMBER	LIST
Proprietary Ingredient	Proprietary	PA1
Tebuthiuron	034014-18-1	NJ2

NJ2=New Jersey Environmental Hazardous Substance (present at greater than or equal to 1.0%).
PA1=Pennsylvania Hazardous Substance (present at greater than or equal to 1.0%).

OSHA HAZARD COMMUNICATION STANDARD: This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND): To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

16. OTHER INFORMATION:

MSDS STATUS: New
Reference: DR-0362-8806
Document Code: D03-094-001

The Information Herein Is Given In Good Faith, But No Warranty, Express Or Implied, Is Made. Consult Dow AgroSciences For Further Information.

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ELECTRONICS

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MSDS Number: 112
Revision Date: 4/20/2012
Supersedes Date: 05/04/2009

MATERIAL SAFETY DATA SHEET

Complies with OSHA Hazard Communication Standard 29 CFR 1910.1200

Product Name: LIQUID SOLDER FLUX

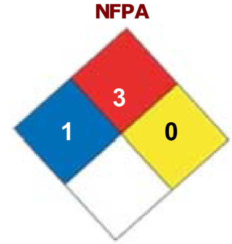
SECTION 1- PRODUCT AND COMPANY IDENTIFICATION

Product Type: Solder Flux
Product Name: **LIQUID SOLDER FLUX**
Part Number(s): 10-4202
10-4216

Emergency Contact: Chemtrec
Phone: (800) 424-9300

Common Name: Liquid Solder Flux
Chemical Name: Rosin Solder Flux
Family Usage: Soldering Flux for Electrical or Electronic Applications
Description: Mixture of the substances listed below with non-hazardous additions.
GHS Class: Highly Flammable liquid and vapour

NFPA



This product has to be labeled due to the calculation procedure of international guidelines. Has a narcotizing effect. Highly flammable. Irritating to eyes. May cause sensitization by skin contact. Vapors may cause drowsiness and dizziness.

Least	0
Slight	1
Moderate	2
High	3
Extreme	4
Gloves, Safety Glasses	B

HMIS

Health Hazard	1
Fire Hazard	3
Reactivity	0
Personal Protection	x

* Chronic Health Effects

Information pertaining to particular dangers for man and environment:

Personal Protective Equipment


Chemical Splash Goggles


Safety Glasses


Protective Gloves

WHMIS Pictograms


Flammable


D2B Toxic

GHS Pictograms


Highly flammable liquid and vapour

DOT Pictograms

Flammable Liquid

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MATERIAL SAFETY DATA SHEET

Product Name: LIQUID SOLDER FLUX

SECTION 2 - COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS#	Ingredient Percent	EC Num.
Gum rosin	8050-09-7	30 - 60 by weight	
Isopropyl alcohol	67-63-0	30 - 60 by weight	

SECTION 3 - HAZARDS IDENTIFICATION

Emergency Overview: DANGER! Flammable. Potential Sensitizer Flux fumes during soldering may cause irritation and damage of mucous membranes and respiratory system.

Route of Exposure: Eyes. Skin. Inhalation. Ingestion.

Eye: Eye contact with product or vapors may result in irritation, redness, and blurred vision. Smoke during soldering can cause eye irritation.

Skin: May cause irritation.
May cause skin sensitization, an allergic reaction, which becomes evident on reexposure to this material.

Inhalation: Inhalation of vapors, fumes or mists of the product may be irritating to the respiratory system.
May cause respiratory sensitization with asthma-like symptoms in susceptible individuals.

Ingestion: May be harmful if swallowed. May cause vomiting.

Chronic Health Effects: Prolonged or repeated contact may cause skin irritation.
Repeated or prolonged inhalation may cause toxic effects.

Signs/Symptoms: Overexposure may cause headaches and dizziness.

Target Organs: Eyes. Skin. Respiratory system. Digestive system.

Aggravation of Pre-Existing Conditions: None generally recognized.

SECTION 4 - FIRST AID MEASURES

Eye Contact: Immediately flush eyes with plenty of water for 15 to 20 minutes. Get medical attention, if irritation or symptoms of overexposure persists.

Skin Contact: Immediately wash skin with soap and plenty of water.
Get medical attention if irritation develops or persists.

Inhalation: If inhaled, remove to fresh air. If not breathing, give artificial respiration or give oxygen by trained personnel. Seek immediate medical attention.

Ingestion: If swallowed, do NOT induce vomiting. Call a physician or poison control center immediately. Never give anything by mouth to an unconscious person.

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MATERIAL SAFETY DATA SHEET

Product Name: LIQUID SOLDER FLUX

SECTION 5 - FIRE FIGHTING MEASURES

Flash Point:	18 °C (64 °F)
Auto Ignition Temperature:	425.0 °C (797 °F)
Lower Flammable/Explosive Limit:	2.0 % by volume
Upper Flammable/Explosive Limit:	12.0 % by volume
Extinguishing Media:	Use alcohol resistant foam, carbon dioxide, dry chemical, or water fog or spray when fighting fires involving this material.
Unsuitable Media:	Do not use a solid water stream as it may scatter and spread fire.
Protective Equipment:	As in any fire, wear Self-Contained Breathing Apparatus (SCBA), MSHA/NIOSH (approved or equivalent) and full protective gear.
Hazardous Combustion Byproducts:	Oxides of carbon, oxides of nitrogen, aliphatic aldehydes, and other organic substances may be formed during combustion..

NFPA Ratings:

NFPA Health:	1
NFPA Flammability:	3
NFPA Reactivity:	0

SECTION 6 - ACCIDENTAL RELEASE MEASURES

Personnel Precautions:	Evacuate area and keep unnecessary and unprotected personnel from entering the spill area. Avoid breathing vapor, aerosol or mist. Avoid contact with skin, eyes and clothing.
Environmental Precautions:	Avoid runoff into storm sewers, ditches, and waterways.
Methods for containment:	Contain spills with an inert absorbent material such as soil, sand or oil dry.
Methods for cleanup:	Remove all sources of ignition. Absorb spill with inert material (e.g., dry sand or earth), then place in a chemical waste container. Provide ventilation. Collect spill with a non-sparking tool. Place into a suitable container for disposal.

SECTION 7 - HANDLING and STORAGE

Handling:	Use with adequate ventilation. Avoid breathing vapor and fumes. Use only in accordance with directions. To reduce potential for static discharge, bond and ground containers when transferring material.
Storage:	Store in a cool, dry, well ventilated area away from sources of heat, combustible materials, direct sunlight, and incompatible substances. Keep container tightly closed when not in use.
Special Handling Procedures:	DANGER! Rags, steel wool and waste soaked with this product may spontaneously catch fire if improperly discarded or stored. To avoid a spontaneous combustion fire, immediately after use, place rags, steel wool or waste in a sealed, water-filled, metal container.
Hygiene Practices:	Wash thoroughly after handling. Avoid inhaling vapors, mists, or fumes.

SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION - EXPOSURE GUIDELINES

Engineering Controls:	Use appropriate engineering control such as process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below recommended exposure limits. Where such systems are not effective wear suitable personal protective equipment, which performs satisfactorily and meets OSHA or other recognized standards. Consult with local procedures for selection, training, inspection and maintenance of the personal protective equipment.
Eye/Face Protection:	Tightly fitting safety goggles. Wear a face shield also when splash hazards exist
Hand Protection Description:	Wear appropriate protective gloves. Consult glove manufacturer's data for permeability data. Nitrile rubber or natural rubber gloves are recommended.
Respiratory Protection:	A NIOSH approved air-purifying respirator with an organic vapor cartridge or canister may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air purifying respirators is limited. Use a positive pressure air supplied respirator if there is any potential for an uncontrolled release, exposure levels are not known, or any other circumstances where air purifying respirators may not provide adequate protection.
Other Protective:	Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower.

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MATERIAL SAFETY DATA SHEET

Product Name: LIQUID SOLDER FLUX

SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION - EXPOSURE GUIDELINES (CONTINUED)

Gum rosin :

Guideline ACGIH:	Sensitizer.: Sen

Isopropyl alcohol :

Guideline ACGIH:	TLV-STEL: 400 ppm TLV-STEL: 400 ppm
Guideline OSHA:	PEL-TWA: 400 ppm

SECTION 9 - PHYSICAL and CHEMICAL PROPERTIES

Physical State Appearance:	Liquid.
Color:	Amber
Odor:	Alcohol-like
Boiling Point:	82 °C (180 °F)
Melting Point:	Not determined.
Density:	0.880 g/cm³ @ 20°C (68°F)
Vapor Pressure:	33 mmHg @ 20°C (68°F)
Flash Point:	18 °C (64 °F)
Auto Ignition Temperature:	425.0 °C (797 °F)

SECTION 10 - STABILITY and REACTIVITY

Chemical Stability:	Stable under normal temperatures and pressures.
Hazardous Polymerization:	Not reported.
Conditions to Avoid:	Keep away from heat, ignition sources and incompatible materials.
Incompatible Materials:	Oxidizing agents. Strong acids and alkalis.
Special Decomposition Products:	When heated to soldering temperatures, the solvents are evaporated and rosin may be thermally degraded to liberate aliphatic aldehydes and acids.

MATERIAL SAFETY DATA SHEET

Product Name: LIQUID SOLDER FLUX

SECTION 11 - TOXICOLOGICAL INFORMATION

Gum rosin :

RTECS Number:	VL0480000
Inhalation:	Inhalation. - Rat LC50: 110 mg/m3 [Behavioral - somnolence (general depressed activity) Cardiac - pulse rate Lungs, Thorax, or Respiration - respiratory depression] (RTECS)
Ingestion:	Oral - Mouse LD50: 2.2 mg/kg [Behavioral - somnolence (general depressed activity) Cardiac - pulse rate Lungs, Thorax, or Respiration - respiratory depression] Oral - Rat LD50: 3.0 mg/kg [Brain and Coverings - other degenerative changes Liver - other changes Biochemical - Metabolism (Intermediary) - other] (RTECS)

Isopropyl alcohol :

RTECS Number:	NT8050000
Eye:	Eye - Rabbit Standard Draize test: 100 mg Eye - Rabbit Standard Draize test: 10 mg Eye - Rabbit Standard Draize test: 100 mg/24H (RTECS)
Skin:	Administration onto the skin - Rabbit Standard Draize test: 500 mg Administration onto the skin - Rabbit LD50: 12800 mg/kg [Details of toxic effects not reported other than lethal dose value.] (RTECS)
Inhalation:	Inhalation. - Rat LC50: 16000 ppm/8H [Details of toxic effects not reported other than lethal dose value.] Inhalation. - Mouse LC50: 53000 mg/m3 [Behavioral - general anesthetic Lungs, Thorax, or Respiration - other changes] Inhalation. - Rat LC50: 72600 mg/m3 [Behavioral - general anesthetic Lungs, Thorax, or Respiration - other changes] (RTECS)
Ingestion:	Oral - Rat LD50: 5045 mg/kg [Behavioral - altered sleep time (including change in righting reflex) Behavioral - somnolence (general depressed activity)] Oral - Mouse LD50: 3600 mg/kg [Behavioral - altered sleep time (including change in righting reflex) Behavioral - somnolence (general depressed activity)] Oral - Mouse LD50: 3600 mg/kg [Behavioral - general anesthetic] Oral - Rat LD50: 5000 mg/kg [Behavioral - general anesthetic] (RTECS)

MATERIAL SAFETY DATA SHEET

Product Name: LIQUID SOLDER FLUX

SECTION 12 - ECOLOGICAL INFORMATION

Ecotoxicity:	No ecotoxicity data was found for the product.
Environmental Fate:	No environmental information found for this product.

SECTION 13 - DISPOSAL CONSIDERATIONS

Waste Disposal:	Consult with the US EPA Guidelines listed in 40 CFR Part 261.3 for the classifications of hazardous waste prior to disposal. Furthermore, consult with your state and local waste requirements or guidelines, if applicable, to ensure compliance. Arrange disposal in accordance to the EPA and/or state and local guidelines.

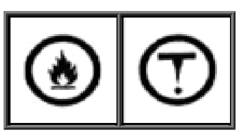
SECTION 14 - TRANSPORT INFORMATION

DOT Shipping Name:	Isopropanol, mixture
DOT UN Number:	UN1219
DOT Hazard Class:	3
DOT Packing Group:	II
Label:	3 Flammable Liquids
Description:	Soldering Flux
IATA Shipping Name:	Isopropanol, mixture
IATA UN Number:	UN1219
IATA Hazard Class:	3
IATA Packing Group:	II
IMDG UN NUmber :	UN1219
IMDG Shipping Name :	Isopropanol, mixture
IMDG Hazard Class :	3
IMDG Packing Group :	II
RID UN Number :	UN1219
RID Shipping Name :	Isopropanol, mixture
RID Hazard Class :	3
RID Packing Group :	II

SECTION 15 - REGULATORY INFORMATION

Canada Reg. Status:	This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all of the information required by the Controlled Products Regulations.
Canada WHMIS:	Controlled - Class: B2 Flammable Liquid Controlled - Class: D2B Toxic
Gum rosin :	
TSCA Inventory Status:	Listed
Canada DSL:	Listed
Isopropyl alcohol :	
TSCA Inventory Status:	Listed
Canada DSL:	Listed

WHMIS Pictograms



SECTION 16 - ADDITIONAL INFORMATION

GC Electronics believes that the information contained herein is accurate and reliable as of the date of this material safety data sheet, but no representation guarantee or warranty, express or implied, is made as to the accuracy, reliability or completeness of the information. Persons receiving information are encouraged to make their own determination as to the information's suitability and completeness for their particular application.
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Product Name: Liquid Solder Flux
MSDS Number: 112
Revision Date: 5/04/09
Supersedes Date: 8/16/06

MATERIAL SAFETY DATA SHEET

Complies with OSHA Hazard Communication Standard 29 CFR 1910.1200

Product Type:	Solder Flux		
Product Name:	**Liquid Solder Flux**		
Part Number(s):	**10-4202**	**Emergency Contact:**	**Chemtrec**
	10-4216	**Phone:**	**(800) 424-9300**

Section 1 – Identification of Product

Common Name: Liquid Solder Flux
Chemical Name: Rosin Solder Flux
Family Usage: Soldering Flux for Electrical or Electronic Applications
Description: Mixture of the substances listed below with non-hazardous additions.

HMIS RATINGS		NFPA RATINGS			
				Least	0
				Slight	1
Health	1	Health	1	Moderate	2
Flammability	3	Flammability	3	High	3
Reactivity	0	Reactivity	0	Extreme	4
Personal Protection	5			Gloves, Safety Glasses	B

Information pertaining to particular dangers for man and environment:


This product has to be labeled due to the calculation procedure of international guidelines. Has a narcotizing effect. Highly flammable. Irritating to eyes. May cause sensitization by skin contact. Vapors may cause drowsiness and dizziness.

Section 2 – Hazardous Ingredients/SARA III Information

Hazardous Ingredients 1% or greater Carcinogens 0.1% or greater	C.A.S. NUMBER	WEIGHT PERCENT	OSHA PEL	SHORT TERM REL	LONG TERM REL	ACGIH TLV SHORT TERM	ACGIH TLV LONG TERM
Propan-2-ol*	67-63-0	50-100	980 mg/m3 400 ppm	1225 mg/m3 500 ppm	980 mg/m3 400 ppm	1230 mg/m3 500 ppm	983 mg/m3 400 ppm
Rosin (Colophony)	8050-09-7	25-50	NE	NE	NE		

Notes: *Chemical subject to the reporting requirements of Section 313 of Title III of the U.S.A. Superfund Amendment and Reauthorization Act (SARA) of 1986 and 40 CFR Part 372.

Section 3 – Physical Data

Physical State at 20°C:	Liquid
Density at 20°C (68°F):	0.880 g/cm^3
Boiling Point (760 mm Hg):	180°F 82°C
Melting Point:	Undetermined
Vapor Pressure (mm Hg at 20°C):	33
Solubility in /Miscibility w/Water :	Partly miscible
Flash Point:	64°F (18°C)
Ignition Temperature:	797°F (425/0°C
Odor Threshold:	200 ppm for 2-propanol
Appearance and Odor:	Amber, liquid with alcohol odor

Section 4 – Fire and Explosion Hazards

Flammability:	Yes
Conditions to Avoid:	Sparks, open flames
Flash Point (T.O.C.):	65°F 18°C
Auto-Ignition Temperature:	750°F 399°C
Flammability Limits Percent by Volume in Air:	LEL: 2.0
	UEL: 12.0
Extinguishing Means:	CO2, sand, extinguishing powder. Do not use water.
Hazardous Combustion Products:	Carbon monoxide, carbon dioxide, aliphatic aldehydes.
Danger of Explosion:	Product is not explosive. However, formation of explosive air/vapor mixtures are possible.
Explosion Limits:	
Lower:	2.0 Vol %
Upper:	12.0 Vol %
Unusual Fire and Explosion Hazards:	A moderate explosion hazard exists when exposed to heat or flames.
For safety reasons unsuitable extinguishing Agents:	Water with full jet
In case of fire, the following can be Released:	Carbon monoxide (CO), carbon dioxide (CO2), aliphatic aldehydes
Protective equipment:	Wear self-contained respiratory protective device.

Section 5– Health Hazard Data

Emergency Overview:

Fumes during soldering are irritating to eyes and may cause headache and respiratory system irritation or damage. Prolonged or repeated exposure to rosin flux fumes during soldering may result in allergic reaction in a sensitive person, resulting in asthma symptoms. Harmful if swallowed. May cause allergic skin reaction. Flammable liquid and vapor.

ECC (Europe) Dangerous Substance Hazard Designation:	R-Phrases (Risks to Humans and the Environment): R11-Highly flammable. F=Easily Flammable R20/22-Harmful by inhalation and if swallowed. R42/43-May cause sensitization by inhalation and skin contact.
Exposure Limits:	Not determined for the product. See Section 2 for ingredients.
Primary Exposure:	Fumes during soldering will contain evaporated solvent and droplets of rosin and/or organic decomposition products.
Primary Routes of Entry:	__ Skin X Eyes X Inhalation X Ingestion
Target Organs:	Eyes, skin, mucous membranes and respiratory system.

Effects of Acute (severe short-term) Exposure:

Inhalation:	Flux fumes during soldering may cause irritation and damage of mucous membranes and respiratory system. High concentrations can cause headache, dizziness, narcosis and nausea.
Skin Contact:	Possible local irritation by contact with flux or fumes.
Skin Absorption:	None
Eye Contact:	Irritation from contact with liquid and smoke from soldering.
Ingestion:	May exhibit burning sensation in the digestive tract.

Effects of Chronic (prolonged) Exposure

Inhalation:	Vapors can cause headache, dizziness, narcosis and irritation of the mucous membranes. Smoke during soldering will contain resin which is an allergen that can cause eye irritation and respiratory system irritation and damage.
Skin Contact:	Prolonged or repeated contact with skin can cause a rash.
Medical Conditions Generally Aggravated by Exposure:	Chemical hypersensitivity, asthma and other respiratory conditions, existing eye and skin disorders. Continued breathing of high concentrations of solvent vapors can affect the liver and central nervous system.

First Aid Measures

Seek medical assistance for further treatment, observation and support if needed.

Eye Contact:	Rinse opened eye for several minutes under running water. If symptoms persist, consult a doctor..
Skin Contact:	Immediately wash with water and soap and rinse thoroughly.
Inhalation:	Remove person from exposure to fumes. Supply fresh air. Consult a doctor in case of complaints.
Ingestion:	Induce vomiting if person is conscious. Seek medical help.

Section 6–Reactivity Data

Chemical Stability:	X Stable __ Unstable
Conditions to Avoid:	
Thermal Decomposition:	No decomposition if used according to specifications.
Incompatibility (materials to avoid):	Strong oxidizing materials. Strong acids.
Hazardous Decomposition Products:	When heated to soldering temperatures, the solvents are evaporated and rosin may be thermally degraded to liberate aliphatic aldehydes and acids.
Hazardous Polymerization:	__ May Occur X Will Not Occur
Dangerous Reactions:	No dangerous reactions known.
Dangerous Products of Decomposition:	When heated to soldering temperatures, the solvents are evaporated and rosin may be thermally degraded to liberate alphatic aldehydes and acids.

Section 7-Spill or Leak Procedures

Procedures for Material Control

Steps to be Taken if Material is Spilled or Released:	Ensure adequate ventilation. Keep away from ignition sources. Use caution to avoid breathing fumes.
Measures for environmental Protection	Do not allow product to reach sewage system or any water course.:Prevent runoff into storm sewers and natural waterways.
Measures for cleaning/ collecting:	Absorb with clay, diatomaceous earth, dry sand or other inert material. Do not use combustible materials such as sawdust. Place in a chemical waste container. Keep out of waterways. Harmful to fish and other water organisms. Biodegradation is expected in a waste treatment plant. Emissions are photochemically reactive.
Waste Disposal Methods:	According to local regulations, usually by incineration. EPA Hazardous Waste Number is D001. Hazard Class is Ignitable Waste.
Caution:	Empty containers may contain product residue. Observe all label precautions
Ecological Information:	
General Notes:	Do not allow product to reach ground water, water course or sewage system.
Product Recommendation:	Must not be disposed of together with household garbage. Do not allow product to reach sewage system.
Uncleaned Packagings:	
Recommendation:	Disposal must be made according to official regulations.

Section 8 – Special Protection Information

Personal Protective Equipment
General Protective & Hygienic Measures: Keep away from foodstuffs, beverages and feed. Immediately remove all soiled and contaminated clothing. Wash hands before breaks and at the end of work. Avoid contact with the eyes and skin.

Ventilation to be used: Provide adequate exhaust ventilation (general and/or local) if necessary to meet exposure requirements. Local exhaust ventilation is preferred to minimize dispersion of smoke and fumes into the work area.

Respiratory Protection: When ventilation is not sufficient to remove fumes from the breathing zone, a NIOSH approved respirator or self-contained breathing apparatus should be worn.

Protective Gloves: Nitrile or natural rubber gloves where necessary to avoid skin contact. The exact break through time has to be found out by the manufacturer of the protective gloves and has to be observed.

Eye Protection: Safety glasses or tightly sealed goggles should be used.

Other Protective Clothing and Equipment: Impermeable apron is advised to avoid contact through clothing.

Hygienic Work Practices: Wash hands thoroughly after handling chemicals or solder containing lead before eating or smoking.

Exposure Limits:

Not determined for the product. See section 2 for ingredients. Rosin is an allergen. Prolonged or repeated exposure to fumes during soldering may result in allergic reaction In a sensitive person, resulting in eye and skin irritation and asthma symptoms.

Section 9 – Special Precautions

Waste Disposal Methods: According to local regulations, usually by incineration. EPA Hazardous Waste Number is D001. Hazard Class is Ignitable Waste.

Caution: Empty containers may contain product residue. Observe all label precautions

Precautions to be taken in handling and storage: Store in cool, dry conditions in well sealed receptacles. Store in a cool location. Store away from oxidizing agents. Store away from sources of ignition. Keep containers sealed when not in use. Open containers cautiously to allow venting of any internal pressure. Use grounding and bonding connection when transferring material to prevent static discharge, fire or explosion. Do not use a cutting torch or containers (even empty) as residual may explode.

Personal Precautions: Avoid breathing smoke/fumes generated during soldering. Avoid contact with eyes and skin. Ensure good ventilation/exhaustion at the workplace.

Information about Protection Against Explosions and Fire: Keep ignition sources away. Do not smoke. Protect against electrostatic charges.

Recommendation:	Must not be disposed of together with household garbage. Do not allow product to reach sewage system.

Section 10 – Regulatory Information

DOT Classification:	Isopropanol, mixture
Hazard Class:	3
UN #:	UN1219
Packing Group:	II
Label:	3
Description:	Soldering Flux

Land Transport ADR/RID (cross border):

ADR/RID Class:	3 Flammable Liquids
Danger Code (Kemler):	33
UN-Number:	1219
Packaging Group:	II
Description of Goods:	1219 Isopropanol, Mixture

Maritime Transport IMDG:

IMDG Class:	3
UN Number:	1219
Label:	3
Packaging Group:	II
EMS Number:	F-E,S-D
Marine Pollutant:	No
Proper Shipping Name:	Isopropanol, Mixture

Air Transport ICAO-TI and IATA-DGR:

ICAO/IATA Class:	3
UN/ID Number:	1219
Label:	3
Packaging Group:	II
Proper Shipping Name:	Isopropanol, Mixture

Toxicological Information:

Acute Toxicity:	Oral	LD50	5045 mg/kg (rat)
	Dermal	LD50	12800 mg/kg (rabbit)
	Inhalative	LC50/4 h	30 mg/l (rat)

Primary Irritant Effect:

Skin:	Possible local irritation by contact with flux or fumes.
Eye:	Smoke during soldering can cause eye irritation.

Inhalation:	Fumes during use may irritate mucous membranes and respiratory system. High concentrations can cause headache, dizziness, narcosis, and nausea. Flux fumes during soldering may cause irritation and damage of mucuous membranes and respiratory system.
Ingestion:	May cause gastrointestinal irritation.
Sensitization:	Sensitization possible through skin contact.
Additional Toxicological Information:	The product shows the following dangers according to internally approved calculation methods for preparations: Irritant
U.S.A.	All chemical substances in this product are listed in the EPA (Environmental Protection Agency) TSCA (Toxic Substances Control Act) Inventory.
California Proposition 65:	None
Carcinogenicity:	
67-63-0 Propanol-2-ol	
NTP	None
OSHA	None
IARC	None
TLV	None
NIOSH-Ca	None

Canada:
WHMIS (Workplace Hazardous Materials Information System)

Classification:	B2 D2B
Components on Ingredient List for WHMIS:	Rosin, Propan-2-ol

This product has been classified in accordance with the hazard criteria of the Canadian Controlled Product Regulations (CPR) and the MSDS contains all the information required by the CPR.

NA = Not Applicable NE = Not Established UN = Unknown

Hazard communication regulations, U.S.A. Occupational Safety and Health Act (OSHA) and Canada Workplace Hazardous Materials Information Systems (WHMIS), require that employees must be trained how to use a Material Safety Data Sheet as a source for Hazard information.

European Union:	The following information relates to product regulation specific to the directives of the European Union.
Europe:	European Council Directive 67/548/EEC
Dangerous Substance Hazard Classification:	F=Highly Flammable Xn=Harmful
R-Phrases (Risks to Humans or the Environment):	R11=Highly flammable. Irritating to eyes. R20/22=Harmful by inhalation and if swallowed. R42/43=May cause sensitization by skin contact. Vapors may cause drowsiness and dizziness.
S-Phrases (Safety pre-cautions for storing, handling and using the product):	Wear suitable gloves S2=Keep out of reach of children Avoid contact with skin and eyes. S7=Keep containers tightly closed. S16=Keep away from sources of ignition-No Smoking. S23=Do not breathe the fumes. S29=Do not empty into drains. Dispose of this material and its containers at hazardous or special waste collection points.

If swallowed, seek medical advise immediately and show this container or label.

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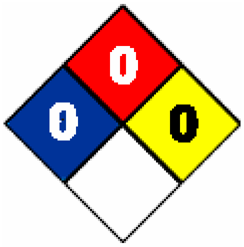
MATERIAL SAFETY DATA SHEET

Protective Clothing	NFPA Rating (USA)	EC Classification	WHMIS (Canada)	Transportation
Not required for normal use		Not Dangerous	Not Controlled	Not Regulated

Section 1: Product and Company Information

Product Name: Regular Soldering Flux Paste

Product Use: Soldering flux for copper, brass, galvanized iron, lead, zinc, tin, silver, nickel, mild steel, terne plate and malleable iron.

Manufacturer: LA-CO Industries, Inc.
1201 Pratt Boulevard
Elk Grove Village, IL.
60007-5746

Phone Number: (847) 956-7600

Fax: (847) 956-9885

24-hour Emergency: **CHEMTREC: (800) 424-9300**

Section 2: Composition and Ingredient Information

Hazardous/Dangerous Ingredients:

Chemical Name	CAS No.	Wt.%	EINECS / ELINCS	Symbol	Risk Phrases
Hydrochloric acid	7647-01-0	10 – 20	231-595-7	C, Xi	R34, R37
2-aminoethanol	141-43-5	7 – 13	205-483-3	Xn, C	R20/21/22; R34
Ammonium Chloride	12125-02-9	7 – 13	235-186-4	Xn, Xi	R22, R36
Stearic Acid	57-11-4	1 – 5	200-313-4	None	None

Note: See Section 8 of this MSDS for exposure limit data for these ingredients.
See Section 16 for the full text of the R-phrases above.

MATERIAL SAFETY DATA SHEET

Section 3: Hazards Identification

Preparation Hazards and Classification:

Normal use of this product is not expected to cause any harm or irritation to the user.

USA: This product is not a hazardous material as defined by 29 CFR1910.1200, OSHA Hazard Communication Evaluation.

Canada: This is not a controlled product under WHMIS.

European Communities (EC): This preparation is not classified as dangerous according to Directive 1999/45/EC and its amendments.

Appearance, Color and Odor: White colored paste

Primary Route(s) of Exposure: Inhalation, Ingestion

Potential Health Effects: **ACUTE (short term): see Section 8 for exposure controls**

Inhalation: Inhalation of vapors is not expected with normal use. Over exposure to high vapor concentrations may cause nasal and respiratory irritation, sore throat, coughing and difficulty breathing. High concentrations may also cause dizziness, headache, nausea, vomiting or in extreme cases, unconsciousness or asphyxiation.

Ingestion: Not an expected route of occupational exposure. Low oral toxicity. Ingestion of large quantities may cause abdominal and chest pain, nausea, vomiting, diarrhea or dizziness. Aspiration into the lungs may occur during ingestion of large quantities or vomiting, resulting in lung injury.

Skin: This product has been tested and found to be non-irritating to skin.

Eye: This product has been tested and found to be non-irritating to eyes. May be irritating as a foreign object in the eye.

CHRONIC (long term): see Section 11 for additional toxicological data

Chronic effects are not expected with normal use. Prolonged or repeated over exposure to high vapor concentrations may cause damage to the respiratory tract or lungs.

Medical Conditions Aggravated by Exposure: Not available

Section 4: First Aid Measures

Inhalation: No health effects expected. If symptoms are experienced remove source of contamination or move victim to fresh air and obtain medical advice.

Eye Contact: No health effects expected. If material becomes lodged in the eye, do not allow victim to rub eye(s). Let the eye(s) water naturally for a few minutes. Have victim look right and left, then up and down. If particle does not dislodge, flush with lukewarm, gently flowing water for 5 minutes or until removed, while holding eyelid(s) open. If irritation occurs, obtain medical attention. DO NOT attempt to manually remove anything stuck to the eye.

Skin Contact: No health effects expected. If irritation does occur, flush with lukewarm, gently flowing water for 5 minutes or until chemical is removed.

Ingestion: No health effects expected. If irritation or discomfort occurs, obtain medical advice.

MATERIAL SAFETY DATA SHEET

Section 5: Fire Fighting Measures

Extinguishing Media: Use water spray, carbon dioxide, dry chemical powder or foam.

Unusual Fire and Explosion Hazards: Sensitivity to mechanical impact: Not sensitive
Sensitivity to static discharge: Not sensitive

Fire Fighting Instructions: Self-contained breathing apparatus and protective clothing should be worn.

Hazardous Combustion Products: Carbon dioxide, carbon monoxide, ammonia, hydrochloric acid fumes, smoke and irritating and toxic fumes may be formed.

Section 6: Accidental Release Measures

Personal Precautions: Wear protective equipment. Keep unauthorized personnel away.

Environmental Precautions: Do not allow product to reach sewage systems or ground water.

Methods for Containment: Stop the spill if it is safe to do so. Contain spilled flux with earth, sand, or absorbent material which does not react with spilled material.

Methods for Clean-up: Scrape or scoop up the spilled material. Put material in suitable, labeled container. Flush area with water.

Section 7: Handling and Storage

Handling Avoid breathing fumes. Do not ingest. Keep away from children. Use this material with adequate ventilation. Keep container closed when not in use.

Storage: Store in a cool, dry area. Keep containers tightly closed when not in use. Store away from incompatible materials

MATERIAL SAFETY DATA SHEET

Section 8: Exposure Controls and Personal Protection

Exposure Limits

Ingredient	ACGIH TLV (8-hr. TWA)	U.S. OSHA PEL (8-hr. TWA)	Ontario (Canada) TWAEV	UK OEL (8-hr. TWA)
Hydrochloric acid	2 ppm CEL	5 ppm (7 mg/m^3) CEL	2 ppm CEV	1 ppm (2 mg/m^3); 5 ppm (8 mg/m^3) STEL
2-aminoethanol	3 ppm 6 ppm STEL	3 ppm (6 mg/m^3)	3 ppm (7.5 mg/m^3); 6 ppm (15 mg/m^3) STEV	1 ppm (2.5 mg/m^3); 3 ppm (7.6 mg/m^3) STEL
Ammonium Chloride	10 mg/m^3 (fume); 20 mg/m^3 STEL	Not established	10 mg/m^3; 20 mg/m^3 STEV	10 mg/m^3 (fume); 20 mg/m^3 STEL
Stearic Acid	Not established	Not established	Not established	Not established

CEL = Ceiling Exposure Limit
CEV = Ceiling Exposure Value
STEV = Short Term Exposure Value
STEL = Short Term Exposure Limit

Exposure Controls

Engineering Controls: Provide adequate ventilation/local exhaust to keep vapor concentrations below the exposure limits listed above.

A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 or Canadian Standards Association (CSA) Standard Z94.4-93 must be followed whenever workplace conditions warrant a respirator's use.

Personal Protection:

Respiratory Protection: Not required for normal use.

Skin Protection: Not required for normal use. Wear appropriate protective gloves and clean, body-covering clothing, when workplace conditions warrant their use.

Eye Protection: Not required for normal use. Wear appropriate safety goggles, when workplace conditions warrant their use.

Other Protective Equipment: If used during welding, wear appropriate equipment required for welding operations.

Hygiene Measures: Avoid breathing fumes. Keep container tightly closed when not in use. Wash hands thoroughly after handling this material. Maintain good housekeeping.

MATERIAL SAFETY DATA SHEET

Section 9: Physical and Chemical Properties

Physical State:	Paste	**Vapor Pressure: (mm Hg @ 25°C)**	Not available
Appearance:	White	**Vapor Density: (Air = 1)**	Not available
pH:	6.5 – 7	**Solubility in Water:**	Water soluble Fat insoluble
Relative Density: (water = 1)	1.1	**Water / Oil distribution coefficient:**	Not available
Boiling Point:	Not available	**Odor Type:**	Low odor
Freezing Point:	Not available	**Odor Threshold:**	Not available
Viscosity:	Not available	**Evaporation Rate: (n-Butyl Acetate = 1)**	Not available
Oxidizing Properties:	Not available	**Auto Ignition Temperature (°C):**	Not available
Flash Point and Method:	>204°C (400°F) TOC	**Flammability Limits (%):**	Not available

Section 10: Stability and Reactivity

Stability: Stable at normal temperature

Conditions to Avoid: No known conditions to avoid.

Incompatible Materials: Incompatible with strong oxidizing agents, strong acids, bases, amines, carbonates, aldehydes, acid chlorides and anhydrides, aluminum, cellulose nitrate, cyanides, sulfides, and potassium chlorate.

Hazardous Decomposition Products: Products of incomplete combustion may include ammonia, carbon dioxide and dense smoke. Heat can cause evolution of gaseous hydrogen chloride.

Possibility of Hazardous Reactions: Not available

Other Reactivity Concerns: Not available

MATERIAL SAFETY DATA SHEET

Section 11: Toxicological Information

Acute Toxicity Data

Ingredient	LD_{50} Oral (mg/kg)	LD_{50} Dermal (mg/kg)	LC_{50} Inhalation (4 hrs.)
Hydrochloric acid	238 - 277 (female rat) 700 (rat)	> 5 010 (rabbit)	544 ppm (mouse) 1 562 ppm (rat)
2-aminoethanol	1 720 (rat)	1 000 (rabbit)	1 210 mg/m^3 (mouse)
Ammonium Chloride	1 300 (mouse) 1 650 (rat)	Not available	Not available
Stearic Acid	> 5 000 (rat)	> 5 000 (rabbit)	Not available

Chronic Toxicity Data

Carcinogenicity: The table below indicates whether each agency has listed any ingredient as a carcinogen.

Ingredient	ACGIH	IARC	NTP
Hydrochloric acid	A4	Group 3	Not listed
2-aminoethanol	Not listed	Not listed	Not listed
Ammonium Chloride	Not listed	Not listed	Not listed
Stearic Acid	Not listed	Not listed	Not listed

ACGIH: (American Conference of Governmental Industrial Hygienists)
A4 – Not Classifiable as a Human Carcinogen.
IARC: (International Agency for Research on Cancer)
Group 3 – The agent is not classifiable as to its carcinogenicity in humans.
NTP: (National Toxicology Program)

Other Toxicity Data: Regular Soldering Flux Paste Toxicity Data: LD_{50} Oral: > 5 gm/kg (rat)
(Tested by Rosner-Hixson Laboratories; August 30, 1962)

Irritation: The product is essentially non-irritating to the eyes and skin. Application of the product to areas of intact and abraded rabbit skin produced no signs of skin irritation (Rosner-Hixson Laboratories; Aug 30, 1962).

Sensitization: Not applicable

Neurological Effects: Not applicable for normal use.

Teratogenicity: Not applicable

Reproductive Toxicity: Not applicable

Mutagenicity (Genetic Effects): Not applicable

Toxicologically Synergistic Materials: Not applicable

MATERIAL SAFETY DATA SHEET

Section 12: Ecological Information

Ecotoxicity: Not available

Mobility: Not available

Persistence and degradability: Not available

Bioaccumulative potential: Not available

Other adverse effects: Not available

Section 13: Disposal Considerations

Waste Disposal Method: Do NOT dump into any sewers, on the ground or into any body of water. Store material for disposal as indicated in Section 7 Handling and Storage.

USA: Dispose of in accordance with local, state and federal laws and regulations.

Canada: Dispose of in accordance with local, provincial and federal laws and regulations.

EC: Waste must be disposed of in accordance with relevant EC Directives and national, regional and local environmental control regulations. For disposal within the EC, the appropriate code according to the European Waste Catalogue (EWC) should be used.

Section 14: Transport Information:

U.S. Hazardous Materials Regulation (DOT 49CFR) Not regulated

Canadian Transportation of Dangerous Goods (TDG) Not regulated

ADR/RID: Not regulated

IMDG: Not regulated

Marine Pollutants: Not applicable

ICAO/IATA : Not regulated

MATERIAL SAFETY DATA SHEET

Section 15: Regulatory Information

NFPA Hazard Rating

Category	NFPA
Acute Health	0
Flammability	0
Instability	0

USA

TSCA Status: All ingredients in the product are listed on the TSCA inventory.

SARA Title III:
Sec. 302/304: None
Sec: 311/312: None
Sec. 313: None
CERCLA RQ Hydrochloric acid 5 000 lbs (2 270 kg); Ammonium Chloride 5 000 lbs (2 270 kg)

California Prop 65 : This product does not contain chemicals known to the State of California to cause cancer or reproductive toxicity.

State Right-to-Know Lists : Hydrochloric acid, 2-aminoethanol and Ammonium chloride can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.

Canada This product has been classified in accordance with the hazard criteria of the *Controlled Products Regulations* and the MSDS contains all the information required by the *Controlled Products Regulations*.

WHMIS Classification: Not Controlled

NSNR Status (New Substance Notification Regulations): All ingredients in the product are listed, as required, on Canada's Domestic Substances List (DSL).

NPRI Substances (National Pollutant Release Inventory): Hydrochloric acid is an NPRI reportable substance.

EC Classification for the Substance/Preparation:

Symbol: Not Dangerous

Risk Phrases: None

Safety Phrases: S1/2: Keep locked up and out of the reach of children.

MATERIAL SAFETY DATA SHEET

Section 16: Other Information

Full Text of R-phrases appearing in Section 2:	R20/21/22: Harmful by inhalation, in contact with skin, and if swallowed R22: Harmful if swallowed R34: Causes burns R36: Irritating to eyes R37: Irritating to respiratory system

Preparation Information:

Preparation Date:	August 11, 2005
Revision Date:	March 4, 2008
Revision Summary:	August 11, 2005: Preparation Date March 4, 2008: Updated Exposure Limits (Section 8) and Toxicological Information (Section 11).
Prepared by:	LEHDER Environmental Services Limited 704 Mara Street, Suite 210, Pt. Edward, ON N7V 1X4 www.lehder.com
Phone:	(519) 336-4101
Disclaimer:	While LEHDER Environmental Services Limited believes that the data set forth herein is accurate, as of the date hereof, LEHDER makes no warranty with respect thereto and expressly disclaims all liability for reliance thereon. Such data is offered solely for your consideration, investigation and verification.
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MATERIAL SAFETY DATA SHEET

Revised: March 8, 2013

Section 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name: DuPont™ Teflon® Multi-Use Lubricant - Aerosol

Product Use: Lubricant.

Manufacturer/Supplier: Finish Line Technologies
50 Wireless Blvd
Hauppauge, NY
11788

Phone Number: 631-666-7300

Emergency Phone: PROSAR: 1-800-217-5157
CHEMTREC: 1-800-424-9300

Date of Preparation: August 17, 2011

Section 2: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

DANGER

EXTREMELY FLAMMABLE. HARMFUL BY INHALATION. MAY CAUSE EYE IRRITATION. MAY CAUSE SKIN IRRITATION. CONTENTS UNDER PRESSURE. CONTAINER MAY EXPLODE IF HEATED. HARMFUL: MAY CAUSE LUNG DAMAGE IF SWALLOWED.

Potential Health Effects: See Section 11 for more information.

Likely Routes of Exposure: Skin contact, eye contact, inhalation, and ingestion.

Eye: May cause eye irritation.

Skin: May cause skin irritation.

Ingestion: Not a normal route of exposure. Harmful: may cause lung damage if swallowed.

Inhalation: Harmful by inhalation. May cause respiratory tract irritation. Intentional misuse by deliberately concentrating and inhaling the contents may be harmful or fatal. This product may be aspirated into the lungs and cause chemical pneumonitis.

Chronic Effects: Prolonged or repeated contact may dry skin and cause irritation.

Signs and Symptoms: Symptoms may include discomfort or pain, excess blinking and tear production, with marked redness and swelling of the conjunctiva. Symptoms may include redness, edema, drying, defatting and cracking of the skin. Headache. Sore throat. Cough. Laboured breathing. CNS depression. Vapours may cause drowsiness and dizziness.

Medical Conditions Aggravated By Exposure: Because of its irritating properties, product may aggravate preexisting skin, eye, and respiratory conditions.

Target Organs: Skin, eyes, gastrointestinal tract, respiratory system.

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

Potential Environmental Effects: May cause long-term adverse effects in the aquatic environment. See Section 12 for more information.

MATERIAL SAFETY DATA SHEET

Section 3: COMPOSITION / INFORMATION ON INGREDIENTS

Ingredient	CAS #	Wt. %
Distillates (petroleum), hydrotreated light	64742-47-8	15 - 40
Heptane, branched, cyclic and linear	426260-76-6	10 - 30
Heptane	142-82-5	10 - 30
Butane	106-97-8	5 - 10
Propane	74-98-6	5 - 10
Distillates (petroleum), hydrotreated light paraffinic	64742-55-8	3 - 7

Section 4: FIRST AID MEASURES

Eye Contact: In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If easy to do, remove contact lenses, if worn. Get medical attention immediately.

Skin Contact: In case of contact, immediately flush skin with plenty of soap and water. Remove contaminated clothing and shoes. Wash clothing before reuse. Call a physician if irritation develops and persists.

Inhalation: If breathed in, move person into fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Ingestion: DO NOT induce vomiting. If victim is conscious and alert, give 2 cupfuls of water. Never give anything by mouth to an unconscious person. Seek medical attention or call poison control.

General Advice: In case of accident or if you feel unwell, seek medical advice immediately (show the label or MSDS where possible).

Note to Physicians: Symptoms may not appear immediately.

Section 5: FIRE FIGHTING MEASURES

Flammability: Extremely flammable by WHMIS/OSHA criteria.

Means of Extinction:

Suitable Extinguishing Media: Powder, water spray, foam, carbon dioxide.

Unsuitable Extinguishing Media: Not available.

Products of Combustion: May include, and are not limited to: oxides of carbon, noxious fumes.

Explosion Data:

Sensitivity to Mechanical Impact: Not available.

Sensitivity to Static Discharge: Not available.

Protection of Firefighters: Containers may explode when heated. Keep upwind of fire. Wear full fire fighting turn-out gear (full Bunker gear) and respiratory protection (SCBA).

Section 6: ACCIDENTAL RELEASE MEASURES

Personal Precautions: Use personal protection recommended in Section 8. Isolate the hazard area and deny entry to unnecessary and unprotected personnel. Eliminate sources of ignition. Ruptured cylinders may rocket.

Environmental Precautions: Many gases are heavier than air and will spread along ground and collect in low or confined areas (sewers, basements, tanks). Keep out of drains, sewers, ditches, and waterways. Minimize use of water to prevent environmental contamination.

Methods for Containment: Contain and/or absorb spill with inert material (e.g. sand, vermiculite), then place in a suitable container. Do not flush to sewer or allow to enter waterways. Use appropriate Personal Protective Equipment (PPE).

Methods for Clean-Up: Scoop up material and place in a disposal container. Provide ventilation.

Other Information: Not available.

Section 7: HANDLING AND STORAGE

Handling:
Keep away from sources of ignition. No smoking. Avoid contact with skin and eyes. Do not swallow. Do not breathe gas/fumes/vapor/spray. Use only in well-ventilated areas. Launder contaminated clothing before reuse. When using do not eat or drink. Wash hands before eating, drinking, or smoking.

Storage:
Keep out of the reach of children. Keep container in a well-ventilated place. Do not store at temperatures above 49 °C / 120 °F. Store away from light.

Section 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Guidelines

	Exposure Limits	
Ingredient	**OSHA-PEL**	**ACGIH-TLV**
Distillates (petroleum), hydrotreated light	5 mg/m^3	5 mg/m^3
Heptane, branched, cyclic and linear	400 ppm	400 ppm
Heptane	400 ppm	400 ppm
Butane	Not available.	800 ppm
Propane	1000 ppm	1000 ppm
Distillates (petroleum), hydrotreated light paraffinic	Not available.	Not available.

Engineering Controls: Use ventilation adequate to keep exposures (airborne levels of dust, fume, vapor, etc.) below recommended exposure limits.

Personal Protective Equipment:

Eye/Face Protection: Wear eye/face protection.

Hand Protection: Wear suitable gloves.

Skin and Body Protection: Impervious protective clothing recommended.

Respiratory Protection: In case of insufficient ventilation, wear suitable respiratory equipment.

General Hygiene Considerations: Handle according to established industrial hygiene and safety practices.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Translucent.
Color:	White.
Odour:	Light petroleum odor.
Odour Threshold:	Not applicable.
Physical State:	Liquid.
pH:	Not applicable.

Viscosity:	< 10 cSt @ 40 °C (104 °F)
Freezing Point:	Not available.
Boiling Point:	Not available.
Flash Point:	Not available.
Evaporation Rate:	Not applicable.
Lower Flammability Limit:	Not applicable.
Upper Flammability Limit:	Not applicable.
Vapor Pressure:	Not applicable.
Vapor Density:	Not applicable.
Specific Gravity:	Not available.
Solubility in Water:	Insoluble.
Coefficient of Water/Oil Distribution:	Not available.
Auto-ignition Temperature:	Not available.
Percent Volatile, wt. %:	49
VOC content, wt. %:	49

Section 10: STABILITY AND REACTIVITY

Stability: Stable under normal storage conditions. Contents under pressure. Container may explode if heated. Do not puncture. Do not burn. Keep in a cool place.

Conditions of Reactivity: Heat. Incompatible materials.

Incompatible Materials: None known.

Hazardous Decomposition Products: May include, and are not limited to: oxides of carbon, noxious fumes.

Possibility of Hazardous Reactions: No dangerous reaction known under conditions of normal use.

Section 11: TOXICOLOGY INFORMATION

EFFECTS OF ACUTE EXPOSURE

Component Analysis

Ingredient	LD_{50} (oral)	LC_{50}
Distillates (petroleum), hydrotreated light	> 5000 mg/kg, rat	> 5.2 mg/L 4hr, rat
Heptane, branched, cyclic and linear	Not available.	103 g/m³ 4hr, rat
Heptane	5000 mg/kg, mouse	103 g/m³ 4hr, rat
Butane	Not available.	658 mg/L 4hr, rat
Propane	Not available.	658 mg/L 4hr, rat
Distillates (petroleum), hydrotreated light paraffinic	>5000 mg/kg, rat	3900 mg/m³ 4hr, rat

Eye: May cause eye irritation. Symptoms may include discomfort or pain, excess blinking and tear production, with marked redness and swelling of the conjunctiva.

Skin: May cause skin irritation. Symptoms may include redness, edema, drying, defatting and cracking of the skin.

Ingestion: Not a normal route of exposure. Harmful: may cause lung damage if swallowed.

Inhalation: Harmful by inhalation. May cause respiratory tract irritation. This product may be aspirated into the lungs and cause chemical pneumonitis. Vapours may cause drowsiness and dizziness.

EFFECTS OF CHRONIC EXPOSURE

Target Organs: Not available.

Chronic Effects: Not hazardous by WHMIS/OSHA criteria.

Carcinogenicity: Not hazardous by WHMIS/OSHA criteria.

Ingredient	Chemical Listed as Carcinogen or Potential Carcinogen *
Distillates (petroleum), hydrotreated light	I -3, G-A3
Heptane, branched, cyclic and linear	Not listed.
Heptane	Not listed.
Butane	Not listed.
Propane	Not listed.
Distillates (petroleum), hydrotreated light paraffinic	Not listed.

* See Section 15 for more information.

Mutagenicity: Not hazardous by WHMIS/OSHA criteria.

Reproductive Effects: Not hazardous by WHMIS/OSHA criteria.

Developmental Effects:

Teratogenicity: Not hazardous by WHMIS/OSHA criteria.

Embryotoxicity: Not hazardous by WHMIS/OSHA criteria.

Respiratory Sensitization: Not hazardous by WHMIS/OSHA criteria.

Skin Sensitization: Not hazardous by WHMIS/OSHA criteria.

Toxicologically Synergistic Materials: Not available.

Section 12: ECOLOGICAL INFORMATION

Ecotoxicity: Not available.

Persistence / Degradability: Not available.

Bioaccumulation / Accumulation: Not available.

Mobility in Environment: Not available.

Section 13: DISPOSAL CONSIDERATIONS

Disposal Instructions:
This material must be disposed of in accordance with all local, state, provincial, and federal regulations.

Section 14: TRANSPORTATION INFORMATION

DOT Classification
UN1950; AEROSOLS, Flammable; Class 2.1
ORM-D (≤ 1L)

TDG Classification
UN1950; AEROSOLS, Flammable; Class 2.1
Limited Quantity (≤ 1L)

Section 15: REGULATORY INFORMATION

Federal Regulations

Canadian: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

US: MSDS prepared pursuant to the Hazard Communication Standard (CFR29 1910.1200).

SARA Title III

Ingredient	Section 302 (EHS) TPQ (lbs.)	Section 304 EHS RQ (lbs.)	CERCLA RQ (lbs.)	Section 313
Distillates (petroleum), hydrotreated light	Not listed.	Not listed.	Not listed.	Not listed.
Heptane, branched, cyclic and linear	Not listed.	Not listed.	Not listed.	Not listed.
Heptane	Not listed.	Not listed.	Not listed.	Not listed.
Butane	Not listed.	Not listed.	Not listed.	Not listed.
Propane	Not listed.	Not listed.	Not listed.	Not listed.
Distillates (petroleum), hydrotreated light paraffinic	Not listed.	Not listed.	Not listed.	Not listed.

State Regulations

California Proposition 65:
This product does not contain a chemical known to the State of California to cause cancer, birth defects or other reproductive harm.

Global Inventories

Ingredient	Canada DSL/NDSL	USA TSCA
Distillates (petroleum), hydrotreated light	DSL	Yes.
Heptane, branched, cyclic and linear	DSL	Yes.
Heptane	DSL	Yes.
Butane	DSL	Yes.
Propane	DSL	Yes.
Distillates (petroleum), hydrotreated light paraffinic	DSL	Yes.

HMIS - Hazardous Materials Identification System

Health - 1 **Flammability -** 3 **Physical Hazard -** 0 **PPE –** B

NFPA - National Fire Protection Association:

Health - 1 **Fire -** 3 **Reactivity -** 0

Hazard Rating: 0 = minimal, 1 = slight, 2 = moderate, 3 = severe, 4 = extreme

WHMIS Classification(s):
Class A - Compressed Gas
Class B5 - Flammable Aerosol
Class D2B - Skin/Eye Irritant

WHMIS Hazard Symbols:

SOURCE AGENCY CARCINOGEN CLASSIFICATIONS:

OSHA (O) Occupational Safety and Health Administration.

ACGIH (G) American Conference of Governmental Industrial Hygienists.
A1 - Confirmed human carcinogen.
A2 - Suspected human carcinogen.
A3 - Animal carcinogen.
A4 - Not classifiable as a human carcinogen.
A5 - Not suspected as a human carcinogen.

IARC (I) International Agency for Research on Cancer.
1 - The agent (mixture) is carcinogenic to humans.
2A - The agent (mixture) is probably carcinogenic to humans; there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals.
2B - The agent (mixture) is possibly carcinogenic to humans; there is limited evidence of carcinogenicity in humans in the absence of sufficient evidence of carcinogenicity in experimental animals.
3 - The agent (mixture, exposure circumstance) is not classifiable as to its carcinogenicity to humans.
4 - The agent (mixture, exposure circumstance) is probably not carcinogenic to humans.

NTP (N) National Toxicology Program.
1 - Known to be carcinogens.
2 - Reasonably anticipated to be carcinogens.

Section 16: OTHER INFORMATION

Disclaimer:
The information contained in this document applies to this specific material as supplied. It may not be valid for this material if it is used in combination with any other materials. It is the user's responsibility to satisfy oneself as to the suitability and completeness of this information for the user's own particular use.

Expiry Date: August 17, 2014

Version #: 1.0

Prepared by: Nexreg Compliance Inc.
Phone: (519) 488-5126
www.nexreg.com

Appendix D
Spill Reports

SPL001

THIS SICK

SPILL SUN 4/3/88

7 GAL OF TRANSMISSION FLUID
AT THE FIRE DEPT.

SPILL SOAKED UP W/SPILL DRY
AND DISPOSED OF IN DUMPSTER
PER RECOMMENDATION OF
J. HENDERSON

SPILL REPORT

Date: April 13, 1988 Time: 10:30am

The southern transformer in the Bldg. 201/203 substation developed a leak (1 qt.) at the sample port. The transformers had been sampled April 7, 1988, by an outside contractor. It appears that the valve was not properly sealed after the sampling event. The leak was corrected and the spill cleaned up with paper towels and spill dry. The transformer (Serial #6436916) did not contain PCB's. Therefore, the disposal method is the WSTF landfill.

WIWPS # 20-99-08

ITEM	QTY	LOCATION	KVA	PHASE	PRIMARY VOLTAGE	SECONDARY VOLTAGE	POLE #	MFG	S/N	CONTENT (GALS)	PCB CONTENT	TEST DATE	COMMENTS
13													
14													
15													
16	1	BLDG 200 SUBSTATION	1000	3	24900	480/277	PAD	ESCO	12336127	685	NONE	TCI 10/85	1970
17	1	BLDG 201/203 SUBSTATION	1500	3	24900	480/277	PAD	ESCO	6436916	620	NONE	TCI 10/85	1970
18	1 1 1	250 AREA	167	1 1 1	24.9/14.4	480/277	POLE	ESCO	87IN52934 87IN52935 87IN52933	114 114 114			NEW 1987 NON-PCB
19	1	200 AREA PARKING LOT		1									
20	1	BLDG 201/203 SUBSTATION	300	3	24900	208/120	PAD	ESCO	9437388	295	NONE	TCI 10/85	1970
21	1	BLDG 201/203 SUBSTATION	300	3	24900	208/120	PAD	ESCO	2740114	304	2 PPM	TCI 10/85	1970
22													
23													
24	1	BLDG 300 SUBSTATION	1500	3	24900	480/277	PAD	GE	E-690843	520	20 PPM	TCI 8/85	1970

SPILL SUMMARY

On June 1, 1987, a stained area of soil was noted under building 253 (chemical storage building) in the 200 Area. Further investigation revealed that a 5 gallon oil container, which had been stored in the building since 1984, had developed a leak and lost its contents through the floor and into the soil beneath the building. The container still had its original seals on the top of the pail. The oil is a water soluble cutting oil from Texaco which is used in the Met. Lab. There was no MSDS for this chemical. Environmental Problem Report # 11, and DR 2-HWM-037, were issued in response to this release. An MSDS has been obtained by the Environmental Group.

SPILL SUMMARY

On June 24, 1987 at approximately 8:00 am a spill of paint occurred at the 100 Area main warehouse. Five 1-gallon cans of paint were dropped from the loading dock onto the asphalt during a transfer from the dock to a truck. Several of the cans came open and a spill of about one gallon occurred. This material was destined for the HELSTF facility. The first response taken was to wash off the paint which had splashed onto the truck. This practice of washing down a spill prior to determining the hazards involved with the spilled material is not a correct action. There is, however, no written procedure(s) readily available which outlines what is to be done in response to a spill. The warehouse was aware, because of other recent spills, that the Environmental Group should be notified and did provide prompt notification to the Environmental Group. The Environmental Group arrived on the scene to find about one gallon of paint had been spilled and that the limited washdown had not resulted in any soil contamination, and the washwater was still on the asphalt. The next step in the cleanup was to identify the paint and the hazardous constituents, if any. There was not an MSDS at the warehouse or in the Safety office for this product. The information on the label indicated that the paint was water-based. The label also provided the manufacturers name. A call was placed to the manufacturer to determine the hazardous nature of the paint. The paint was determined to be non-hazardous and was picked up with the use of spill pillows and sand which were disposed of in a dumpster. The remaining material was washed down with water.

INSIGHTS FROM THIS SPILL

PROBLEM
This paint was traced back to a specific MR (attached) which specified that an MSDS was not required for this product. The lack of an MSDS can result in resource overkill, eg., the use of self contained breathing apparatus and fully encapsulating suits for the cleanup of a chemical that is later determined to be non-hazardous.

PROBLEM
Spill pillows are a restricted item and the Environmental Group is not on the list of people authorized to sign for them.

PROBLEM
If this spilled material had been a hazardous material the response would have been delayed until paperwork could be written, signed, logged, and scheduled to work. There are also special training requirements for workers involved in the clean up of hazardous waste spills.

PROBLEM
There are no site wide, readily available, procedures to follow in the event of a spill.

SPILL REPORT

DATE: November 18, 1988 **TIME:** 9:30 a.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: David Barrera, Warehouse

WHAT WAS SPILLED: Given Black Enamel Paint

QUANTITY: 1 gallon **LOCATION:** Inside Bldg. 120

WHO WAS NOTIFIED (WSTF): I.D. Smith, 100 Area Emergency Coord.

R. Mitchell, WSTF Environmental Emergency Coordinator

DESCRIPTION: A can of paint was dropped and spilled on the floor of the warehouse. The Safety Department was contacted for an MSDS, but was not able to find one for the spilled material. Based on information previously obtained by the Environmental Section, the paint was assumed to be a mineral spirit based paint with no heavy metal content. The flash point was assumed to be less that 140^{0}F. Based on this information TPS 6-HWM-056 was implemented as a work authorizing document for spill response. A Facilities Service Section hazardous waste handler was used for the clean-up. Using rags, spill pillows, and mineral spirits the spill was collected and the floor cleaned. The collected liquids were placed in paint drum #3A in the Drum Storage Facility. The rags and spill pillows were allowed to dry and were placed into the landfill.

RESPONSE COST

ITEM	COST $	CHARGE
Spill Pillows	$ 20.00	JBL
Rags, Drum Liner, etc.	30.00	JBL
1 Hour M & C Tech.	28.00	JBL
2 Hours ES Engineer	56.00	JAA
	$ 134.00	

Lockheed Engineering and Management Services Company, Inc.

INTERDEPARTMENTAL COMMUNICATION

						DATE	ES88-208 12/15/88		
TO	Bob Mitchell	DEPT./ ORGN.	NASA	BLDG. ZONE	100	PLANT/ FAC.	WSTF		
FROM	Peter H. Pache	DEPT./ ORGN.	40-01	BLDG. ZONE	100	PLANT/ FAC.	WSTF	EXT.	5451

SUBJECT: Isopropyl Alcohol Spill - 400 Area

The Propulsion Test Department was performing maintenance on their 10,000-gallon isopropyl alcohol (IPA) storage tank on Monday, December 5, 1988. In order to completely empty the tank of all liquids, approximately 1,500 gallons of IPA was placed in two galvanized metal storage tanks (cattle tanks). When work was begun Tuesday, December 6, it was noticed that the soil under one tank was damp. The IPA was pumped into a second tank which also began to leak once the liquid reached a 3-foot level. After this, the liquid was placed back into the IPA storage tank. The soil contaminated with IPA was collected, placed in a cattle tank, and covered.

Isopropyl alcohol is not a reportable quantity material, therefore reporting to outside regulatory authorities was not required. The contaminated soil is awaiting disposition. There is approximately 1,100 gallons (147 cu. ft.) of contaminated soil. Our Section recommends that the soil be sampled and analyzed for flash point. If the flash point of the soil is less than 140°F, the soil is regulated as an ignitable hazardous waste and the recommended disposal would be off-site incineration. If the flash point is greater than 140°F (which is highly likely), the soil would not be a regulated waste and could be disposed of on site.

The cattle tanks which leaked were marked "leaks" and set aside. It is suspected that the lower surface tension of IPA compared to water could explain why the IPA leaked. Prior to using these particular tanks elsewhere, they will be leak tested with water. If this leak test fails, the tanks will be replaced.

Please inform either myself or Joe Hossley on the sampling, analysis, and disposal steps to be taken for the collected contaminated soil.

Peter H. Pache
Supervisor, Environmental Section
LESC/WSTF Operations

kjs

cc:
NASA:
R. Tillett
W. Waldrip
I.D. Smith
LESC:
J. Schentrup
R. Wingfield
B. Silver

NASA WHITE SANDS TEST FACILITY

SAMPLE IPA SPILL RESIDUE

CHEMICAL ANALYSIS REPORT

March 22, 1989

TPS-4-HWM-044

Source:	NASA WHITE SANDS, New Mexico
Site Description:	Dirt stored in stock tank adjacent to 400 Area IPA storage tank.
Sample Type:	Dirt
Parameter:	Flash Point (Ignitability)

QUALITY ASSURANCE FLAGS AND PARAMETERS

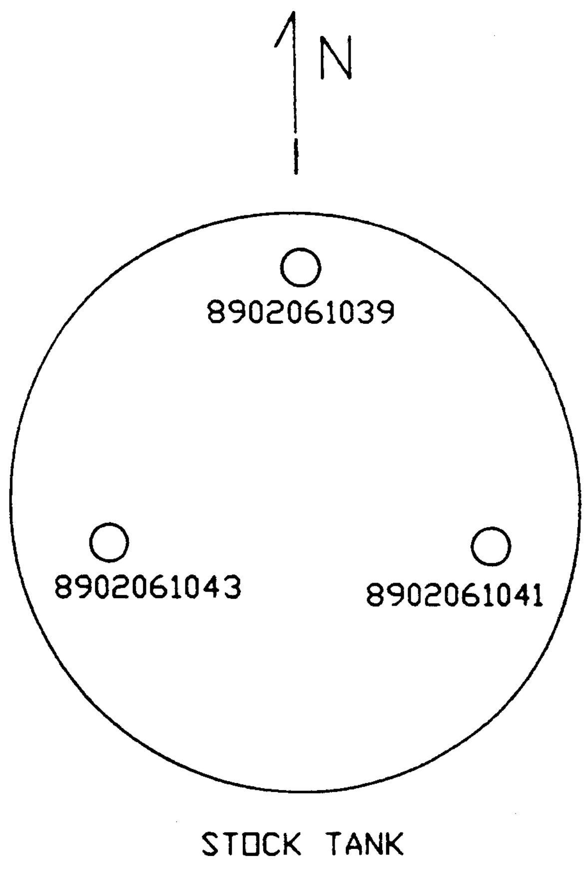
Notes: Results are flagged with a designated Quality Assurance parameter only when a problem is found.

- A indicates the analyst's check standard was outside standard limits.
- RB indicates the analyte was detected in the laboratory reagent blank.
- TB indicates the analyte was detected in the trip blank.
- EB indicates the analyte was detected in the equipment blank.
- FB indicates the analyte was detected in the field blank.
- Q indicates the result for the analyte in a blind control was outside standard limits.
- QD means the precision for duplicate analysis was outside the standard limits.
- T indicates the sample was analyzed outside the specified holding time.
- J indicates an estimated value outside the range of calibration.
- G indicates a value was greater than the indicated calibration limit.
- NC indicates not calculated.
- NA means not analyzed/not applicable.
- ND means not detected at the reporting limit.
- NS value not supported by certified standards.

"Reporting limit" indicates the minimum concentration for which calibration has been established.

SAMPLING PROCEDURE

The soil contained in a 1000-gallon stock tank located near the 400 area was sampled. Samples were taken with a stainless steel scoop, six inches below the surface, at three distinct locations within the stock tank. During sampling, a slight alcohol odor was detected by the sampling team. The diagram below illustrates the sample locations and the sample identification numbers.



CHEMICAL ANALYSIS DATA

General Inorganics
Location: 400-Area Stock Tank
Sample # 8902061039
Date Sampled: 02/06/89
Time Sampled: 10:39

Laboratory: RMAL
Date Received: 02/08/89
Date Analyzed: 02/15/89

Method	Parameter	Units	Result	Reporting Limit	QA Flag
1010/1020	Flash Point	°C	69	NA	

CHEMICAL ANALYSIS DATA

General Inorganics
Location: 400-Area Stock Tank
Sample # 8902061041
Date Sampled: 02/06/89
Time Sampled: 10:41

Laboratory: RMAL
Date Received: 02/08/89
Date Analyzed: 02/15/89

Method	Parameter	Units	Result	Reporting Limit	QA Flag
1010/1020	Flash Point	°C	69	NA	

CHEMICAL ANALYSIS DATA

General Inorganics
Location: 400-Area Stock Tank
Sample # 8902061043
Date Sampled: 02/06/89
Time Sampled: 10:43

Laboratory: RMAL
Date Received: 02/08/89
Date Analyzed: 02/15/89

Method	Parameter	Units	Result	Reporting Limit	QA Flag
1010/1020	Flash Point	°C	ND	NA	

COMMENTS AND QUALITY ASSURANCE PROCEDURES

1. IPA means 2-propanol or isopropyl alcohol.

2. No QA/QC data were provided by the analyst.

3. All specified sampling and chain of custody procedures were followed.

4. No blind controls were provided.

Prepared By: Jan Kilduff

Jan Kilduff
Scientist
Lockheed-ESC

Prepared By: Ben Greene

Ben Greene
Scientist
Lockheed-ESC

Prepared By: Keith Burke

Keith E. Burke
Laboratory Quality Assurance
Lockheed-ESC

Approved By: R. P. Jbr

Robert Johnson
Chemistry Laboratory Supervisor
Lockheed-ESC

Approved By: Harry L. Johnson

Harry Johnson
Laboratory Manager
NASA Laboratories Office

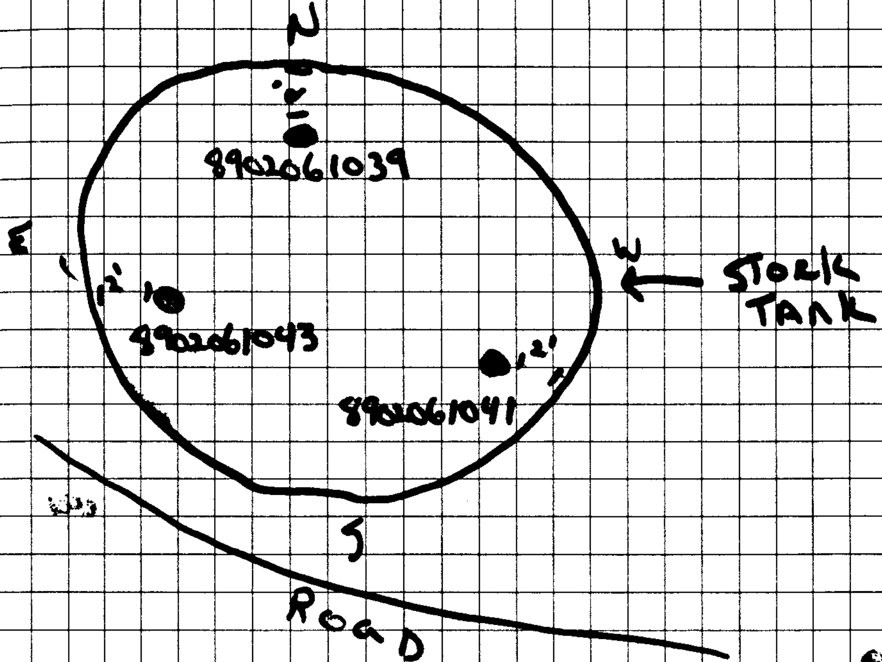
Bottle
500 ml P
1 l Glass
1 l Glass
PLASTIC 500 ml
1 l glass
40 ml glass
1 l glass
500 ml P
1 l glass

250 ml P

Arrive @ 400 Area IPA Stock Tank at 1038, C. Warner + P. Matthews Present.

Soil samples were taken with S.S. scoop 6" below surface of soil in stock tank

IPA odor was observed



SAMPLE	Parameter	Lab
8902061039	Flash Point	
-1041	"	
-1043	"	

Secured area at 1050

Continued on Page

Read and Understood By

Signed	Date	Signed	Date
[signature]	2-6-87		

…ued on Page
Date

LABORATORY WORK ORDER

REQUESTED BY	NEED DATE	PRIORITY	W.O. NUMBER	T & D RECEIVED
J Henderson				

ORGANIZATION	PHONE	PROMISED DATE	TASK NUMBER	T & D COMPLETED
LSSC			033JBL00	

SUPERVISOR	WORK CONTACT	PHONE	LABORATORY FILE NUMBER	DOCUMENTATION (1)
P Parke			661191	

DELIVERED TO	LAB (1)	HOURS	LAB (3)	HOURS	DOCUMENTATION (2)

DATE DELIVERED	LAB (2)	HOURS	LAB (4)	HOURS	DOCUMENTATION (3)

BRIEF DESCRIPTION (MFR - MODEL - SER. NO.) (IDENTIFY IF CHEMICAL/METALLIC ETC.)

COMMENTS

SERVICES REQUESTED

Sample + analyze per TPS

CHEM & MET. LABS ONLY

APPLICABLE SPECS	SAMPLE TAKEN FROM	TPS NO.
	Dist 4 area IPA	4-H0V-044

ADDITIONAL COMMENTS

SAMPLE RECEIVED BY | DATE | TIME

ITEM	LABORATORY OPERATION OR COMMENTS	TECH	QA	OTHER
	See attached report.			
	R P Jok 03/29/89			

REMARKS

(TECH APPROVED FOR WORK)

WSTF-122

SPILL REPORT

DATE: December 19, 1988 **TIME:** 1:15 p.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: Gary Charles, Warehouse

WHAT WAS SPILLED: Hydrofluoric Acid (HF)

QUANTITY: 2 ounces **LOCATION:** Inside Bldg. 120

WHO WAS NOTIFIED (WSTF): Dale Ready, Emergency Center

DESCRIPTION: Eight gallons of 52% hydrofluoric acid (HF) were received by the warehouse from VWR Scientific. The HF was packed in 1-gallon containers, four per box. The boxes appeared wet on the bottom, so Gary Charles called me to investigate. The moisture was determined to be HF by using pH paper. It appeared that the bottles had leaked from the top, perhaps from being stored on their sides during transit. A warehouse technician, Lawrence Gloria, who had handled the boxes, was sent to the dispensary as a safety measure. Donna Simon, a warehouse technician who went through the hazardous waste handlers training last week, repackaged the boxes in a drum liner (a large heavy trash bag). The Emergency Center (Dale Ready) was notified of the spill and asked to relay the information on the spill to I.D. Smith and R. Mitchell. The Emergency Center contacted I.D. Smith and R. Mitchell. This spill did not involve a reportable quantity. On December 22, 1988, with assistance from Laboratory Services Section, the HF was transported to the clean room pad and decontaminated. The boxes and other decontaminated items were placed in the trash and the HF was placed into stock (Bldg. T-253) for future use by the Laboratory Services Section.

SPILL REPORT

SPL023

DATE: January 10, 1989 **TIME:** 3:20 p.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: Gary Charles, Warehouse

WHAT WAS SPILLED: Plastic Polish, Novus No. 1

QUANTITY: 8 ounce **LOCATION:** Inside Bldg. 120

WHO WAS NOTIFIED (WSTF): Robert Mitchell, I. D. Smith

DESCRIPTION: One 8-ounce bottle of plastic polish (a stock item) was spilled. The material was wiped up with rags and the rags were bagged. No MSDS was found on site for the product. The manufacturer was contacted January 11, 1989, and an MSDS was requested. Information obtained from the phone call indicates that the polish contains isopropyl alcohol as the only hazardous ingredient. The flash point of the product is 200°F. The residue is non-hazardous and will be placed in the WSTF landfill.

SPILL REPORT

SPL024

DATE: February 2, 1989 TIME: 2:15 p.m.

NAME OF PERSON COMPLETING FORM: Joseph B. Hossley, Environmental Section

NAME OF PERSON REPORTING SPILL: Irene Portillo, x5167

WHAT WAS SPILLED: Gasoline (unleaded)

QUANTITY: 5-10 gallons LOCATION: 113 Yard @ gas pumps

WHO WAS NOTIFIED (WSTF): Robert Mitchell, I. D. Smith

DESCRIPTION: Approximately 5-10 gallons of gasoline spilled when the gas pump didn't shut off and a vehicle's gas tank was over-filled. Vermiculite (Floor-Dri) was spread on the spill. After sitting overnight, the vermiculite will be collected and placed in a drum. The waste will be disposed of in the WSTF landfill after airing out.

SPILL REPORT

SPL025

DATE: February 15, 1989 **TIME:** 7:30 a.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: Irene Portillo, x5167

WHAT WAS SPILLED: Gasoline

QUANTITY: 2-3 gallons **LOCATION:** Bldg. 113, gas pumps

WHO WAS NOTIFIED (WSTF): Robert Mitchell, NASA

DESCRIPTION: The automatic shut-off on the unleaded gas pump failed resulting in a spill. Spill dry was used to absorb the spilled gas. The spill dry will be swept up and placed in a drum. The waste will be disposed of in the WSTF landfill after airing out.

Lockheed Engineering and Management Services Company, Inc.

INTERDEPARTMENTAL COMMUNICATION

ES89-047

DATE 02/15/89

TO	R. E. Wingfield	DEPT./ORGN.	40-20	BLDG./ZONE	100	PLANT/FAC.	WSTF		
FROM	Peter H. Pache	DEPT./ORGN.	40-01	BLDG./ZONE	101	PLANT/FAC.	WSTF	EXT.	5464

SUBJECT: Gasoline Spill

On February 2 and 15, 1989, spills of gasoline have occurred from the unleaded gas pump. The attached spill reports provide details of the spills and cleanups.

Peter H. Pache, Supervisor
Environmental Section
LESC/WSTF Operations

kjs

Attachments: a/s

cc: J. Schentrup
C. Coburn

FORM LEMSCO 426-1

SPILL REPORT SPL026

DATE: February 21, 1989 **TIME:** 1:18 p.m.

NAME OF PERSON COMPLETING FORM: James Henderson, Environmental Section

NAME OF PERSON REPORTING SPILL: Byron Moore, x5744

WHAT WAS SPILLED: Hydraulic Fluid

QUANTITY: 2 liters **LOCATION:** Bldg. 800, Rm. 119

WHO WAS NOTIFIED (WSTF): Harry Johnson, NASA

DESCRIPTION: A bottle of hydraulic fluid was dropped inside on the floor. The oil was soaked up using rags and the rags placed in the dumpster.

SPILL REPORT SP031

DATE: March 16, 1989 **TIME:** 1000 hours

NAME OF PERSON COMPLETING FORM: Ray Spencer & Joe Hossley, Environmetal Sect.

NAME OF PERSON REPORTING SPILL: Ron Pridmore, Warehouse

WHAT WAS SPILLED: Sulfuric Acid (Electrolyte Battery Fluid)

QUANTITY: < 1 ounce **LOCATION:** Bldg. 120 Dock

WHO WAS NOTIFIED (WSTF): Sam Carr, WSTF Emergency Center

DESCRIPTION: Electrolyte Battery Fluid (Sulfuric Acid) delivered by NAPA was accepted by the warehouse. Inspection following acceptance showed that six containers (5 gallons each) out of the 40 in the shipment had apparently leaked in transit. The outer cardboard boxes on these containers were wet and discolored, but it appeared that no liquid had leaked past the box. Two of the warehouse hazardous waste spill responders (Donna Simon and Charlie Davis) separated out the damaged containers, packaged them, and loaded them onto the Environmental Section's truck. The containers were then transported to Contamination Control. The acid, diluted 50% with water, will be drained into the 200 Evaporation Tank System by Contamination Control. The empty containers will be rinsed (with the rinsate also going to the 200 Area Evaporation Tank System) and then discarded in the WSTF landfill (via dumpster).

Joseph B Hossley
3-16-89

SPL033

SPILL REPORT

DATE: April 17, 1989 TIME: 1305 hrs

NAME OF PERSON COMPLETING FORM: J. B. Hossley

NAME OF PERSON REPORTING SPILL: Save Santner (x5125)

WHAT WAS SPILLED: Oil (Non-contaminated)

QUANTITY: ~2 quarts

LOCATION: Test Stand 401

WHO WAS NOTIFIED (WSTF): WSTF Emergency Center

DESCRIPTION: Oil leaking out at water pumps in front of Test Stand 401. Oil is not contaminated with fuel or oxidizer. Oily dirt will be collected, placed on plastic, allowed to dry, and disposed of at WSTF landfill. Oil leak will be investigated and repaired.

SPL034

SPILL REPORT

DATE: April 18, 1989 TIME: 0855 hrs

NAME OF PERSON COMPLETING FORM: James Henderson

NAME OF PERSON REPORTING SPILL: Gary Charles, Warehouse

WHAT WAS SPILLED: Kodak 1st Dev. Rep, Proc. R3

QUANTITY: <1 gallon

LOCATION: 120 warehouse

WHO WAS NOTIFIED (WSTF): R. Mitchell, NASA

DESCRIPTION: A case (6 - 1 quart bottles) of replenisher was received which had some leakage onto the box. The individual containers were rinsed with water and placed into a new box. The wash water was drained to the sewage lagoon and the box was placed in the dumpster. The replenisher will be placed into stock and issued as needed.

MATERIAL SAFETY DATA SHEET

EASTMAN KODAK COMPANY
343 State Street
Rochester, New York 14650

For Emergency Health, Safety, and Environmental Information, call 716 722-5151
For other purposes, call the Marketing and Distribution Center in your area.

Date of Preparation: 6/02/86 Kodak Accession Number: 427739

SECTION I. IDENTIFICATION

- Product Name: KODAK First Developer Replenisher, Process R-3, MX 1238
- Formula: Aqueous Mixture
- Kodak Photographic Chemicals Catalog Number(s): CAT 824 4931 - To Make 5 Litres
- Solution Number: 4816
- Kodak's Internal Hazard Rating Codes: R 1 S: 2 F: 0 C: 0

SECTION II. PRODUCT AND COMPONENT HAZARD DATA

A. PRINCIPAL COMPONENT(S):

PRINCIPAL COMPONENT(S):	Weight Percent	ACGIH TLV(R)	Kodak Accession No.	CAS Reg. No.
Water	60-70	---	035290	7732-18-5
Potassium sulfite	10-15	---	907064	10117-38-1
Potassium/Sodium carbonate mixture	10-15	---	---	---
*Potassium hydroquinone monosulfonate	5-10	---	911867	21799-87-1

*Principal Hazardous Component(s)

B. PRECAUTIONARY LABEL STATEMENT(S):

CONTAINS: potassium hydroquinone monosulfonate
WARNING!
CAN CAUSE ALLERGIC SKIN REACTION
Avoid prolonged or repeated contact with skin.
First Aid: In case of skin contact, immediately wash with soap and plenty of water. Get medical attention.

Skin: Flush skin with plenty of water and wash with a non-alkaline (acid) type of skin cleanser. If skin irritation or an allergic skin reaction develops, get medical attention.

SECTION VII. VENTILATION AND PERSONAL PROTECTION

A. VENTILATION: Good general ventilation should be sufficient.

B. SKIN AND EYE PROTECTION:

Safety glasses are recommended.
Impervious gloves should be worn.
The routine use of a non-alkaline (acid) type of skin cleanser and regular cleaning of working surfaces, gloves, etc, will help minimize the possibility of allergic skin reaction.

SECTION VIII. SPECIAL STORAGE AND HANDLING PRECAUTIONS

Keep container tightly closed and away from strong acids.

SECTION IX. SPILL, LEAK, AND DISPOSAL PROCEDURES

Flush material to an acid-free sewer with large amounts of water. Discharge, treatment, or disposal may be subject to federal, state, or local laws.

SECTION X. ENVIRONMENTAL EFFECTS DATA

This chemical formulation has not been tested for environmental effects. Some laboratory test data and published data are available for the major components of this chemical formulation, and these data have been used to provide the following estimate of environmental impact:1-4

This chemical formulation has a low biological oxygen demand, and it is expected to cause little oxygen depletion in aquatic systems. It is expected to have a moderate potential to affect the germination of some plants. It is expected to have a low potential to affect aquatic organisms, secondary waste treatment microorganisms, and the growth of some plants. The components of this chemical formulation are biodegradable and are not likely to bioconcentrate. The direct instantaneous discharge to a receiving body of water of an amount of this chemical formulation which will rapidly produce, by dilution, a final concentration of 100 mg/L or less is not expected to cause an adverse environmental effect. After dilution with a large amount of water, followed by secondary waste treatment, the chemicals in this formulation are not expected to have any adverse environmental impact.

SPL035

SPILL REPORT

DATE: April 28, 1989 TIME: 1:50 pm

NAME OF PERSON COMPLETING FORM: J. Henderson JH

NAME OF PERSON REPORTING SPILL: John Bernal

WHAT WAS SPILLED: Tetraethylene Pentamine

QUANTITY: < 1 ounce

LOCATION: 120 Warehouse

WHO WAS NOTIFIED (WSTF): R. Mitchell, NASA

I. D. Smith, NASA

DESCRIPTION: A 1-gallon container was received by the warehouse. When the box was opened to check the contents, some leakage was noted around the cap. The residue was wiped up with paper towels and placed in a box. The box containing vermiculite and paper towels was determined to be non-hazardous and placed in the dumpster.

MORTON THIOKOL, INC.
Morton Chemical Division

Material Safety Data Sheet

SECTION I: PRODUCT IDENTIFICATION

PRODUCT NAME:	EM-308
CHEMICAL NAME:	Amide Reaction Product of Tall Oil and Tetraethylene pentamine
COMMON NAME:	Amide Reaction Product of Tall Oil and Tetraethylene pentamine
CAS NUMBER:	None
PRODUCT USE:	Epoxy Flexibilizer and Hardener
EMERGENCY PHONE:	815-338-1800 (24 hours/day)
OTHER EMERGENCY PHONE:	312-807-3142
EFFECTIVE DATE:	October 1987
SUPERSEDES:	January 1987

SECTION II: HAZARDOUS INGREDIENTS

CHEMICAL NAME/COMMON NAME	%	CAS NO.	OSHA PEL	ACGIH/TLV TWA	STEL
Tetraethylene pentamine/TEPA	1-10	112-57-2	Not established		
Other alkylethylene amines	1-5	------	Not established		

SECTION III: PHYSICAL DATA

BOILING POINT (760 mm Hg):	318 degrees C (for tetraethylene pentamine)
SPECIFIC GRAVITY (Water = 1):	0.950
VAPOR PRESSURE (mm Hg):	< 0.001mm @ 20 degrees C
VAPOR DENSITY (Air=1):	> 1
% NONVOLATILE:	100% (at 120 degrees C)
pH:	9.8
EVAPORATION RATE (Ether=1):	<< 1
SOLUBILITY IN WATER:	Complete
APPEARANCE:	Clear amber liquid
ODOR:	Slight Amine odor

SECTION IV: FIRE AND EXPLOSION DATA

FLASH POINT: > 200 degrees F (> 93 degrees C)
METHOD USED: SETAFLASH

FLAMMABLE LIMITS Lel: Not Applicable
Uel: Not Applicable

EXTINGUISHING MEDIA: Water, carbon dioxide, dry chemical, foam.

SPECIAL FIRE FIGHTING PRACTICES: Fire fighters should wear NIOSH-MSHA approved self-contained positive pressure breathing apparatus.

UNUSUAL FIRE AND EXPLOSION HAZARDS: None as far as known.

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon monoxide, carbon dioxide, oxides of nitrogen, ammonia, and possibly some aldehydes and inorganic acids.

SECTION V: HEALTH HAZARD DATA

ORAL TOXICITY: Rats: LD50: 3.23g/Kg

DERMAL TOXICITY: A skin irritant.

EYE TOXICITY: Corrosive to the eye.

INHALATION TOXICITY: Not established for the product.

SENSITIZATION: TEPA: Consider a skin and pulmonary sensitizer.

CHRONIC TOXICITY:
- Carcinogen: Unknown.
- Teratogen: Unknown.
- Mutagen: Unknown.

EFFECTS OF OVEREXPOSURE:

INGESTION:	May cause gastrointestinal irritation, nausea, and vomiting.
SKIN CONTACT:	Will cause irritation. Repeated or prolonged contact may cause dermatitis, sensitization.
EYE CONTACT:	Will cause severe eye irritation and corneal edema. Corrosive to eye tissue.
INHALATION:	Unknown for product. May cause irritation and pulmonary sensitization and asthmatic-type reaction.
ACUTE SYSTEMIC:	Unknown.
CHRONIC SYSTEMIC:	Unknown.

NOTES: Persons with preexisting skin disorders may be more susceptible to dermal contact.

SECTION VI: EMERGENCY HEALTH AND FIRST AID PROCEDURES

INGESTION: Seek medical attention, if unavailable contact nearest Poison Control Center.

SKIN CONTACT: Promptly remove all contaminated clothing; shower if necessary. Wash with soap and water. If irritation is present after washing, get medical attention immediately.

EYE CONTACT: Flush with large amounts of fresh water for 15 minutes lifting upper and lower eyelids frequently. Get medical attention immediately.

INHALATION: Remove to fresh air. If breathing has stopped, perform artificial respiration. Keep affected person warm and at rest. Get medical attention immediately.

NOTE TO PHYSICIAN: Supportive therapy is recommended. No known antidote.

SECTION VII: REACTIVITY DATA

STABILITY: Stable under ordinary storage conditions.

HAZARDOUS CONDITIONS TO AVOID: Long storage at temperatures above 110 degrees F (43 degrees C).

INCOMPATIBILITY: (MATERIALS TO AVOID) None known.

CAN HAZARDOUS POLYMERIZATION OCCUR: No.

HAZARDOUS DECOMPOSITION PRODUCTS: Oxides of nitrogen, carbon monoxide, carbon dioxide, ammonia, and possibly some aldehydes and inorganic acids.

SECTION VIII: SPILL OR LEAK PROCEDURES

RESPONSE TO SPILLS: Stop discharge and contain spill or contaminated material using dike, barrier or other means. Recover with pumping equipment, vacuum truck, sorbent, vermiculite or other means. Place contaminated material in suitable container(s) for further handling.

HAZARDS TO BE AVOIDED: Do not flush to stream, other bodies of water or sewer. Avoid contact with skin or clothing. Other hazard information see Section Nos. IV (FIRE AND EXPLOSION DATA), V (HEALTH HAZARD DATA) and IX (CONTROL MEASURES).

SPILL NOTIFICATION: Check Federal and State reporting regulations.

DISPOSAL METHODS:
1 Recycle if feasible.
2 Incinerate at authorized facility.
3 Treatment at Industrial or Liquid Waste treatment facility.
4 Landfill after solidification in a facility authorized to receive waste.

NOTE: IF DISCARDING THIS MATERIAL, DISPOSE OF IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REGULATIONS.

SECTION IX: CONTROL MEASURES

RESPIRATORY PROTECTION: Not typically required. NIOSH-MSHA approved chemical cartridge respirator with organic vapor cartridges as necessary. Comply with OSHA 1910.134 (CFR), respiratory protection. Contaminant levels will vary dependent on the operation. Industrial hygiene consultation is recommended to assist in respirator selection, use and training.

FOR HANDS, BODY: Chemical resistant gloves recommended for hand protection, chemical resistant work clothing for general body protection.

FOR EYES: Wear safety glasses, chemical goggles or face shield (eight inch minimum).

VENTILATION: Provide adequate ventilation to minimize inhalation.

SECTION X: SPECIAL PRECAUTIONS

RECOMMENDED STORAGE PRACTICE AND CONDITIONS: Store between 50 and 110 degrees F (10 and 43 degrees C). EM-308 is hygroscopic and it is therefore recommended that it be stored in a tightly closed container in a cool dry place.

OTHER PRECAUTIONS: Eye wash and shower should be available. Use only under well ventilated conditions. For personal hygiene protection, personnel should wash thoroughly after handling product. Always wash up before eating, smoking or using washroom facilities. Do not breathe vapor. Do not contact eyes, skin and or clothing.

SECTION XI: LABELING INFORMATION

DOT SHIPPING NAME:	Corrosive Liquid, N.O.S.
DOT IDENTIFICATION NO.:	UN 1760
DOT LABEL:	Corrosive
MORTON PRECAUTIONARY LABEL:	L132

SECTION XII: USER'S RESPONSIBILITY

A bulletin such as this cannot be expected to cover all possible situations. As the user has the responsibility to provide a safe workplace, all aspects of an individual operation should be examined to determine if, or where, precautions in addition to those described herein, are required. Any health hazard and safety information contained herein should be passed on to your customers or employees, as the case may be. Morton Thiokol, Inc. must rely on the user to utilize the information we have supplied to develop work practice guidelines and employee instructional programs for the individual operation.

DISCLAIMER OF LIABILITY

The information contained herein is, to the best of our knowledge and belief, accurate. However, since the conditions of handling and use are beyond our control we make no guarantee of results, and assume no liability for damages incurred by use of this material. All chemicals may present unknown health hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards which exist. Final determination of suitability of the chemical is the sole responsibility of the user. Users of any chemical should satisfy themselves that the conditions and methods of use assure that the chemical is used safely. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO THE INFORMATION CONTAINED HEREIN OR THE CHEMICAL TO WHICH THE INFORMATION REFERS. It is the responsibility of the user to comply with all applicable federal, state, and local laws and regulations.

Nothing contained herein is to be construed as a recommendation for use in violation of any patents or of applicable laws or regulations.

Morton Thiokol, Inc.
Morton Chemical Division
333 West Wacker Drive
Chicago, Illinois 60606-1292
(312) 807-2000

SPILL REPORT

DATE: May 4, 1989 **TIME:** 15:00 hrs

NAME OF PERSON COMPLETING FORM: Joseph B. Hossley

NAME OF PERSON REPORTING SPILL: David Santner

WHAT WAS SPILLED: Diesel

QUANTITY: ~ 2 gallons

LOCATION: Diesel Pad - 400 Area

WHO WAS NOTIFIED (WSTF): Joseph B. Hossley, LESC Environmental Sect.

DESCRIPTION: The return line from diesel engines leaked below ground level. Leak was discovered and discolored soil surrounding leaking pipe was removed. Discolored soil was placed on plastic to allow volatiles to evaporate. Pipe leak will be repaired. Soil, after exposure for five days, will be placed in the WSTF landfill. Trench will be filled with fresh sand.

SPL037

SPILL REPORT

DATE: May 8, 1988 **TIME:** 09:00 hrs

NAME OF PERSON COMPLETING FORM: Joseph B. Hossley

NAME OF PERSON REPORTING SPILL: John Bernal

WHAT WAS SPILLED: Bioact DG-1 (MSDS attached)

QUANTITY: < 1 pint

LOCATION: Warehouse Receiving

WHO WAS NOTIFIED (NASA): R. Mitchell

DESCRIPTION: Bioact DG-1 (petroleum derivative, MSDS attached) was received by warehouse. Shipment, five 1-gallon cans, had leaked out lids and contaminated shipping papers. Papers were placed in plastic, copied, and then discarded. Cans were wiped dry and then issued to Contamination Control, the requestor.

Material Safety Data Sheet [illegible]

May be used to comply with OSHA's Hazard Communication Stan[illegible] 29 CFR 1910.1200. Standard must b[illegible] consulted for specific requirements.

[illegible]S. Department of Labor

[illegible]cupational Safety and Health Administration
([illegible]n-Mandatory Form)
[illegible]m Approved
[illegible] No. 1218-0072

IDENTITY *(As Used on Label and List)*
BIOACT®* DG-1

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name: PETROFERM INC.	Emergency Telephone Number: 1-904-261-8286
Address *(Number, Street, City, State, and Zi[illegible])*: 5400 First Coast Highw[illegible] Fernandina Beach, FL 3203[illegible]	Telephone Number for Information: 1-904-261-8286
	Date Prepared: 7/18/88
	Signature of Preparer *(optional)*:

Section II — Ha[illegible]ormation

Hazardous Components [illegible] Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Terpene Hydrocarbons CAS # 138-86-3	Not Est.	Not Est.	Not Est.	65 - 95

All ingredients are listed [illegible] on the GRAS or as an approved substance for use either as an indirect [illegible]ditive or for use in the manufacture of metal food containers [illegible] the code of Federal Regulations, Title 21, Part 178, Secti[illegible]tion 3910.

None of the ingredients contained in the product are listed in the Threshold Limit Values and Biological Exposure Indices compiled by the American Conference of Governmental Industrial Hygienists.

Section III — Physical/Chemical Characteristics

Boiling Point	[illegible]40 - [illegible]72°F	Specific Gravity (H_2O = 1)	0.85
Vapor Pressure (mm Hg.) at 70°F	[illegible]	Melting Point	< 0°F
Vapor Density (AIR = 1)	[illegible]	Evaporation Rate (Butyl Acetate = 1)	< 1

Solubility in Water: Emulsifiable

Appearance and Odor: Clear free flowing [illegible] Citrus odor.

Section IV — Fire and Explosion Hazar[illegible]

Flash Point (Method Used)	Flammable Limits	LEL	UEL
145°F COC / 120°[illegible]	at 302°F	0.7%	6%

Extinguishing Media: Dry chemical, Foam, CO_2 [illegible]

Special Fire Fighting Procedures: Precautions use[illegible] fires.

Use self-contained br[illegible]ing apparatus.

Unusual Fire and Explosion Hazards: None

Section V — Reactivity Data

Stability			
Stability	Unstable		Conditions to Avoid
	Stable	X	

Incompatibility *(Materials to Avoid)* Strong Mineral Acids, Str[illegible]

Hazardous Decomposition or Byproducts None, other than normal products of combustion.

Hazardous Polymerization			
Hazardous Polymerization	May Occur	X	Conditions to Avoid: Polymerization may occ[illegible] contamination with strong acids.
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry:	Inhalation?	Skin?	Ingestion?
	No	Yes	Yes

Health Hazards *(Acute and Chronic)*
Excessive skin contact will remove natural skin oi[illegible] could lead to reversible dermatitis. Contact with eyes may cause irritation. [illegible] chronic inhalation in unventilated areas may cause irritation of the respi[illegible] inhalation overexposure should be avoided by adequate ventilati[illegible]ls.

Carcinogenicity:	NTP?	IARC Monographs?	OSHA Regulated?
	No	No	No

Signs and Symptoms of Exposure Dry, reddened skin, eye irritation, [illegible]piratory tract irritation.

Medical Conditions Generally Aggravated by Exposure Not Est.

Emergency and First Aid Procedures For suspected oral ingestion, do not induce v[illegible]ing. Seek medical attention. In case of eye contact, flush eyes with water and obtain [illegible] attention if symptoms persist. In case of skin contact, wash well with water and use skin cream if irritation is severe.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled
Mop up spills on hard surfaces and transfer to waste container for disposal.
Dilute spills on ground or porous surfaces with water.

Waste Disposal Method
Collect contaminated material in containers and repro[illegible] or incinerate.
Disposal must comply with all applicable government [illegible]ulations.

Precautions to Be Taken in Handling and Storing
Store in original closed container, preferably in a [illegible] ventilated, fire resistant building.

Other Precautions None.

Section VIII — Control Measures

Respiratory Protection *(Specify Type)* None Required

Ventilation			
Ventilation	Local Exhaust: Acceptable	Special	None Needed
	Mechanical *(General)*: Acceptable	[illegible]	None Needed

Protective Gloves: Solvent Resistant	Eye Protection: Safety Glasses/Goggles

Other Protective Clothing or Equipment Eyewash facilities

Work/Hygienic Practices None Known.

U.S.G.P.O. 1986-491-529/45775

SPL038

SPILL REPORT

DATE: May 9, 1988 **TIME:** 1:25 pm

NAME OF PERSON COMPLETING FORM: James E. Henderson

NAME OF PERSON REPORTING SPILL: John Bernal

WHAT WAS SPILLED: Bioact DG-1

QUANTITY: < 1 pint

LOCATION: Warehouse Receiving

WHO WAS NOTIFIED (NASA): R. Mitchell

DESCRIPTION: Bioact DG-1 (petroleum derivative, MSDS attached) was received by warehouse. Shipment, five 1-gallon cans, had leaked around the lids and contaminated the box and packing materials. The cans were washed and placed into stock and the box and packing materials were placed in the dumpster.

Material Safety Data Shee[illegible]
May be used to comply with
OSHA's Hazard Communication Stand[illegible]
29 CFR 1910.1200. Standard must b[illegible]
consulted for specific requirements.

[illegible]. Department of Labor
[illegible]ccupational Safety and Health Administration
[illegible]-Mandatory Form)
[illegible]m Approved
[illegible] No. 1218-0072

IDENTITY *(As Used on Label and List)* BIOACT®* DG-1	*Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that*

Section I

Manufacturer's Name: PETROFERM INC.	Emergency Telephone Number: 1-904-261-8286
Address *(Number, Street, City, State, and Z[illegible])*: 5400 First Coast Highw[illegible]	Telephone Number for Information: 1-904-261-8286
Fernandina Beach, FL 3203[illegible]	Date Prepared: 7/18/88
	Signature of Preparer *(optional)*

Section II — Ha[illegible]ormation

Hazardous Components [illegible] Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*
Terpene Hydrocarbons CAS # 138-86-3	Not Est.	Not Est.	Not Est.	65 - 95

All ingredients are listed [illegible] on the GRAS or as an approved substance for use either as an indirect [illegible]dditive or for use in the manufacture of metal food containers [illegible] the code of Federal Regulations, Title 21, Part 178, Secti[illegible]ction 3910.

None of the ingredients contained in the product are listed in the Threshold Limit Values and Biological Exposure Indices compiled by the American Conference of Governmental Industrial Hygienists.

Section III — Physical/Chemical Characteristics

Boiling Point	[illegible]0 - [illegible]72°F	Specific Gravity (H_2O = 1)	0.85
Vapor Pressure (mm Hg.)	at 70°F	Melting Point	< 0°F
Vapor Density (AIR = 1)		Evaporation Rate (Butyl Acetate = 1)	< 1

Solubility in Water: Emulsifiable

Appearance and Odor: Clear free flowing [illegible] Citrus odor.

Section IV — Fire and Explosion Hazar[illegible]

Flash Point (Method Used)	Flammable Limits	LEL	UEL
145°F COC / 120°[illegible]	at 302°F	0.7%	6%

Extinguishing Media: Dry chemical, Foam, CO_2 [illegible]

Special Fire Fighting Procedures: Precautions use[illegible] fires.

Use self-contained br[illegible]ing apparatus.

Unusual Fire and Explosion Hazards: None

(Reproduce locally) * "BIOACT" IS A REGISTERED TRADEMARK OF PETROFERM INC.

Section V — Reactivity Data

Stability			
Stability	Unstable		Conditions to Avoid
	Stable	X	

Incompatibility (*Materials to Avoid*) Strong Mineral Acids, Str[illegible]

Hazardous Decomposition or Byproducts None, other than normal [illegible]cts of [illegible]bustion.

Hazardous Polymerization			
Hazardous Polymerization	May Occur	X	Conditions to Avoid Polymerization may occ[illegible]ntamination with strong acids.
	Will Not Occur		

Section VI — Health Hazard Data

Route(s) of Entry:	Inhalation?	Skin?	Ingestion?
	No	Yes	Yes

Health Hazards (*Acute and Chronic*)
Excessive skin contact will remove natural skin oi[illegible] could lead to reversible dermatitis. Contact with eyes may cause irritation. [illegible]r chronic inhalation in unventilated areas may cause irritation of the respi[illegible] inhalation overexposure should be avoided by adequate ventilati[illegible]ls.

Carcinogenicity:	NTP?	IARC Monographs?	OSHA Regulated?
	No	No	No

Signs and Symptoms of Exposure Dry, reddened skin, eye irritation, [illegible]piratory tract irritation.

Medical Conditions Generally Aggravated by Exposure Not Est.

Emergency and First Aid Procedures For suspected oral ingestion, do not induce v[illegible]ing. Seek medical attention. In case of eye contact, flush eyes with water and obtain [illegible] attention if symptoms persist. In case of skin contact, wash well with water and use skin cream if irritation is severe.

Section VII — Precautions for Safe Handling and Use

Steps to Be Taken in Case Material Is Released or Spilled
Mop up spills on hard surfaces and transfer to waste container for disposal.
Dilute spills on ground or porous surfaces with water.

Waste Disposal Method
Collect contaminated material in containers and repro[illegible] or incinerate.
Disposal must comply with all applicable government [illegible]lations.

Precautions to Be Taken in Handling and Storing
Store in original closed container, preferably in a [illegible] ventilated, fire resistant building.

Other Precautions
None.

Section VIII — Control Measures

Respiratory Protection (*Specify Type*) None Required

Ventilation			
Ventilation	Local Exhaust: Acceptable	Special	None Needed
	Mechanical (*General*): Acceptable	[illegible]	None Needed

Protective Gloves Solvent Resistant | Eye Protection Safety Glasses/Goggles

Other Protective Clothing or Equipment Eyewash facilities

Work/Hygienic Practices None Known.

*U.S.G.P.O. 1986-491-529/45775

SPL041

SPILL REPORT

DATE: June 14, 1989 TIME: 15:00 hrs.

NAME OF PERSON COMPLETING FORM: Ray Spencer

NAME OF PERSON REPORTING SPILL: Pat Matthews

WHAT WAS SPILLED: Diesel, Cutting/Motor Oil

QUANTITY: Unknown (see **)

LOCATION: ~ 100' NE of GWM Well BW-5-298

WHO WAS NOTIFIED (NASA): Ray Spencer, LESC
Jim Henderson, LESC

DESCRIPTION: Hydrocarbon odors were noted imminating from an arroyo approximately 100 feet northeast of groundwater monitoring Well BW-5-298. Upon investigation of the arroyo area, discolored soil was noted over a 20- to 30-foot length of the arroyo. Using a shovel, several points along the arroyo were excavated to a depth of 1 foot. Soils excavated were damp and exhibited a distinctly diesel odor.

In a search of the immediate area near the diesel spill, numerous other smaller spills of cutting oil and motor oil were also observed.

** Unknown due to the length of time elapsed prior to spill detection and surface grading performed adjacent to the spill area.

BW-5 DIESEL SPILL

During construction of the road to STGT during 1988, the area surrounding what is now BW-5 was used as a home base for heavy equipment and the asphalt plant. Occasional visits were conducted by the Environmental Section to check on waste management practices. Operations including refueling, oil changes, and minor repair were observed in this area. During one visit to the area, drums of discarded hydrocarbon (HC) based material, oil filters, and batteries were discovered. Poor product control was also noted during most visits. Drums of oils and other HC based materials were regularly observed leaking onto the ground. A request was made, through NASA, to the contractor in charge of the area to clean up the waste materials and maintain better product control. The waste materials were gone the next time the area was visited and product control had improved slightly. As the work at STGT was completed and the equipment was removed, some of the trash and scrap lumber was observed being placed in a nearby pit for burial. Because it is common practice for construction operations to bury trash on site and the fact that no hazardous materials were observed in the trash pit, no report was made.

After the area had been abandoned by the construction crew, a groundwater monitoring well (BW-5) was drilled at the northwest end of the area. During a sampling event on June 14, 1989, the sampling crew noted a diesel odor and followed the smell back up an arroyo. Contaminated soil was discovered along the length of an arroyo about 100 feet upgradient from the well. At the top of the arroyo was an area suspected of being a filled over disposal pit.

On July 11, 1989, a backhoe was used to dig several exploratory trenches through the arroyo and into what was the suspected location of the disposal pit. The arroyo trenches showed that the contamination ranged from the surface to a level about a foot down and was spread along the arroyo for about fifty yards. One exception was a dark oily area which went all the way to the caliche layer, but was limited laterally. It looked like someone had drained a crankcase of used oil directly into the ground at this one spot. A hard caliche layer existed at about three feet below the surface in all areas. The suspected disposal pit was not found, and additional holes to find it were not deemed justifiable. Based on the visual limits to the contamination and a failure to pick up any reading on an HNu, a decision was made to remove visual contamination and close out the investigation. Oily dirt was scrapped out of the arroyo and spread out on the hard pack area to the south to be broken down by exposure. The area was then scraped to restore the natural contours.

SPL047

SPILL REPORT

DATE: July 17, 1989 TIME: 7:00 a.m.

NAME OF PERSON COMPLETING FORM: J. Henderson JH

NAME OF PERSON REPORTING SPILL: K. Lambert

WHAT WAS SPILLED: Diesel

QUANTITY: 2-3 Gallons

LOCATION: 200 Area, east side between Bldg. 200 and North High Bay

WHO WAS NOTIFIED (NASA): R. Mitchell

DESCRIPTION: A diesel generator was filled with diesel and left. High temperatures apparently caused the diesel to overflow out of the tank and onto the ground. Spill dry was spread on the spill to absorb the liquid. Spill dry was swept up and bagged by Facilities and will be placed in the WSTF landfill.

SPILL REPORT

DATE: December 16, 1989 **TIME:** 5:30pm

NAME OF PERSON COMPLETING FORM: J. Henderson, LESC

NAME OF PERSON REPORTING SPILL: WSTF Fire Department

WHAT WAS SPILLED: Diesel

QUANTITY: 100 gallons

LOCATION: 150 Area overhead diesel tank

WHO WAS NOTIFIED (NASA): R. Mitchell, NASA

DESCRIPTION: The WSTF Fire Department noted a diesel spill at the overhead diesel tank in the 150 Area and notified the LESC Environmental Section. Fire Department personnel were able to stop the leak by securing the valve, but a puddle, 10 ft. by 10 ft. and 2-3 inches deep, of diesel had formed. The Environmental Section arrived on site at about 6:00pm to evaluate the spill. With assistance from the Fire Department, spill control materials were gathered and used to absorb the free liquids. R. Mitchell was contacted and informed of the spill at about 6:45pm. It was agreed that removal of the contaminated soil would be postponed until Monday.

On Monday, December 18, 1989, heavy equipment was utilized to remove the visually contaminated soil (TPS 6-HWM-158). The soil was transported to the WSTF land-fill and spread on the ground to degrade. The costs

SPILL REPORT

DATE: January 18, 1990 **TIME:** 2:15 p.m.

NAME OF PERSON COMPLETING FORM: J. Henderson

NAME OF PERSON REPORTING SPILL: G. Charles

WHAT WAS SPILLED: Paint

QUANTITY: < 1 gallon

LOCATION: 120 Warehouse

WHO WAS NOTIFIED (NASA): None

DESCRIPTION: A 1 gallon can of paint was received with a loose lid. The spilled paint was wiped up with rags and the can resealed for use.

MATERIAL SAFETY DATA SHEET

BARTIN CHEMICAL LTD.
2686 LISBON ROAD
CLEVELAND, OH. 44104
(216) 721-5755

SECTION I

EMERGENCY NO. 1/800-424-9300 - CHEMTEC

INFORMATION TELEPHONE NO. 216-721-5755

D.O.T. HAZARD CLASS Combustible Liquid UN1263

CHEMICAL NAME AND SYNONYM Blend-not applicable

CHEMICAL FAMILY Blend-not applicable

TRADE NAME 4010 Rubber Base Interior and Exterior Seal

PRODUCT CLASS Code 06, Varnish, Coatings-Clear

D.O.T. SHIPPING NAME Paint

CHEMICAL FORMULA Proprietary

DATE March, 1986

SECTION II - HAZARDOUS INGREDIENTS

INGREDIENT	CAS NO.	%	VAPOR PRESSURE (mm Hg.)	OCCUPATIONAL EXPOSURE LIMITS
Aromatic HydrocarbonSolvent	64742-95-6	39-41	2.2 @ 68°F	100ppm (ACGIH-TLV/TWA) 125ppm (ACGIH-TLV/STEL) 500ppm (OSHA-PEL/TWA)
Mineral Spirits-Rule 66	64741-92-0	39-41	6.3	100ppm (ACGIH-TLV/TWA) 200ppm (ACGIH-TLV/STEL) 500ppm (OSHA-PEL/TWA)

SECTION III - PHYSICAL DATA

BOILING POINT (°F) 311

VAPOR DENSITY heavier than air

SOLUBILITY IN WATER nil

APPEARANCE AND ODOR Slight yellowish liquid with solvent odor.

SPECIFIC GRAVITY (H_2O=1) 0.850

PERCENT VOLATILE BY VOLUME (%) 78-81

EVAPORATION RATE FASTER x SLOWER THAN ETHER

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED) 105°F (COC)

FLAMMABLE LIMITS Lel= Uel= undetermined

EXTINGUISHING MEDIA

X FOAM _ ALCOHOL FOAM X CO_2 X DRY CHEMICAL _ WATER FOG _ OTHER

SPECIAL FIRE FIGHTING PROCEDURES DO NOT use direct water stream. Product will float on top if igni will spread fire rapidly. Spill will make surface slippery exercise due caution. Treat as A Class "B" Fire.

UNUSUAL FIRE AND EXPLOSION HAZARDS Pressure increases in overheated tightly closed containers. Containers may be cooled with water provided that product is not on fire itself and that it is not detrimental to other involved materials. Vapors are volatile and are heavier than ai

SECTION V - HEALTH HAZARD DATA

EFFECTS OF OVEREXPOSURE
Primary Entry; Dermal, Inhalation, Oral.
Skin-prolonged or repeated contact may result in defatting, irritation, and dermatitis.
Eyes-burning, irritant.
Ingestion-nausea, vomiting.
Inhalation of fumes may result in dizziness, headache, blurred vision, and unconsiousness.
None expected when good industrial hygiene practices are employed.

EMERGENCY AND FIRST AID PROCEDURES
Skin-wash thoroughly with soap and water.
Launder contaminated clothing before re-use.
Flush eyes with copius amounts of cool water for at least 15 minutes-seek medical attention.
If spontaneous vomiting occurs take steps to prevent aspiration into the lungs.
Contact nearest Poison control Center. If pain persists or further problems develop, seek medical attention. Inhalation-remove to fresh air. Administer oxygen if available. Treatment is to be based on the sound judgment of the physician and the individual reaction(s) of the patient.

SECTION VI - REACTIVITY DATA

STABILITY: ___ UNSTABLE x STABLE   CONDITIONS TO AVOID High temperature, open flames.

INCOMPATABILITY (MATERIALS TO AVOID) Strong Oxidants.

HAZARDOUS DECOMPOSITION PRODUCTS Carbon Dioxide, carbon monoxide and unidentified organic constituents. Smoke.

HAZARDOUS POLYMERIZATION ___ MAY OCCUR x MAY NOT OCCUR

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED Contain spill,notify appropriate company personnel. Eliminate ignition osurces. Keep unecessary out of and away from the away. Avoid breathing fumes. Limit exposure as much as possible. If spill enters sewers or waterways use Booms (if available) ot control dispersion.

WASTE DISPOSAL METHOD
Dispose of in accordance with Federal, State and Local Laws. Check also your company's policy. Notify local fire department of spill as a safety precaution and alert.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION As required to stay below TLV. Use NIOSH approved breathing apparatus.

VENTILATION Yes-to keep below TLV. In accordance with Reg. 29 CFR. Part 1910

PROTECTIVE GLOVES yes impervious gloves

EYE PROTECTION splashproof goggles

OTHER PROTECTIVE EQUIPMENT Eyewash station/ safety shower Impervious boots, apron suggested to minimize skin contact. long sleeve shirt/pants suggested/

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING Wash hands before and after use. Store only in clean dry areas in properly labelled containers. Do not re-use empty containers. DO NOT take internally. Keep out of the reach of children. Please read the complete directions and precautions before use. NO SMOKING signs should be posted and enforced. For industrial use ONLY. DO NOT weld or use cutting torches on or near empty containers. Vapors are volatile. DO NOT permit personnel to use without proper safety/hazards training.

OTHER PRECAUTIONS
The suggestions and data provided herewith are based upon tests and information which we believe to be reliable. However, users should make their own investigations to determine the suitability of the information or products for their particular purpose. Technical data and/or consultation available on request during regular business hours. Values listed represent typical data and are NOT to be taken as product specifications. As information and/or becomes available you can be assured we'll do our best to keep you informed. All electrical equipment in areas where material is stored and/or handled should be instal. in accordance with applicable requirements of the National Electric Code N.F.P.A.

SPILL REPORT

DATE: May 2, 1990 **TIME:** 11:15 a.m.

NAME OF PERSON COMPLETING FORM: Harold F. Harrison HH

NAME OF PERSON REPORTING SPILL: Gilbert E. Avalos

WHAT WAS SPILLED: Gasoline, Leaded

QUANTITY: Approximately 15 gallons

LOCATION: Temporary fuel tanks

WHO WAS NOTIFIED (NASA): John Edwards, DCAS
Harold Harrison, LESC

DESCRIPTION: Vendor set automatic nozzle while refueling the temporary gas tanks with leaded gas. While the tank was filling, he stepped into his truck to do paperwork as the gas pumped. Once the tank was full, the automatic nozzle got jammed and did not turn off. The tank overflowed, spilling approximately 15 gallons on the floor before the vendor shut off the flow from a switch inside the truck.

Upon observation of the gasoline mixed with gravel, H. Harrison recommended the contaminated gravel be picked up with a spark-proof shovel, double-bagged in poly bags, and taken to the landfill. At the landfill the the gravel should be spread out to air dry on a vinyl vapor barrier.

SPL060

SPILL REPORT

DATE: 10-5-90 TIME: 15:00

NAME OF PERSON COMPLETING FORM: D SANTNER

NAME OF PERSON REPORTING SPILL: MARV ALDRICH

WHAT WAS SPILLED: IPA

QUANTITY: 40-50 GALLONS

LOCATION: ALCOHOL RUN TANK

WHO WAS NOTIFIED (WSTF): BEN SWARTZ

DESCRIPTION: THE AUTOMATIC SHUTOFF DID NOT OPERATE PROPERLY WE WERE TRYING TO GET TANK AS FULL AS POSSIBLE FOR SUPPORT FIRING AT T/S 401

A.B. Swartz 10/10/90: Directed cleanup operation on OT 10/5/90. Liquid IPA to be pumped with E.P. Haz. waste pump to closed head barrel. The solid (ground) contaminated with IPA would be dug-out & placed on plastic to air dry. The solid would then be placed in an open head drum.

As of 10/10/90 initial clean up is complete, but final clean up is not.