DRAFT INVESTIGATION REPORT

MUNITIONS AND EXPLOSIVES OF CONCERN
DATA GAP INVESTIGATION
AEROJET CHINO HILLS FACILITY
CHINO HILLS, CALIFORNIA

PURCHASE ORDER NO. S25387CJ

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FOR THE
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LIST OF ACRONYMS AND ABBREVIATIONS

µsec	micro-second
Aerojet	Aerojet-General Corporation
API	Armor Piercing Incendiary
CSM	Conceptual Site Model
DGM	Digital Geophysical Mapping
DOD	Department of Defense
DQO	Data Quality Objectives
DTSC	Department of Toxic Substances Control
DU	Depleted Uranium
EM	Electromagnetic
EOR	Explosive Ordnance Reconnaissance
EPA	Environmental Protection Agency
ft	Feet
GIS	Geographical Information System
GPO	Geophysical Prove-Out
GPS	Global Positioning System
HEI	High-Explosive Incendiary
m	meter
mm	millimeter
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
mph	miles per hour
MPPEH	Munitions Potentially Presenting an Explosive Hazard
mV	milli-Volt
NMEA	National Marine Electronics Association
OB/OD	Open Burn/Open Detonation
Pd	Probability of Detection
P.G.	Professional Geologist
PDA	Personal Digital Assistant
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
R. GP.	Registered Professional Geophysicist
ROE	Right of Entry

RTK	Real Time Kinematic
SOW	Scope of Work
STACK	EM61-MK2 channels
State Park	Chino Hills State Park
Std. Dev.	Standard Deviation
TP	Target Practice
TR 1 C	Test Range 1 Charlie
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
WESTON®	Weston Solutions, Inc.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Weston Solutions Inc. and Aerojet-General Corporation (Aerojet) completed the planned munitions and explosives of concern (MEC) detection and removal activities at Aerojet's Chino Hills Facility and the surrounding study area within areas that were not previously investigated for MEC (data gap investigation). Digital and analog handheld geophysical instrumentation were used to detect MEC to instrument detection depth within accessible areas of each data gap and within areas that did not contain cultural features which may potentially mask MEC. A total of 39 accessible acres were included in the MEC data gap investigation, including approximately 8.7-acres of digital geophysical mapping coverage and approximately 30.2-acres of mag & dig surveys.

A total of 55 items characterized as material potentially presenting an explosive hazard (MPPEH) were recovered during the investigation. MPPEH were recovered within Area 16, South of Area 16, Bonnett, and Lee #4. Fifty-two (52) of the MPPEH items were recovered in Area 16 and South of Area 16 as anticipated based on the site's conceptual site model. In addition, approximately 70 pounds of munitions debris were recovered during the MEC data gap investigation. No MPPEH were observed within 200-ft of the open burn/open detonation kick out radius and an adaptive clearance was not warranted.

There were several levels of quality assurance and quality control put in place. They included a physics-based test strip approach, a robust site-wide seeding program, establishing individual quality control measurement criteria, and a re-collection program. There were no quality control failures, signifying all detection systems were found to perform in accordance with the California Environmental Protection Agency, Department of Toxic Substances approved project Work Plan. Project data quality objectives of detecting MEC to instrument detection depth were achieved.

SECTION 1

INTRODUCTION

1. INTRODUCTION

This Draft Investigation Report describes the work elements and results of the Munitions and Explosives of Concern (MEC) detection and removal activities (data gaps) conducted as part of the Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) at Aerojet-General Corporation's (Aerojet) Chino Hills Facility and the areas of concern on property adjacent to the facility (study area). Weston Solutions, Inc. (WESTON®) assisted Aerojet with this work between 5 January and 13 February 2009. This project was conducted in consultation with the California Environmental Protection Agency (EPA), Department of Toxic Substances Control (DTSC) as part of corrective action pursuant to the 1994 Agreement on Consent. This project was performed in accordance with the MEC Data Gap Investigation Work Plan dated March 2008 (WESTON, 2008) and approved by DTSC on 25 April 2008 (**Appendix A**).

1.1 SCOPE AND OBJECTIVES

The primary objective of this project was to detect and remove MEC within accessible data gap areas. Data gaps included in the technical scope of this project include areas not previously investigated for MEC, that were accessible to geophysical instrumentation and did not contain cultural features which may mask MEC (such as asphalt/concrete surfaces, buildings/structures and piping). Digital and handheld analog geophysical equipment were used to detect MEC and related items to instrument detection depth using similar processes and parameters determined by the Chino Hills 2004 Geophysical Prove-Out (GPO) Survey and Report (Geomatrix, 2005). The 2004 GPO results provided a baseline for geophysical instrument detection capabilities which were used to develop data quality objectives (DQOs) in the MEC Data Gap Investigation Work Plan dated March 2008. A Physics-Based Test Strip approach, robust seeding program and quality control measurement criteria were used throughout the investigation to demonstrate and verify project DQOs were achieved.

1.2 PROJECT TECHNICAL TEAM

The project technical team consisted of Aerojet, DTSC and WESTON. WESTON was responsible for performing the MEC investigation activities for Aerojet as stipulated in the

approved Work Plan (WESTON, 2008). WESTON provided the resources, both personnel and equipment, to perform the necessary functions to complete project requirements. All project activities were coordinated through Mr. Scott Goulart, the Aerojet Project Manager. DTSC performed quality assurance review and monitoring of the MEC investigation as well as granting approval to the Work Plan.

1.2.1 Project Organization

WESTON's key project personnel assigned to perform the MEC data gap investigation included the following individuals:

- Project Manager – E.F. "Sonny" Richardson
- Site Manager and Quality Control Geophysicist – Ryan Steigerwalt, P.G.
- Project Geophysicist – Matt Gifford
- Senior Unexploded Ordnance Supervisor – Jamie Arizaga
- Unexploded Ordnance Quality Control Specialist and Safety Officer – Troy Phelps
- California Licensed Professional Geophysicist – Richard Lee, P.G., R.GP (Quantum Geophysics)

The Senior UXO Supervisor led a team of UXO Technicians that included a UXO Technician level III (Team Leader) and supporting personnel, including UXO Technicians of levels II and I. Geophysical Technicians supported the Project Geophysicist during data collection and anomaly requisition. Geophysical Technicians also performed location and mapping activities by delineating data gaps using a global positioning system (GPS).

Roles and responsibilities of these positions are further described in the approved Work Plan (WESTON, 2008). A revision to the key personnel discussed in the final Work Plan should be noted. E.F. "Sonny" Richardson was changed to the Project Manager and Director, Military Munitions Services for WESTON.

SECTION 2

SITE BACKGROUND AND DESCRIPTION

2. SITE BACKGROUND AND DESCRIPTION

Detailed information regarding the physical profile, historical operations, area designations, and previous work associated within the study area is provided in the Draft Conceptual Site Model (CSM) for Munitions and Explosives of Concern (Geomatrix, 2007). The following sections provide only a general overview of the study area as it relates to this Investigation Report.

2.1 SITE LOCATION

The Aerojet Chino Hills Facility is located at the end of Woodview Road within the City of Chino Hills, San Bernardino County, California. The facility occupies approximately 400 acres, covering parts of Sections 5, 6, and 32 of Township 2S, Range 8W, San Bernardino Baseline and Meridian. In addition to the original 400 acres of Aerojet-owned property, an additional 400 acres of surrounding properties were leased by Aerojet during its operations. The leased land was used by Aerojet primarily as buffer lands for Aerojet's operations.

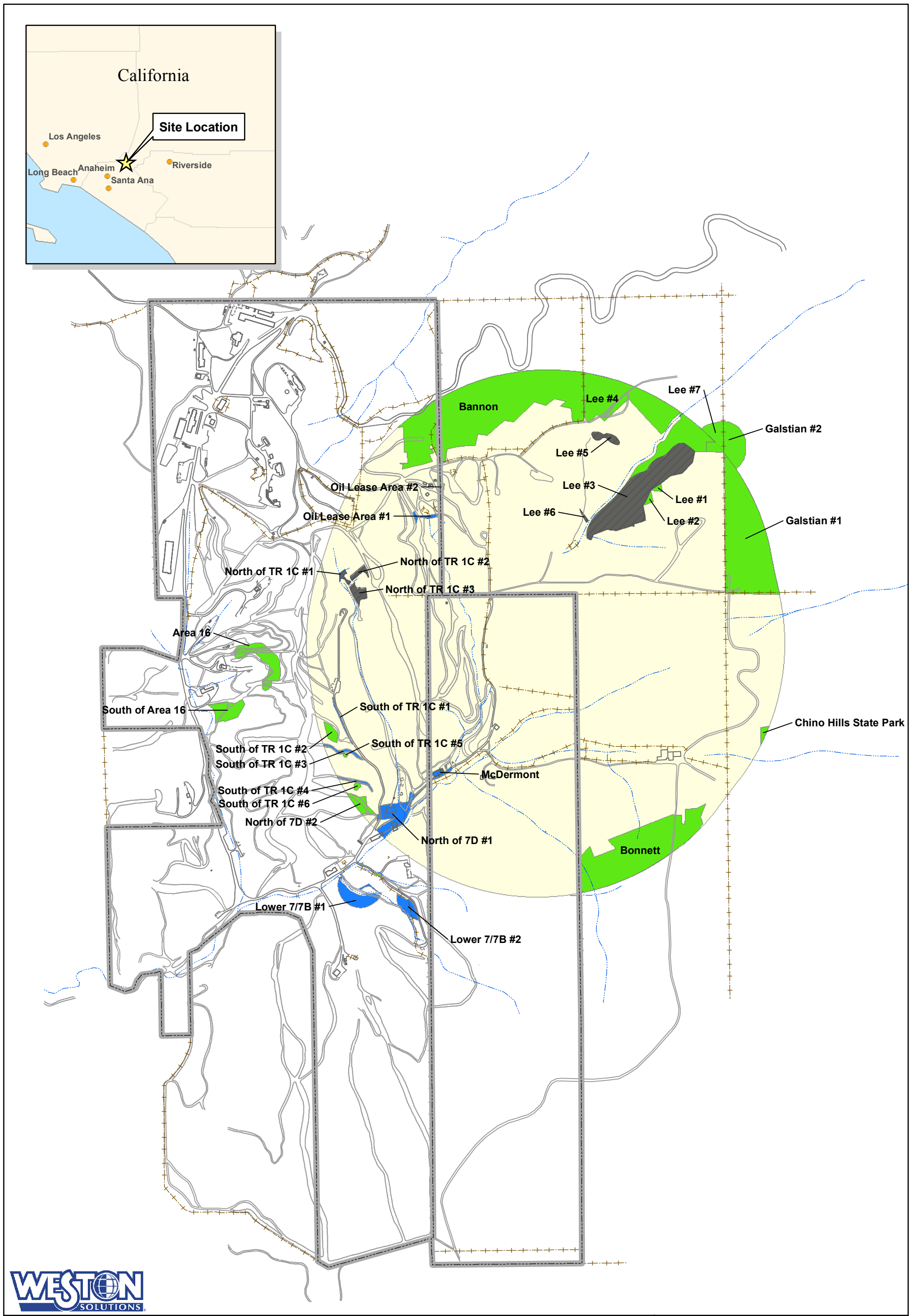
In January 2007, Aerojet acquired the approximately 180-acre McDermont property that was part of the leased property during Aerojet's operations. This is where the DTSC-permitted Open Burn/Open Detonation (OB/OD) unit was located and used by Aerojet for treatment of off-specification ordnance. "Kick-out" of ordnance during treatment activities occurred from this OB/OD unit. A regional location map of the study area is provided in **Figure 2-1**.

2.2 PHYSICAL DESCRIPTION

Topographic maps of the Yorba Linda and Prado Dam quadrangles show that elevation at the study area ranges from 1,025 to 1,331 feet above mean sea level. The topography consists of gently to moderately sloping, rolling terrain and steep canyon slopes (i.e., hills and canyons) within the city of Chino Hills.

2.3 AEROJET CHINO HILLS FACILITY HISTORY

Before 1954, the study area was undeveloped and used for grazing cattle. Operations began in 1954 and included limited testing of ordnance, and research activities. In the 1960s, Aerojet began loading, assembling, and packing operations for several government munitions systems



Aerojet Property Line
OBOD Kick-Out Radius

Data Gaps

Inaccessible Terrain
Cultural Feature Interference
Accessible Terrain

Existing Buildings
Former Buildings
Fence
Drainage Gullies
Asphalt Roads
Dirt Roads

N W E S

0 400 800 1,600
Feet

Figure 2-1
General Vicinity Map
Aerojet Chino Hills Study Area
Chino Hills, California

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under contracts with the United States Department of Defense (DOD). During the 1970s, operations expanded and primarily involved testing explosives and propellants. After 1974, operations primarily involved research, development, and testing of high-explosive incendiary (HEI) projectiles, armor piercing incendiary (API) projectiles composed in part of depleted uranium (DU), target practice (TPs) rounds, and fuzes. These activities were conducted in specific and limited areas within the study area which are referred to as the "operational areas." Aerojet ceased operations at the facility in November 1995.

2.4 DATA GAP AND STUDY AREA LAYOUT

Data gaps were identified during the work planning process through detailed document review, on-site reconnaissance, and Project Team coordination meetings. Maps generated for the Draft CSM (Geomatrix, 2007) were reviewed to identify locations across the study area where no previous MEC investigations were conducted but warranted MEC detection and removal efforts based on the results of the CSM. Once the data gaps were identified, a site reconnaissance was performed to assess each area for accessibility, presence of cultural features and to document physical characteristics that were subsequently used for Work Plan development. Each data gap and representative assessment was then reviewed by the Project Team for further discussion and corroboration. The final data gap assessment is presented in the MEC Data Gap Investigation Work Plan dated March 2008 and approved by DTSC on April 25, 2008.

The data gaps were generally classified as areas that were not previously investigated for MEC. Data gaps included areas where no previous geophysical mapping was conducted, areas where heavy vegetation prevented access during past investigations, or areas falling within the primary OB/OD unit kick-out radius. The MEC Data Gap Investigation Work Plan identified the following data gap categories:

Accessible Terrain – Many of the data gaps are accessible by vehicle or by foot. Some areas may require brush cutting to improve access for geophysical equipment. Generally, all accessible terrain areas can be fully investigated for MEC.

Inaccessible Terrain - Some data gaps are inaccessible to typical MEC investigative activities. These gaps are represented by steep terrain that cannot be accessed by foot. These data gaps will be assessed in the field to ensure maximum MEC investigative coverage is obtained, to the extent safely achievable.

Cultural feature interference – These gaps include areas where cultural features may interfere with the detection of MEC. Features such as asphalt paved roads, parking areas and permanent structures are examples of potential data gaps in this category. Further evaluation would be required to determine the most appropriate MEC investigative approach for cultural feature interference data gaps. When possible, MEC investigative activities will be performed surrounding a cultural feature if a known data gap exists around it. Other cultural features will remain as a data gap and will not be investigated.

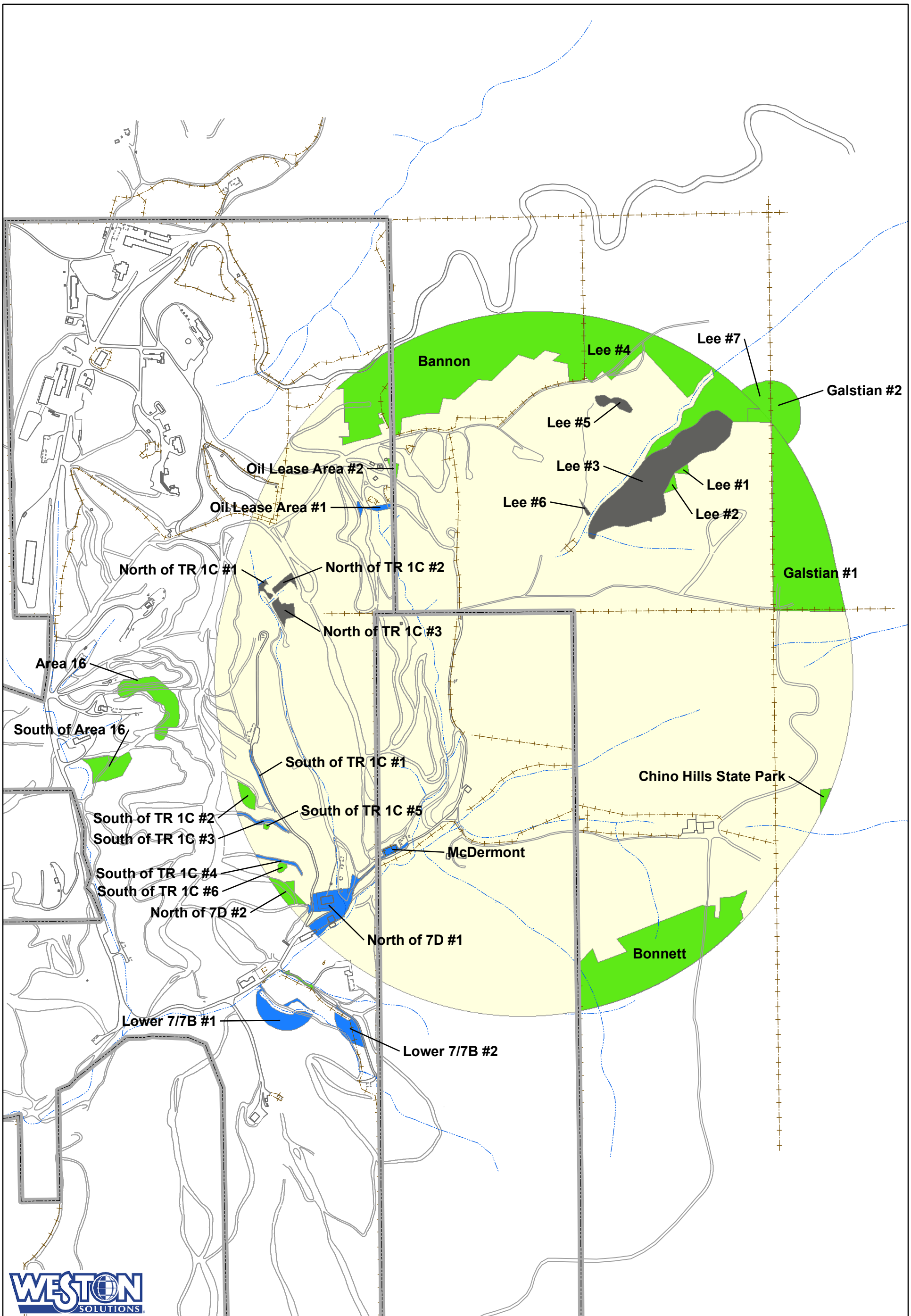
The location and category of each data gap is presented in **Figure 2-2**.

2.5 MILITARY MUNITIONS SOURCES AND TYPES

A limited variety of ordnance was developed and tested at the facility during its operational history. Numerous MEC items have been recovered from the study area during previous investigations. Based on current findings, 30-mm projectiles are the most frequently encountered munition within the OB/OD kick-out radius, and 20-mm projectiles are the most frequently encountered munition in the vicinity of the suspected aircraft crash site within the Lee/Galstian Area. MEC and munitions debris (MD) previously recovered near the data gap areas include:

- 30-mm projectiles,
- 25-mm projectiles,
- 20-mm projectiles,
- 900-series tracers,
- 5-inch tracers,
- M505 fuzes,
- Sub-munitions, and
- Various MD and related components.

Details regarding MEC recovered at the study area are provided in the Draft CSM (Geomatrix, 2007).



Aerojet Property Line
OBOD Kick-Out Radius
Existing Buildings
Former Buildings
Fence
Drainage Gullies

Data Gaps

Inaccessible Terrain
Cultural Feature Interference
Accessible Terrain

N W E S

0 300 600 1,200
Feet

Figure 2-2
Data Gap Categories
Aerojet Chino Hills Study Area
Chino Hills, California

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SECTION 3

MEC DATA GAP INVESTIGATION APPROACH

3. MEC DATA GAP INVESTIGATION APPROACH

The MEC investigation involved the removal of MEC to geophysical instrument detection depth within accessible data gaps on the facility and study areas. Additional MEC investigations were performed in areas within the State Park that were not previously conducted during the prior MEC sweeps. The MEC data gap investigation technical approach is detailed in the project's Final Work Plan (WESTON, 2008). A summary of the removal action operations and approach to key technical elements is presented in the following sections. Each technical element was implemented in accordance with the MEC Data Gap Investigation Work Plan to achieve project DQOs.

3.1 OPERATIONS SUMMARY

Site survey and removal grid layout operations began in December 2008 immediately following the full containment of wildfires which struck the Aerojet Facility and surrounding areas. The wildfires removed vegetation, allowing further accessibility to the survey crew and for subsequent MEC investigations. Following the site survey, site management and digital geophysical mapping (DGM) staff began mobilization, site setup and equipment testing on 5 January 2009. On 8 January 2009, a proposed variance to the MEC Data Gap Investigation Work Plan was submitted to DTSC outlining new quality control and implementation procedures for DGM using physics-based Test Strip approach which would utilize known instrument response curves and a robust seeding program. Upon DTSC's acceptance of the Test Strip approach, both DGM and mag & dig surveys were conducted simultaneously within pre-defined accessible data gaps. Anomalies identified during DGM surveying were reacquired and intrusively investigated for MEC. All anomalies detected during mag & dig surveys were also intrusively investigated. Metal scrap and MD recovered during intrusive work were inspected, inventoried and stored in an on-site explosive storage magazine permitted by WESTON. Items determined to be cultural-related debris, such as barbed wire and farm scrap metal were segregated from MD and recycled. Items identified as Material Potentially Presenting an Explosive Hazard (MPPEH) were inventoried and stored in a separate permitted explosive storage magazine to await final treatment. The field crew demobilized on 13 February 2009.

Figure 3-1 presents the locations where DGM and mag & dig operations were conducted at the facility and study area. A total of approximately 39 accessible acres were included in the MEC data gap investigation and incorporated the following technical elements:

- Site survey and removal grid layout.
- Physics-based Test Strip and seeding program design, implementation and approval.
- MEC detection using geophysical instruments and removal.
- Quality monitoring using a robust seeding program and established measurement criteria.
- Results reporting and data gap revisions.

MEC investigation status and progress were tracked daily using geographic information system (GIS) software, databases and tables. Daily Quality/Safety logs were completed each day detailing pertinent information. Daily logs are provided in **Appendix B**.

3.1.1 Access Agreements and Rights of Entry

The MEC data gap investigation (study area) included five off-site properties; the Bannon, Lee, Galstian, Bonnet, and Chino Hills State Park (State Park). Aerojet coordinated the execution of all access agreements and rights of entry (ROE) for the study area and State Park access. Notice of intent to access the State Park was provided in accordance with the ROE. Even with DTSC assistance, Aerojet was unable to obtain an access agreement for the Galstian data gaps located on the northeastern edge of the OB/OD radius. Aerojet notified DTSC of the access issues and DTSC concluded that Aerojet did not need to conduct MEC detection and removal activities on the Galstian Property as part of corrective action at this time. No MEC investigation operations were conducted on the Galstian property.

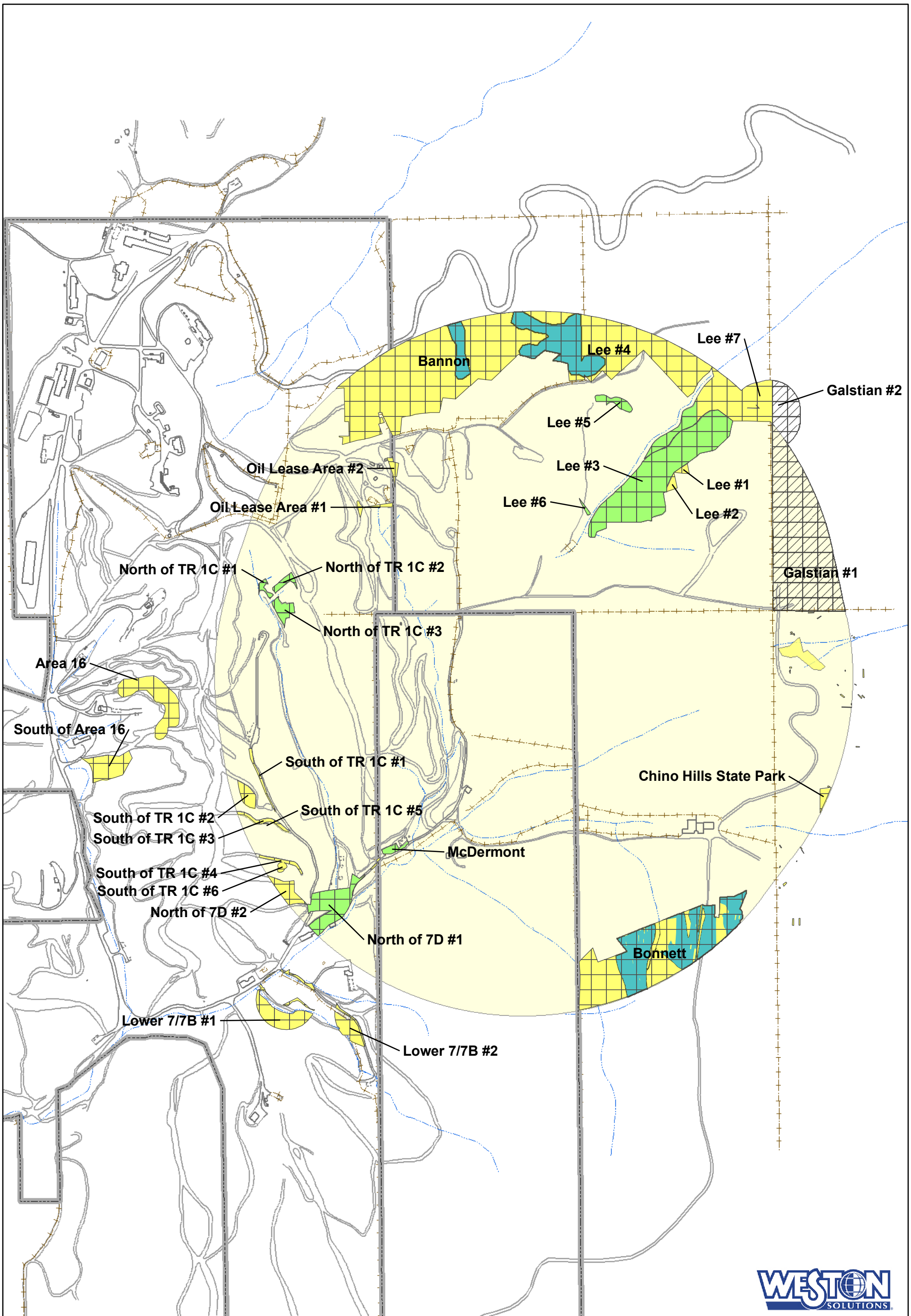

Figure 3-1
Operations Summary
Aerojet Chino Hills Study Area
Chino Hills, California

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3.2 DATA QUALITY OBJECTIVES

The DQOs for this data gap investigation were the removal of MEC to geophysical instrument detection depth while achieving a probability of detection (Pd) of 100% within specific depth intervals, which were established based on equipment capabilities and the type of MEC documented during the 2004 GPO (Geomatrix, 2005). Based on the 2004 GPO, the EM61-MK2 was the sensor selected for the DGM surveys to be conducted within accessible data gaps. The Schonstedt Ordnance Locator (Schonstedt) is the handheld analog geophysical instrument that was selected for mag and dig surveys within data gaps inaccessible to the EM61-MK2. **Table 3-1** lists the detection depth for each geophysical instrument to which a 100% Pd was calculated for 30-mm projectiles, 25-mm projectiles, and 20-mm projectiles (Geomatrix, 2005).

Table 3-1 Detection Depth and Probability of Detection

Sensor/Instrument	Detection Depth Equating to 100% Pd (inches)		
	30-mm Projectiles	25-mm Projectiles	20-mm Projectiles
EM61-MK2	10* (13**)	11	8
Schonstedt	13	11	8

Notes:
* Indicates maximum seeded depth interval for EM61-MK2 Towed Array testing.
** Indicates maximum seeded depth interval for single stand-alone EM61-MK2 sensor testing.
Pd is calculated by dividing the total number of seeds detected by the total number of seeds buried and expressed as a percentage (Geomatrix, 2005).

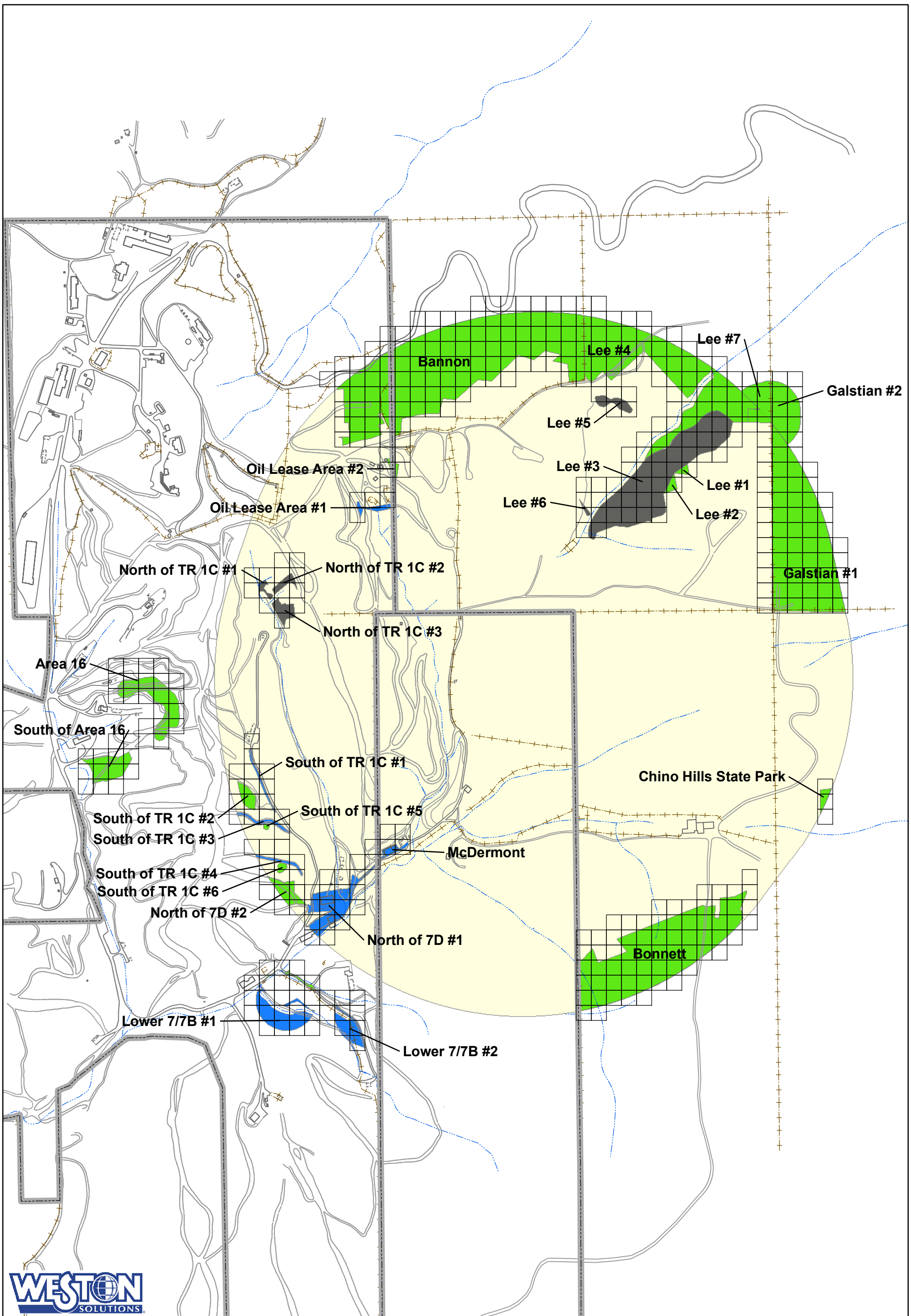
3.3 GRID LAYOUT AND SURVEYING

A 100-ft by 100-ft grid system was established over data gaps prior to initiating MEC removal operations. The grids were set to fully cover each data gap and overlap with previous removal areas to ensure full coverage. A California licensed surveyor, Calvada Surveying, Inc., escorted by a UXO-qualified Technician, first established a temporary site survey control web from known and registered bench marks in the area. Once site control was set, the surveyor then reacquired pre-determined grid node locations and marked each grid corner (southwest corner) with wooden lath labeled with grid ID. A 6-inch rebar spike was set flush to the ground surface at each grid node. The entire grid survey included the location of 480 point (grid nodes) across the data gap investigation area.

All geographically referenced information was projected to the Universal Transverse Mercator (UTM) coordinate system, Zone 11 North, North American Datum (NAD) 1983, in US survey feet units. The removal grid layout is presented in **Figure 3-2**.

3.3.1 Semi-Permanent Control

In addition to the grid layout, five semi-permanent control monuments were established by the Surveyor at Lee, Bonnett, South of Test Range 1 Charlie (TR 1C) and Area 16, for use during DGM and target reacquisition. **Table 3-2** lists the control point positional information.



Aerojet Property Line
OBOD Kick-Out Radius
Existing Buildings
Former Buildings
Fence
Drainage Gullies

Data Gaps

Inaccessible Terrain
Cultural Feature Interference
Accessible Terrain

N W E S

0 300 600 1,200
Feet

Figure 3-2
Grid Layout
Aerojet Chino Hills Study Area
Chino Hills, California

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Table 3-2 Site Semi-Permanent Control

CONTROL POINTS SET BY CALVADA SURVEYING				
Point	**Northing (UTM, Z11N, NAD83, Feet)**	**Easting (UTM, Z11N, NAD83, Feet)**	**ELEVATION (U.S.FEET,NAVD88)**	**Location Description**
1	12326373.00	1414450.91	1335.7584	Industrial Area
2	12326195.96	1417684.74	1210.4499	Lee
3	12321720.65	1417785.43	1428.5271	Bonnett
4	12322652.02	1414575.43	1291.114	South of TR 1C
5	12323720.77	1413801.46	1163.2312	Area 16

3.4 PHYSICS BASED TEST STRIP

A physics-based Test Strip and seeding program approach was initiated in lieu of the Limited Geophysical Prove-Out proposed in the approved MEC Data Gap Investigation Work Plan (WESTON, 2008). The Test Strip approach capitalized on the known performance of geophysical sensors used under the approved Work Plan and established metrics that monitored the entire mapping effort rather than depending only on sensor evaluations made during initial geophysical prove out procedures. The *MEC Data Gap Investigation – Aerojet Chino Hills Facility Variance to Limited Geophysical Prove-Out Memorandum* submitted to DTSC on 8 January 2008 is provided in **Appendix C**. This was approved by DTSC during the field activities and documented in a letter dated March 10, 2009 to Aerojet from DTSC (Appendix C).

As part of the approach, a Test Strip was constructed near the location of the former “POG” No. 1 (Geomatrix, 2005) and seeded with target MEC sized items. Items were seeded linearly over approximately 100-feet. **Table 3-3** tabulates description, quantity, orientation and depth below ground surface for items used during Test Strip construction. An additional Test Strip was constructed at the Bannon property to maximize efficiency. The Test Strips were also used for Schonstedt quality control testing (Section 3.6.3.2)

Table 3-3 Test Strip Seeding Design

Description	Quantity	Orientation	Depth*
30-mm Projectile	2	Horizontal	10-inches**
30-mm Projectile	2	Horizontal	13-inches***
25-mm Projectile	2	Horizontal	11-inches****
20-mm Projectile	2	Horizontal	8-inches****

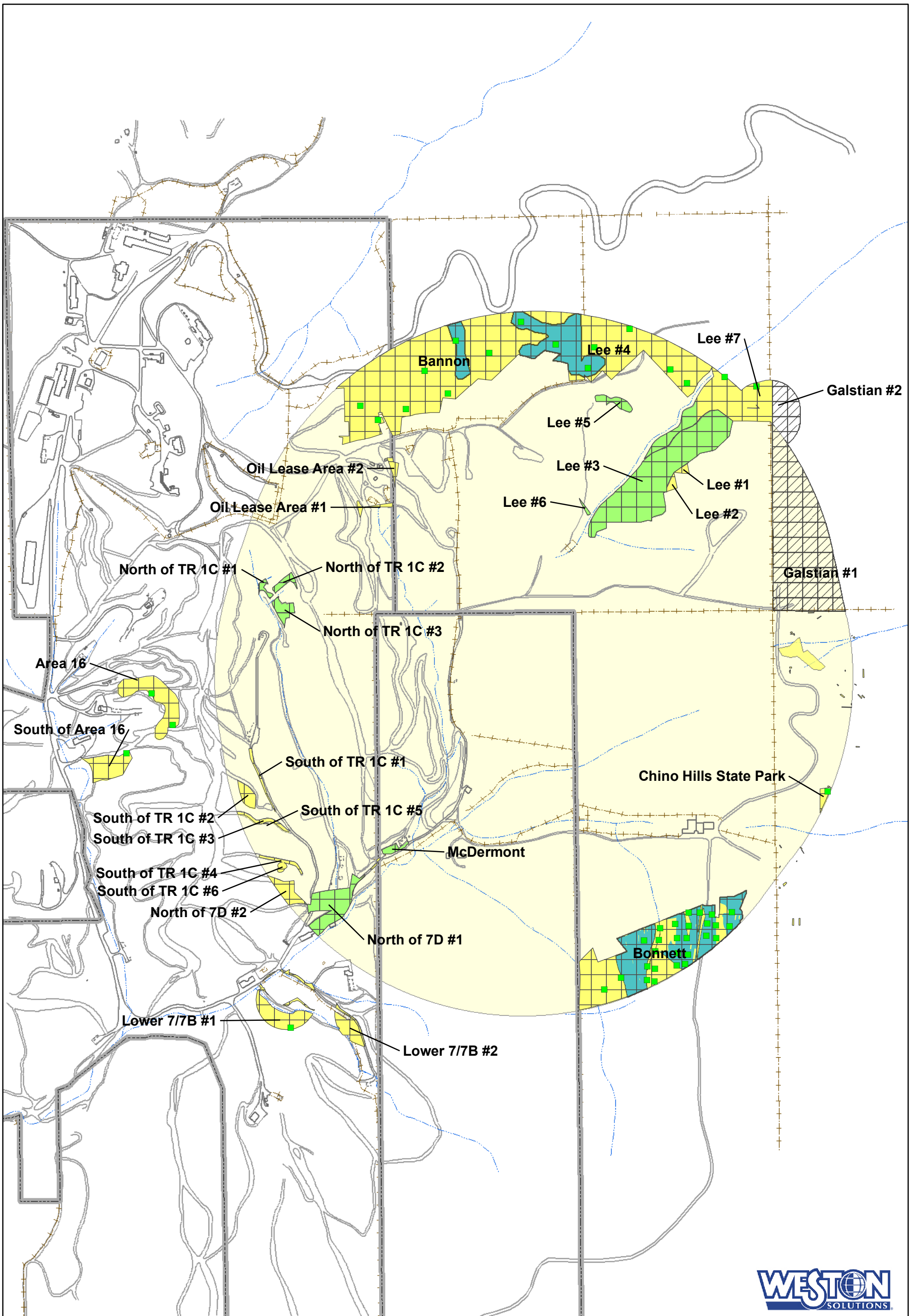
Notes:
* Depth is equal to detection performance metrics established in Final Work Plan.
**Detection performance metric for EM61-MK2.
***Detection performance metric for Schonstedt.
****Detection performance metric for EM61-MK2 and Schonstedt.

3.5 SITE-WIDE SEEDING PROGRAM

A robust seeding program was established for the data gap MEC investigation. These seed items were used to monitor equipment performance in conjunction with the Test Strip. Known seeds consisting of 6-inch rebar pins were placed at grid corner stakes during the survey effort. Blind seeds consisting of 30-mm, 25-mm and 20-mm projectiles were placed within the production grids at depth intervals consistent with the Test Strip to validate detection results. The seeds were placed by site management and quality staff at locations kept confidential (blind) from DGM and UXO Teams. The seeding program was established prior to work being performed in each area.

Initially, blind seeds were placed within each production grid located within the Bonnett area to validate instrument performance. The seeding program at Bonnett consisted of one of each seed item placed in each grid located within a 1-acre area. Once system detection performance (both digital and analog) was sufficiently validated, blind seeds were reduced to a density of approximately one per acre consistent with the approved Work Plan. This density was then used for remaining areas of Bonnett as well as the other data gaps across the facility and study area.

Items were seeded and their locations recorded using RTK GPS by site management and quality staff. **Table 3-4** lists details regarding to the items seeded within the production grids. **Figure 3-3** illustrates the overall distribution of the seeds across the data gaps and study area. Figures showing detailed locations and description of the QC seeds are provided in **Appendix D**.



Aerojet Property Line
OBOD Kick-Out Radius
Existing Buildings
Former Buildings
Fence
Drainage Gullies
No MEC Investigation Completed
No Access Agreement
DGM Coverage
Mag & Dig
QC Seed

N W E S

0 300 600 1,200
Feet

Figure 3-3
Seeding Program Map
Aerojet Chino Hills Study Area
Chino Hills, California

File: \\Fsfed01\TIG\Chino_Hills\MXD\final_report\seed_grids.mxd, 06-May-09 17:33, curtisf

Table 3-4 Seed Item Description List

Data Gap /Study Area	Grid	Item	Depth	Orientation	X	Y
Bonnett	7882/2327	30mm	10in	Horizontal	1417884.50	12322328.89
Bonnett	7782/2328	20mm	8in	Horizontal	1417803.32	12322341.53
Bonnett	7881/2227	25mm	11in	Horizontal	1417908.74	12322253.48
Bonnett	7981/2226	30mm	10in	Horizontal	1417998.57	12322247.37
Bonnett	7982/2326	20mm	8in	Horizontal	1418015.41	12322340.93
Bonnett	7781/2226	30mm	10in	Horizontal	1417850.90	12322269.40
Bonnett	7781/2128	25mm	11in	Horizontal	1417844.18	12322187.70
Bonnett	7880/2127	20mm	8in	Horizontal	1417909.80	12322171.43
Bonnett	7683/2329	30mm	10in	Horizontal	1417729.17	12322339.13
Bonnett	7682/2229	25mm	11in	Horizontal	1417728.46	12322253.90
Bonnett	7681/2129	20mm	8in	Horizontal	1417714.03	12322175.00
Bonnett	7680/2029	30mm	10in	Horizontal	1417721.23	12322063.54
Bonnett	7679/1929	25mm	11in	Horizontal	1417702.75	12322000.99
Bonnett	7579/1930	20mm	8in	Horizontal	1417646.73	12321991.38
Bonnett	7580/2030	25mm	11in	Horizontal	1417655.29	12322074.76
Bonnett	7581/2130	30mm	10in	Horizontal	1417650.53	12322175.53
Bonnett	7582/2230	20mm	8in	Horizontal	1417638.45	12322267.72
Bonnett	7482/2231	30mm	10in	Horizontal	1417539.56	12322240.56
Bonnett	7481/2131	25mm	11in	Horizontal	1417530.07	12322161.18
Bonnett	7480/2031	20mm	8in	Horizontal	1417506.37	12322088.82
Bonnett	7479/1931	30mm	10in	Horizontal	1417502.62	12321972.84
Bonnett	7478/1831	25mm	11in	Horizontal	1417498.34	12321889.09
Bonnett	7378/1832	30mm	10in	Horizontal	1417448.84	12321896.64
Bonnett	7379/1932	20mm	8in	Horizontal	1417453.66	12321989.48
Bonnett	7381/2132	25mm	11in	Horizontal	1417432.09	12322160.49
Bonnett	7178/1834	30mm	10in	Horizontal	1417278.03	12321914.59
Bonnett	7078/1835	20mm	8in	Horizontal	1417164.43	12321837.85
Area16	4098/3764	30mm	13in	Horizontal	1414186.72	12323829.10
Area16	4296/3562	25mm	11in	Horizontal	1414324.05	12323618.71
South of Area16	3994/3365	20mm	8in	Horizontal	1414015.68	12323434.05
Bannon	6819/6036	30mm	10in	Horizontal	1416886.24	12326115.47
Bannon	6621/6238	25mm	11in	Horizontal	1416657.01	12326267.86
Bannon	6419/6040	20mm	8in	Horizontal	1416445.00	12326062.24
Bannon	6220/6142	30mm	10in	Horizontal	1416224.70	12326144.67
Bannon	5919/5945	30mm	13in	Horizontal	1416015.81	12325948.57
Bannon	5816/5646	20mm	8in	Horizontal	1415889.92	12325697.31
Bannon	5516/5649	25mm	11in	Horizontal	1415586.99	12325720.95
Bannon	5615/5548	30mm	13in	Horizontal	1415703.92	12325627.67
Bannon	6116/5743	25mm	11in	Horizontal	1416169.37	12325796.21
Lee	7018/5934	20mm	8in	Horizontal	1417096.86	12325955.53
Lee	7119/6033	20mm	8in	Horizontal	1417141.45	12326092.56
Lee	7320/6131	30mm	13in	Horizontal	1417375.16	12326212.19

Data Gap /Study Area	Grid	Item	Depth	Orientation	X	Y
Lee	7618/5929	20mm	8in	Horizontal	1417642.57	12325940.42
Lee	7717/5828	25mm	11in	Horizontal	1417751.69	12325851.56
Lee	7917/5826	20mm	8in	Horizontal	1418002.31	12325886.40
Lee	8116/5724	30mm	13in	Horizontal	1418212.74	12325822.27
State Park	8590/3120	25mm	11in	Horizontal	1418657.04	12323136.01
Lower 7/7B #1	5076/1555	20mm	8in	Horizontal	1415086.25	12321605.32

3.6 MEC DETECTION AND REMOVAL

3.6.1 Digital Geophysical Mapping

DGM surveys were implemented in areas of data gaps which were accessible to the geophysical instrumentation. Approximately 8.75-acres were digitally mapped to identify subsurface anomalies potentially representing MEC. DGM surveys were performed using an array of four EM61-MK2 sensors which were mounted on a non-conductive sled pulled by a four wheel drive Kubota vehicle. Photos of the DGM operations are provided in **Appendix E**.

3.6.1.1 DGM Equipment Description

The EM61-MK2 sensor is battery-powered and operates at a maximum output of 10,000 milliVolts (mV). The EM61-MK2 sensor is a 1 by 0.5 meter (m) air-cored coil that acts as both a transmitter and receiver. The transmitter generates a pulsed magnetic field that induces eddy currents in conductive objects within the subsurface. These currents are proportional to the conductive nature of the material below the instrument. When conductive objects are present below the instrument, the amplitude and decay time of the induced eddy currents vary in response to the size, mass, and orientation of the objects. The receiver measures the amplitude of these eddy currents at 216, 366, 660, and 1260 micro-second intervals during the decay period.

A four coil EM61-MK2 towed array system was used to collect the geophysics data. A GPS antenna was mounted over the center of the array and linked to a laptop carried inside the tow vehicle, providing real-time display. This receiver captures the real-time differential corrections from a fixed local base station and outputs a National Marine Electronics Association (NMEA) GGA (a code used by NMEA which provides 3D location and accuracy data from the GPS unit)

message directly into the array field computer at 1-second intervals. Direct interfacing between the GPS and EM61-MK2 utilizes a single clock and streams position information directly into the raw EM61-MK2 data file.

The array sensors were set at a height of six inches above ground surface. The lowered operating height allowed for a higher signal to noise ratio to that of a standard EM61-MK2 sensor on the manufacturer's wheel cart.

3.6.1.2 Quality Measurement Criteria

As part of the DQO process, individual quality control (QC) measures were implemented during the data gap investigation to document that the procedures and acquired data can support the project DQOs. Individual quality control measures include the implementation of a Test Strip, instrument standardization protocols, and set data collection parameters with pass/fail metrics to monitor and evaluate the geophysical results. **Table 3-5** lists the QC measurement criteria descriptions and results.

Table 3-5 DGM QC Measurement Criteria

Parameter	Results for DGM QC Measurement Criteria
Test Strip	Implement the Test Strip approach to verify instrument functionality daily.
Equipment Warm-Up	Metric - Geophysical sensors will be allowed to warm-up for a minimum of 5-minutes prior to data collection. Noise levels will be monitored after the 5-minute warm-up period to confirm the sensor has stabilized and is ready for use. Warm-up procedures will be performed after each time the sensor or instrument is shut down and re-started. Result – The EM61-MK2 sensors were evaluated to ensure noise levels were stabilized after at least a 5 minute warm up period.
Sensor Position and Offset	Metric - Sensor position relative to the navigation antenna will be measured as an X/Y offset following instrument set-up. The measured offset will be recorded and subsequently applied to data for correction. Sensor heights above ground surface will also be recorded following instrument set-up. Result - Offsets were checked daily and confirmed before surveying.
Static Background Test	Metric - A static background test will be performed prior to and following the geophysical survey. The purpose of the test is to monitor geophysical background readings and to recognize abnormal response fluctuation indicative of faulty sensors. The static background test will be used to gauge ambient noise levels for the site which are potential sources for unrepeatable readings expected during production surveys. The EM61-MK2 data should remain within the 2 standard deviations (single channel) based on 2004 GPO results (Geomatrix, 2005). Data will be collected for a minimum of 1-minute. Result – Static background test data achieved measurement criteria. Test results are provided in **Appendix F**.

Parameter	Results for DGM QC Measurement Criteria
Static Response Test	Metric - The static response test will monitor the EM61-MK2 sensor's capability to maintain stable and repeatable response readings over a conductive test object. The object will be positioned below the geophysical sensor and data will be recorded for a minimum of 1-minute before and after surveying. Response of the test item during the post-survey response test should be within 20% of the pre-survey test. The EM61-MK2 noise should remain within the 2 standard deviations (single channel) based on 2004 GPO results (Geomatrix, 2005). Result – Static response test data achieved measurement criteria. Data for the 31 January 2009 morning test exceeded metrics due to interference on the left side of the array. This deviation was observed only on the left set of sensors. It appears someone approached the coils during data collection. Post-survey data were not affected. Test results are provided in **Appendix F**.
Cable Connection Test	Metric - The cable connection test will identify wiring and connection problems with the EM61-MK2 sensors. Large anomalous spikes within the test data would indicate poor connectivity between the sensor and the field logger. The test will be performed prior to and following the geophysical survey for approximately 30-seconds or until all cables are tested. The EM61-MK2 noise should remain within the 2 standard deviations (single channel) based on 2004 GPO results (Geomatrix, 2005). Result – Cable connection test data achieved measurement criteria. Test results are provided in **Appendix F**.
Repeatability Test	Metric - Repeat data provides a means to evaluate the ability of the EM61-MK2 system to respond consistently and evaluates the positional accuracy of the data. Repeatability will be tested daily by re-collecting on average one line per grid. Anomaly peak locations within the repeatability test shall be within 1-ft of the original survey data. Result – Repeatability was measured daily during Test Strip data collection. Results achieved QC measurement criteria. Results are summarized in **Table 4-1**.
Background Noise	Metric - Background noise was calculated using the 2004 GPO equation of three times the standard deviation of a windowed anomaly free area in each dataset. The calculated standard deviation for the individual EM61-MK2 channels shall be less than 2.85-mV as observed in the 2004 GPO. Result - An average background noise reading of 2.04 was observed through out the project data collection.

Parameter	Results for DGM QC Measurement Criteria
Mean Speed	Metric - Average data collection speeds were maintained at less than 4 miles per hour (mph). Based on the 2004 GPO, collection speeds are anticipated to be approximately 2-4 mph based on site conditions and sensor configuration. Result – Mean speed was 2.16 mph.
Along Track Sampling	Metric - Along track sampling was evaluated with respect to mean speed. Average along track sampling will not exceed 0.5-ft between data points. It is anticipated that along track sampling will average approximately 0.35-ft based on anticipated speeds. Result – Average along track sampling was 0.31 feet.
Across Track Sampling	Metric - Across track sampling (line spacing) will not exceed 3.0-ft. Minor data gaps may occur if obstructions prevent data collection. Data gaps due to obstructions will be excluded from this metric; however data gaps will be cumulatively tracked. Tighter line spacing may be used to provide a more robust data set necessary to resolve small MEC items. Result – Across track sampling was performed at a 1.5-ft spacing. Any data gaps observed in and surrounding the DGM data were delineated and mag and dig surveys performed.
Latency Correction	Metric - A latency test area was established using a five-spike configuration (to determine latency. The latency correction was applied to each dataset during subsequent data processing activities. No chevron effects shall be visible in the processed EM61-MK2 data. Result - An average latency correction of 0.35 seconds was observed during data collection.
Data Leveling	Metric - Consistent parameters and processing methods were used for all channels within each dataset. Consistent processing routines were used for all datasets throughout the project. Result – Data leveling and processing was performed consistently throughout the project.
Anomaly Selection	Metric - The anomaly selections were accepted by the project geophysicist or his/her designated assistants. These individuals verified that all anomaly selections for a given dataset are reasonable and should identify all buried metal anticipated at the project site. Result – All anomalies above noise levels were selected.
Positioning Errors	Metric - Positioning errors are not to exceed 3.0-ft. The pre-survey function tests will be used to evaluate the navigation performance. Results – Positioning results were evaluated during pre- and post-survey QC testing, Test Strip

Parameter	Results for DGM QC Measurement Criteria
	results and seeding program results. Positioning fell within 3.0-ft metric.
Reacquisition	Metric - Anomaly reacquisition was performed on selected DGM anomalies throughout the duration of the project. 95% of the locations of reacquired anomalies should lie within 3.28-ft of their original surface location as marked on the dig list. 95% of excavated items should lie within an approximate 1-ft radius of their mapped surface location as marked in the field after reacquisition. Result – Anomaly reacquisition results fell within the 3.28-ft metric.

3.6.1.3 Digital Data Processing and Analysis

The raw EM61-MK2 field data were processed using MagMap2000 software. Data were then exported as Geosoft acceptable XYZ file format. XYZ files were imported into Geosoft Oasis montaj™ processing software. Data were checked for navigational accuracy, line distribution, and coverage. Latency values obtained during the pre- and post- survey QC tests were applied to the data, correcting for any temporal lags seen in the data. A Geosoft script was run to automatically progress through the processing steps for each of the four individual EM61-MK2 coils and four data channels. The script was used to drift-correct the data using a common filtering technique. A non-linear drift correction filter was used to remove any drift associated with each data channel occurring throughout the survey period. Velocity and sample separation were calculated for each dataset.

The data channel 3 (CH3_Drift) was then gridded using a grid cell size of 0.25 ft with a search radius of 2 ft and blanking distance of 1.5 ft (for the 4-coil configuration). Subsequent to gridding, the targets were selected for the gridded data, by running the Blakely Peak algorithm in Geosoft. A grid threshold value of 3.0 mV was used to select the initial target list, which was based upon a review of the background signal. Target review consisted of manually evaluating all selected targets, and removing or merging multiple targets associated with large anomalies. Targets were also moved (where necessary) to the location of the peak response associated with a given anomaly. A target decay analysis was also run to remove targets that had an atypical decay between their four time gate channels. An atypical decay occurs when an anomaly undergoes a decay that does not decrease through time, but instead shows an increase in any of the subsequent time gate channels. After the review process was completed, the targets were exported into a target database for creating dig lists. **Table 3-5** summarizes the details of the EM61-MK2 data processing parameters utilizing Geosoft. Plots of the DGM grids and target locations as well as raw data files are provided electronically on CD in **Appendix G**.

Table 3-6 Digital Data Processing Parameters

Process	Parameter
Drift – Non-Linear Drift Correction Filter (UCEDRIFT.GX)	Window Length: 200 fiducials All data channels were processed using the same parameters.
Statistical Evaluation of Background Noise	Windowed section of background/using UX-Process QC module evaluated std dev, min, max, mean, mode
Grid	Cell Size: 0. 25 ft Blanking Distance: 1.5 ft Search Radius: 2 ft
Blakely Peak Picking Algorithm	Smooth Filter: 3 Normal Peak Detection Grid Value Cutoff: EM 3.0 mV – CH3_Drift
Target Decay Analysis	Performed based on each data channel
Target Review	Performed

3.6.1.4 Anomaly Selection

Based on the DGM data, individual point source anomalies and clusters of anomalies were selected for inclusion into a final dig sheet database.

EM anomalies in each of the production grids (UTM-based grid system) were picked in a manner consistent with the test strip surveys. The steps performed utilizing Geosoft Oasis montaj are summarized as follows:

- Set an initial grid cut-off value of 3 mV using the Blakely Peak algorithm.
- Perform decay time analysis (remove anomalies exhibiting atypical decay parameters, typical of non-metallic anomalies).
- Manually review targets (line agreement, crossing lines, data spikes, etc.).
- In Oasis montaj, pull up the EM map and EM target database:
  - Identify duplicate targets.
  - Mask a duplicate target in the EM target database within a 2-ft radius of an EM target.
  - Refine the EM target location, when applicable.
- Construct a merged target database and prepare a target Dig List.

3.6.1.5 DGM Coverage Review

Processed DGM data sets were reviewed for coverage completeness to identify gaps where equipment exceeded the across track quality measurement criteria due to terrain or obstacles (vegetation, cultural features, etc.). Waypoint locations were selected around the perimeter of each gap identified in the DGM data set. These locations were reacquired in the field and marked with non-metallic pin flags. These locations were subsequently investigated using mag & dig surveying methods (Section 3.6.3).

3.6.2 Anomaly Reacquisition

Anomaly reacquisition was performed utilizing the Trimble RTK GPS for navigation to the selected coordinate location for each target. A Reacquisition Team navigated to the location and marked it with a non-metallic pin flag containing the unique target identifier. A dig team consisting of UXO technicians followed up for excavation at the target location. Anomaly investigations began by sweeping a 3-ft radius around the pin flag with a Schonstedt to focus the excavation at the peak response and subsequently utilizing the personal digital assistant (PDA)-based RespondFast-MEC Investigation^{SM} data logging system to electronically log the anomaly target characteristics real-time in the field. A Schonstedt was utilized to clear the hole of ferrous material. Photos of the anomaly reacquisition process are provided in **Appendix E**.

3.6.3 Mag & Dig Surveying

A Schonstedt model GA52-CX was used as the MEC detection tool for mag & dig surveying in areas inaccessible to the digital geophysical instrumentation. **Figure 3-2** illustrates areas where mag & dig surveying operations were performed. UXO Teams began mag & dig surveys once DGM operations were complete. In addition, mag & dig surveys were performed in coverage gaps identified during DGM data processing and QC review. These gaps were required and delineated with poly pin flags using the project RTK GPS prior to performing mag & dig surveys.

During mag & dig operations, the Senior UXO Supervisor assigned each UXO Team a grid or set of grids for investigation and subsequent MEC removal actions. The UXO Teams first

located the southwest corner marker of the assigned grid to identify/confirm they were in the specific pre-assigned grid. The Teams then marked 5-ft intervals along the north and south or east and west bounds of the grid. The 5-ft intervals were then connected with ropes to delineate the lanes to be cleared of MEC. The 5-ft lane spacing was selected based on the 2004 GPO results (Geomatrix, 2005). No change in Pd was identified between a 3-ft and 5-ft lane spacing during the Schonstedt test phase of the GPO process. In areas of steep or difficult terrain, UXO Teams used spray paint and pin flags to mark survey lanes. Lane spacing adjustments were determined on a case-by-case basis by the UXO Team Leader and Senior UXO Supervisor.

3.6.3.1 Mag & Dig Equipment Description

Schonstedt magnetic locators detect ferrous metal materials. Schonstedts are hand-held units with an audible alarm that detects changes in the Earth's ambient magnetic field caused by ferrous metal. The technology utilizes two fluxgate sensors mounted a fixed distance apart and aligned in gradiometer configuration to eliminate a response to the Earth's ambient field. The magnetic locators generate an audio output when either of the two sensors is exposed to a disturbance of the Earth's ambient field associated with a ferrous target and/or the presence of a permanent field associated with a ferrous target.

3.6.3.2 Mag & Dig Daily Quality Control Testing

Prior to performing mag & dig surveys, UXO Technicians field-tested their assigned Schonstedts through the established Test Strips. Each test strip was seeded with 30-mm, 25-mm and 20-mm projectiles at maximum detection depths established by the 2004 GPO. The purpose of this daily process was to test the equipment on a similar setting to what would be encountered in the field. It allowed the UXO Technicians to check the equipment sensitivity setting required to achieve DQOs. All equipment was found to perform adequately during the daily check. QC measurement criteria and results for the analog instrumentation are provided in **Table 3-7**.

3.6.4 Excavation and Item Evaluation

Excavations were used to investigate subsurface anomalies located during mag and dig and DGM reacquisition surveys. All excavations were dug using hand tools by UXO qualified

technicians. Explosive Ordnance Reconnaissance (EOR) procedures were performed by the UXO Technicians to assess conditions and potential hazards of all MEC-related material. MD and metal scrap were removed from the excavation hole to prevent masking of potential deeper MEC. Once the visible material was removed from the excavation, the area was rechecked with the Schonstedt to confirm no additional anomalies were present.

Table 3-7 Analog Instrument QC Measurement Criteria

Parameter	Results for Analog Instrument QC Measurement Criteria
Test Strip	Implement the Test Strip approach to verify instrument functionality daily.
Analog Instrument Calibration	Metric - The Schonstedt instruments were tested daily for functionality and sensitivity at the Test Strip. The instruments were operated over all the seeded items. If an instrument is malfunctioning it will be tagged and taken out of service until fully repaired. Result – Each Schonstedt was able to detect all seed items within the Test Strip daily.
Analog Instrument Lane Spacing	Metric - Handheld Analog Instrument lane spacing will not exceed 5.0-ft. The same Pd between the 3.0-ft and 5.0-ft lane spacing was observed during the 2004 GPO (Geomatrix, 2005). Result – Analog instrument lane spacing was set at 5.0-ft.

3.7 MEC DATA GAP INVESTIGATION RESULTS

Results from the MEC data gap investigation were tracked throughout the project by removal grid. **Figure 3-4** depicts the overall results from the investigation. A summary of the results of the investigation are provided in **Table 3-8**. **Appendix I** presents the results by data gap area.

Table 3-8 Results for the MEC Data Gap Investigation

Parameter	Result
Number of Days for Removal Activities	30
Mag & Dig Area (acres)	30.17
DGM Area (acres)	8.74
Total Area Investigated (acres)	38.91
Number of DGM Targets	789
Number of Grids with MD	21
Number of MD items	144
Total MD Weight (pounds)	70
Number of MPPEH Recovered	55

3.7.1 MPPEH Type and Description

MPPEH was recovered during the course of the MEC Data Gap Investigation. Due to the condition of these items, UXO Technicians could not completely discount the presence of explosives or explosive components on them. These items were recovered and stored within a locked explosive storage magazine. A total of 55 MPPEH items were recovered within the data gaps. **Table 3-9** summarizes the type and location of MPPEH recovered during the investigation.

Table 3-9 MPPEH Recovery Information

Grid ID	Item Description	Easting	Northing
3794/3367	MPPEH: 30mm,Projectile, partial,HE	1413829.4	12323402.3
3794/3367	MPPEH: 30mm,Projectile, partial,HE	1413874.4	12323372.3
3794/3367	MPPEH: M505,fuze,	1413854.4	12323387.3
3794/3367	MPPEH: 30mm,Projectile, partial,HE	1413804.4	12323369.3
3898/3766	MPPEH: 20mm,Projectile, partial,APHE	1413988.3	12323846.2
3898/3766	MPPEH: 20mm,Projectile, partial,APHE	1413993.3	12323816.2
3898/3766	MPPEH: 20mm,Projectile, partial,APHE	1413983.3	12323864.2
3899/3866	MPPEH: 30mm,projectile, partial,HE	1413994.3	12323871.1
3994/3365	MPPEH: M505,fuze,	1413996.3	12323425.4
3998/3765	MPPEH: 25mm,projectile, partial,HE	1414048.2	12323864.2
3998/3765	MPPEH: 30mm,projectile, partial,HE	1414078.2	12323855.2

Grid ID	Item Description	Easting	Northing
3998/3765	MPPEH: M505,Fuze,	1414003.2	12323850.2
3998/3765	MPPEH: 20mm,Projectile, partial,APHE	1414010.2	12323860.2
3998/3765	MPPEH: 20mm,Projectile, partial,APHE	1414016.2	12323835.2
3998/3765	MPPEH: M505,Fuze,	1413999.2	12323815.2
3998/3765	MPPEH: 20mm,Projectile, partial,APHE	1414005.2	12323825.2
3998/3765	MPPEH: 20mm,Projectile, partial,APHE	1414020.2	12323840.2
3998/3765	MPPEH: 20mm,Projectile, partial,APHE	1414006.2	12323837.2
3998/3765	MPPEH: M505,Fuze,	1414008.2	12323837.2
3999/3865	MPPEH: 30mm,projectile, partial,HE	1414004.2	12323870.1
3999/3865	MPPEH: 30mm,projectile, partial,HE	1414009.2	12323865.1
3999/3865	MPPEH: 25mm,projectile, partial,HE	1413999.2	12323870.1
3999/3865	MPPEH: 25mm,projectile, partial,HE	1414004.2	12323872.1
4098/3764	MPPEH: 20mm,Projectile, partial,APHE	1414193.2	12323844.2
4098/3764	MPPEH: 30mm,Projectile, partial,HE	1414133.2	12323859.2
4098/3764	MPPEH: 25mm,projectile, partial,HE	1414102.2	12323859.2
4098/3764	MPPEH: 30mm,Projectile, partial,HE	1414173.2	12323824.2
4098/3764	MPPEH: M505,Fuze,	1414138.2	12323784.2
4098/3764	MPPEH: M505,Fuze,	1414106.2	12323863.2
4098/3764	MPPEH: 20mm,Projectile, partial,APHE	1414099.2	12323860.2
4098/3764	MPPEH: 20mm,Projectile, partial,APHE	1414148.2	12323849.2
4098/3764	MPPEH: 30mm,Projectile, partial,HE	1414158.2	12323861.2
4098/3764	MPPEH: 30mm,Projectile, partial,HE	1414183.2	12323849.2
4099/3864	MPPEH: 25mm,projectile, partial,HE	1414104.2	12323914.2
4099/3864	MPPEH: M505,Fuze,	1414124.2	12323934.2
4099/3864	MPPEH: 20mm,Projectile, partial,APHE	1414189.2	12323924.2
4099/3864	MPPEH: 30mm,Projectile, partial,HE	1414111.2	12323866.2
4099/3864	MPPEH: 30mm,Projectile, partial,HE	1414109.2	12323874.2
4195/3463	MPPEH: 20mm,Projectile, partial,APHE	1414235.2	12323538.4
4195/3463	MPPEH: M505,fuze,	1414245.2	12323538.4
4195/3463	MPPEH: 30mm,Projectile, partial,HE	1414240.2	12323543.4
4195/3463	MPPEH: 20mm,Projectile, partial,APHE	1414240.2	12323553.4
4196/3563	MPPEH: 20mm,Projectile, partial,APHE	1414211.2	12323573.3
4196/3563	MPPEH: M505,fuze,	1414206.2	12323583.3
4196/3563	MPPEH: M505,fuze,	1414206.2	12323588.3
4197/3663	MPPEH: M505,fuze,	1414292.2	12323743.3
4198/3763	MPPEH: Tracer,Aluminum, base,	1414218.2	12323773.2
4198/3763	MPPEH: 25mm,projectile, partial,HE	1414248.2	12323823.2
4198/3763	MPPEH: 20mm,Projectile, partial,APHE	1414223.2	12323773.2
4198/3763	MPPEH: 30mm,Projectile, partial,HE	1414203.2	12323768.2
4298/3762	MPPEH: frag,HE	1414303.1	12323772.2
4298/3762	MPPEH: M505,fuze,	1414308.1	12323787.2
7618/5929	MPPEH: 40mm, projectile, base, APHE	1417648.3	12325969.0
7581/2130	MPPEH: 40mm, projectile, base, APHE	12322416.0	1417948.0
7782/2328	MPPEH: 40mm, projectile, base, APHE	12322348.3	1417843.3

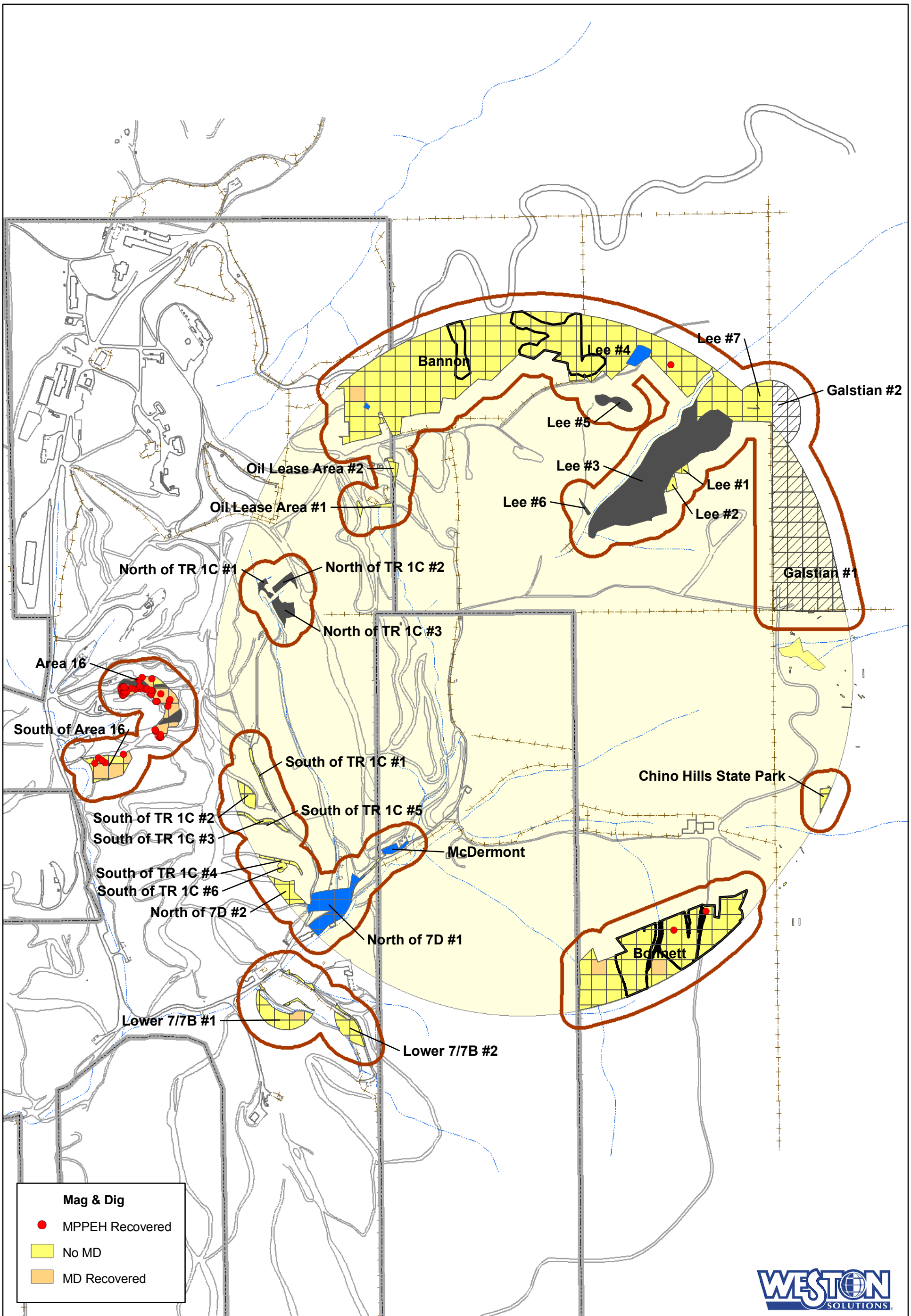
Most of the MPPEH was recovered within the Area 16 and South of Area 16 data gaps consistent with the limited demilitarization activities conducted in the area during prior sweeps as described in the CSM. MPPEH was also recovered in Lee and Bonnett. All MPPEH will remain in the explosive storage magazine until treatment can occur.

3.7.2 Munitions Debris

All MD was tracked and stored in a locked explosive storage magazine segregated from cultural debris and MPPEH. MD included fragmentation and components from MPPEH items listed in Table 3-9. Approximately 144 MD items were recovered weighing approximately 70 pounds. MD remains locked in an explosive storage magazine at the facility.

3.7.3 Adaptive Clearance

Locations of recovered MPPEH were monitored through the course of the MEC data gap investigation to evaluate if an adaptive clearance was required to achieve a minimum buffer zone of 200-ft of 'no MEC detected' around the OB/OD kick out radius. Results show all MPPEH were found within 200-ft of the OB/OD kick out radius. This assessment found that no adaptive clearance was warranted.



Aerojet Property Line
OBOD Kick-Out Radius
Existing Buildings
Former Buildings
Fence
Drainage Gullies
118-ft Hazardous Fragment Distance
DGM Coverage
No Access Agreement
Inaccessible Area
Cultural Features

N W E S

0 300 600 1,200
Feet

Figure 3-4
MEC Investigation Results Summary
Aerojet Chino Hills Study Area
Chino Hills, California

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SECTION 4

QUALITY CONTROL

4. QUALITY CONTROL RESULTS

4.1 PHYSICS BASED TEST STRIP

The Test Strip was used to validate that the digital geophysical instrumentation achieved detection performance metrics established in the approved Work Plan. The Test Strip was also used by Sweep Personnel to test each Schonstedt for functionality and sensitivity prior to beginning detection and/or removal work.

DGM data was collected over a course of seven days. Two Test Strips were constructed using the criteria discussed in Section 3.4 – Physics Based Test Strip. **Table 4-1** presents the Test Strip results collected for each day of DGM and at both Test Strips. The table summarizes the response for each seed item and calculates the mean and standard deviation (Std Dev) of the response to evaluate repeatability.

Results show agreement and repeatable results for the series of Test Strip seeds. These results demonstrate that the digital geophysical equipment was functioning within a tolerable range to achieve detection performance metrics. Test Strip plots and photos of the Test Strip seed items are provided in **Appendix J**.

Table 4-1 Physics Based Test Strip Results

Item #		1	2	3	4	5	6	7	8
Item Description		30-mm Projectile	30-mm Projectile	30-mm Projectile	30-mm Projectile	25-mm Projectile	25-mm Projectile	20-mm Projectile	20-mm Projectile
Item Depth (inches)		10-inches	10-inches	13-inches	13-inches	11-inches	11-inches	8-inches	8-inches
Test Strip 1	1/07/09	10.25	7.90	13.33	13.81	11.44	6.46	5.72	6.40
	1/08/09	10.12	4.89	14.18	9.22	9.71	6.31	7.01	3.04
	1/11/09	8.09	7.43	12.49	12.68	7.69	6.24	6.99	3.11
	1/13/09	7.43	4.90	13.74	7.58	9.90	5.42	6.50	5.40
	1/29/09A	8.51	4.40	14.88	8.81	10.07	6.14	7.62	4.00
	1/30/09	9.68	5.16	12.85	6.75	8.75	5.58	7.46	4.97
	Mean (mV)	**9.01**	**5.78**	**13.58**	**9.81**	**9.59**	**6.02**	**6.88**	**4.49**
	Std Dev	**1.2**	**1.5**	**0.9**	**2.8**	**1.3**	**0.4**	**0.7**	**1.3**
Test Strip 2	1/29/09B	17.71	6.94	15.69	3.99	12.25	11.32	9.46	4.93
	1/30/09B	24.42	9.24	16.69	6.86	21.98	8.18	10.38	6.19
	1/31/09A	19.50	8.14	17.68	5.06	17.59	9.76	10.93	6.42
	1/31/09B	22.24	8.23	18.02	5.18	20.43	9.29	12.10	6.45
	Mean (mV)	**20.97**	**8.14**	**17.02**	**5.27**	**18.06**	**9.64**	**10.72**	**5.99**
	Std Dev	**3.0**	**0.9**	**1.0**	**1.2**	**4.3**	**1.3**	**1.1**	**0.7**

4.2 SITE-WIDE SEEDING PROGRAM RESULTS

A total of 48 seeds were placed across the data gaps and study area to monitor and verify detection capabilities of the geophysical instrumentation. **Table 4-2** presents the results from the seeding program. The Table lists seed location, type, and seed recovery mechanism. If the item was within a DGM survey area, Table 4-2 provides the anomaly Target ID, position, and offset from the original surveyed seed location. All seeds were recovered during the MEC investigation. Locations of seed items are presented on Figure 3-3 and in Appendix D.

Table 4-2 Site-Wide Seeding Program Results

Data Gap	Grid	Item	Depth	Orientation	Seed Y	Seed X	Status	Recovery System	Target Y	Target X	Target ID	Peak Response (mV)	Offset (feet)
Area16	4098/3764	30mm	13in	Horizontal	12323829.10	1414186.72	Recovered	Mag & Dig					
Area16	4296/3562	25mm	11in	Horizontal	12323618.71	1414324.05	Recovered	Mag & Dig					
Bannon	5516/5649	25mm	11in	Horizontal	12325720.95	1415586.99	Recovered	Mag & Dig					
Bannon	5615/5548	30mm	13in	Horizontal	12325627.67	1415703.92	Recovered	Mag & Dig					
Bannon	5816/5646	20mm	8in	Horizontal	12325697.31	1415889.92	Recovered	Mag & Dig					
Bannon	5919/5945	30mm	13in	Horizontal	12325948.57	1416015.81	Recovered	Mag & Dig					
Bannon	6116/5743	25mm	11in	Horizontal	12325796.21	1416169.37	Recovered	Mag & Dig					
Bannon	6220/6142	30mm	10in	Horizontal	12326144.67	1416224.70	Recovered	Anomaly Reac	12326145.00	1416224.80	6220/6142-1095	18.9	0.3
Bannon	6419/6040	20mm	8in	Horizontal	12326062.24	1416445.00	Recovered	Mag & Dig					
Bannon	6621/6238	25mm	11in	Horizontal	12326267.86	1416657.01	Recovered	Anomaly Reac	12326269.90	1416657.70	6621/6238-1367	8.2	2.2
Bannon	6819/6036	30mm	10in	Horizontal	12326115.47	1416886.24	Recovered	Anomaly Reac	12326117.00	1416885.80	6819/6036-0999	18.6	1.6
Bonnett	7078/1835	20mm	8in	Horizontal	12321837.85	1417164.43	Recovered	Mag & Dig					
Bonnett	7178/1834	30mm	10in	Horizontal	12321914.59	1417278.03	Recovered	Mag & Dig					
Bonnett	7378/1832	30mm	10in	Horizontal	12321896.64	1417448.84	Recovered	Mag & Dig					
Bonnett	7379/1932	20mm	8in	Horizontal	12321989.48	1417453.66	Recovered	Mag & Dig					
Bonnett	7381/2132	25mm	11in	Horizontal	12322160.49	1417432.09	Recovered	Anomaly Reac	12322160.75	1417434.25	7381/2132-2	9.2	2.2
Bonnett	7478/1831	25mm	11in	Horizontal	12321889.09	1417498.34	Recovered	Mag & Dig					
Bonnett	7479/1931	30mm	10in	Horizontal	12321972.84	1417502.62	Recovered	Mag & Dig					
Bonnett	7480/2031	20mm	8in	Horizontal	12322088.82	1417506.37	Recovered	Mag & Dig					
Bonnett	7481/2131	25mm	11in	Horizontal	12322161.18	1417530.07	Recovered	Mag & Dig					
Bonnett	7482/2231	30mm	10in	Horizontal	12322240.56	1417539.56	Recovered	Mag & Dig					
Bonnett	7579/1930	20mm	8in	Horizontal	12321991.38	1417646.73	Recovered	Anomaly Reac	12321993.50	1417645.00	7579/1930-0083	3.8	2.7
Bonnett	7580/2030	25mm	11in	Horizontal	12322074.76	1417655.29	Recovered	Anomaly Reac	12322075.98	1417654.63	7580/2030-0162	8.1	1.4
Bonnett	7581/2130	30mm	10in	Horizontal	12322175.53	1417650.53	Recovered	Anomaly Reac	12322177.75	1417650.00	7581/2130-0442	15.21	2.3
Bonnett	7582/2230	20mm	8in	Horizontal	12322267.72	1417638.45	Recovered	Mag & Dig					
Bonnett	7679/1929	25mm	11in	Horizontal	12322000.99	1417702.75	Recovered	Anomaly Reac	12322003.34	1417702.16	7679/1929-0097	6.15	2.4
Bonnett	7680/2029	30mm	10in	Horizontal	12322063.54	1417721.23	Recovered	Anomaly Reac	12322063.25	1417720.50	7680/2029-0146	15.2	0.8
Bonnett	7681/2129	20mm	8in	Horizontal	12322175.00	1417714.03	Recovered	Anomaly Reac	12322175.25	1417714.50	7681/2129-0434	12.6	0.5
Bonnett	7682/2229	25mm	11in	Horizontal	12322253.90	1417728.46	Recovered	Mag & Dig					

Data Gap	Grid	Item	Depth	Orientation	Seed Y	Seed X	Status	Recovery System	Target Y	Target X	Target ID	Peak Response (mV)	Offset (feet)
Bonnett	7683/2329	30mm	10in	Horizontal	12322339.13	1417729.17	Recovered	Anomaly Reac	12322337.75	1417729.75	7683/2329-1141	3.7	1.5
Bonnett	7781/2128	25mm	11in	Horizontal	12322187.70	1417844.18	Recovered	Anomaly Reac	12322186.75	1417845.00	7781/2128-0472	7.1	1.3
Bonnett	7781/2226	30mm	10in	Horizontal	12322269.40	1417850.90	Recovered	Anomaly Reac	12322268.75	1417851.25	7781/2228-0828	12.0	0.7
Bonnett	7782/2328	20mm	8in	Horizontal	12322341.53	1417803.32	Recovered	Anomaly Reac	12322344.25	1417804.25	7782/2328-1169	52.8	2.9
Bonnett	7880/2127	20mm	8in	Horizontal	12322171.43	1417909.80	Recovered	Anomaly Reac	12322173.25	1417910.75	7880/2127-0426	3.9	2.1
Bonnett	7881/2227	25mm	11in	Horizontal	12322253.48	1417908.74	Recovered	Anomaly Reac	12322252.75	1417910.50	7881/2227-0770	4.5	1.9
Bonnett	7882/2327	30mm	10in	Horizontal	12322328.89	1417884.50	Recovered	Anomaly Reac	12322328.25	1417884.00	7882/2327-1101	117.3	0.8
Bonnett	7981/2226	30mm	10in	Horizontal	12322247.37	1417998.57	Recovered	Anomaly Reac	12322249.00	1417998.00	7981/2226-0753	15.5	1.7
Bonnett	7982/2326	20mm	8in	Horizontal	12322340.93	1418015.41	Recovered	Anomaly Reac	12322339.75	1418016.75	7982/2326-1152	8.5	1.8
Lee	7018/5934	20mm	8in	Horizontal	12325955.53	1417096.87	Recovered	Mag & Dig					
Lee	7119/6033	20mm	8in	Horizontal	12326092.56	1417141.45	Recovered	Mag & Dig					
Lee	7320/6131	30mm	13in	Horizontal	12326212.19	1417375.16	Recovered	Mag & Dig					
Lee	7618/5929	20mm	8in	Horizontal	12325940.42	1417642.57	Recovered	Mag & Dig					
Lee	7717/5828	25mm	11in	Horizontal	12325851.56	1417751.70	Recovered	Mag & Dig					
Lee	7917/5826	20mm	8in	Horizontal	12325886.40	1418002.32	Recovered	Mag & Dig					
Lee	8116/5724	30mm	13in	Horizontal	12325822.27	1418212.75	Recovered	Mag & Dig					
Lower 7/7B #1	5076/1555	20mm	8in	Horizontal	12321605.32	1415086.25	Recovered	Mag & Dig					
South of Area16	3994/3365	20mm	8in	Horizontal	12323434.05	1414015.68	Recovered	Mag & Dig					
State Park	8590/3130	25mm	11in	Horizontal	12323136.01	1418657.04	Recovered	Mag & Dig					

4.3 RE-COLLECTION PROGRAM

Following MEC removal operations by the UXO Teams, the WESTON UXO Quality Control Officer (UXOQCO) performed grid inspections encompassing approximately 25% to 10% of the grid surface area. This inspection included both mag and dig and DGM survey areas to ensure project DQOs were being achieved. Inspections were performed using a Schonstedt magnetometer to identify any potential remaining anomalies. All removal grids were found to meet DQO requirements by the UXOQCO. No MEC or MD debris was recovered during the QC inspection.

4.4 SITE VISITS AND MONITORING

Site visits were conducted by the Aerojet Project Manager and DTSC throughout the course of the investigation. DTSC planted Quality Assurance seeds in planned DGM accessible areas of the data gaps to evaluate detection and anomaly investigation performance.

SECTION 5

UPDATED MEC DATA GAP IDENTIFICATION AND SUMMARY MATRIX

5. UPDATED MEC DATA GAP IDENTIFICATION AND SUMMARY MATRIX

5.1 INVESTIGATION BOUNDARIES AND EXTENTS

MEC investigation boundaries include data gaps identified within the facility and surrounding study areas (Figure 2-2). Boundaries of each data gap were delineated using a survey grade RTK GPS to ensure full coverage. Areas within the data gaps that were inaccessible to the geophysical instrumentation were surveyed using RTK GPS to track where MEC investigation activities did not occur. Also, areas where cultural features may mask the detection of MEC were delineated and tracked.

In addition to those data gaps identified in the MEC Data Gap Investigation Work Plan dated March 2008, several coverage gaps within Chino Hills State Park were also investigated. These coverage gaps include 1) areas that were heavily vegetated preventing prior MEC investigation activities from being conducted, and 2) areas where DGM data appear to show across line gaps that exceed 2-ft in width. Those areas that were not investigated due to heavy vegetation were delineated and marked using pin flags based on coordinates and maps provided by Geomatrix, Inc. Once located, UXO Teams performed mag & dig surveys across these areas. Concurrently, previously collected DGM data within the State Park was reviewed for coverage gaps that appeared to exceed 2-ft in width. Thirty gaps were identified and reacquired using RTK GPS. The perimeter of each gap was marked using non-metallic pin flags to delineate the area requiring investigation. Following reacquisition, UXO Teams performed mag & dig surveys in all coverage gaps. No MEC or MD was recovered within the State Park during this investigation. Locations of the coverage gaps are presented in Figure 3-4 and in Appendix I. The memorandum describing the State Park coverage gap work is provided in **Appendix K**.

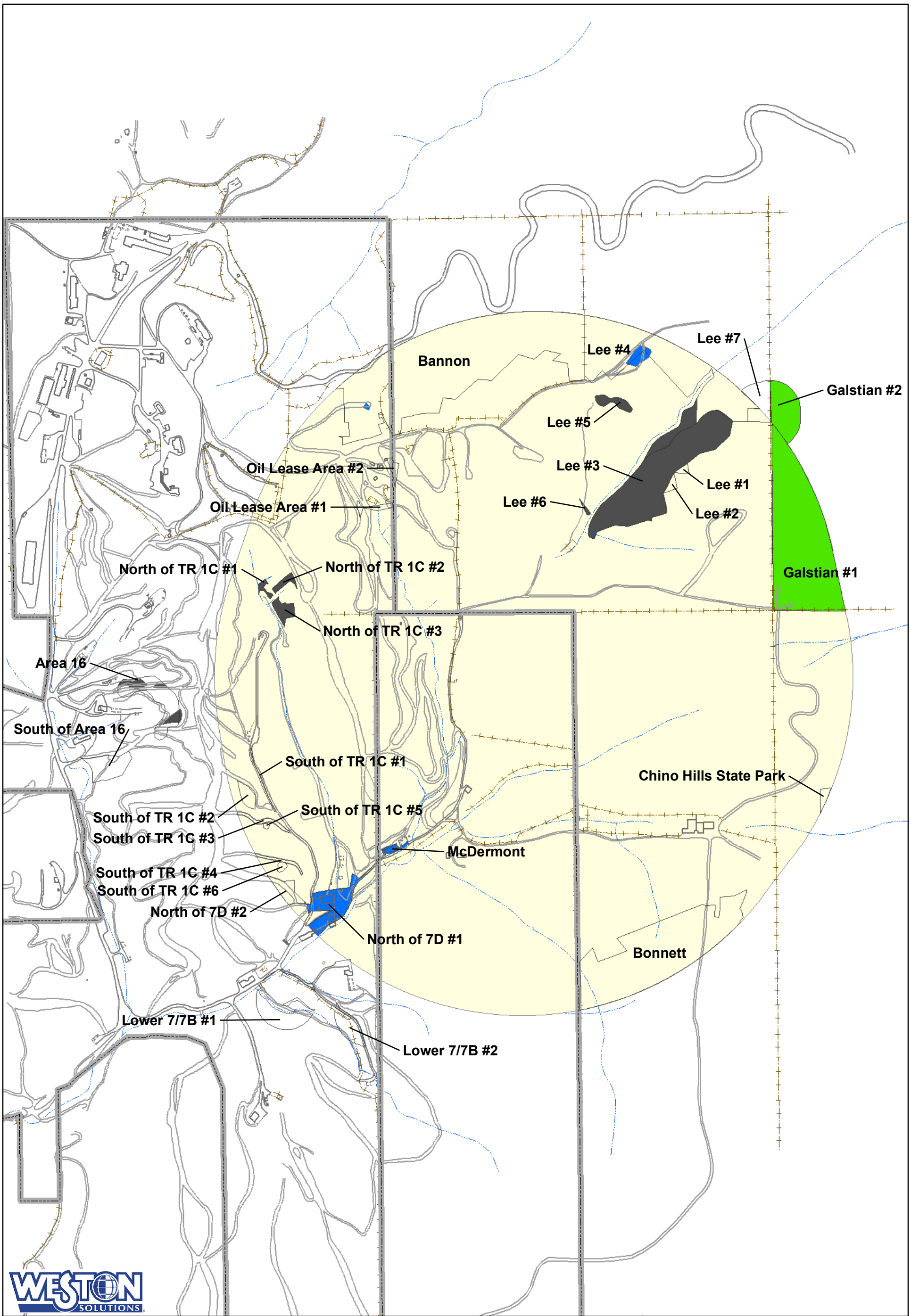
5.2 DATA GAP SUMMARY

Figure 5-1 presents areas that were inaccessible or contained surface features that prevented the MEC investigation. **Table 5-1** provides a summary of the status of each data gap.

Table 5-1 Data Gap Summary

Data Gap	Status	Discussion
Area 16	Inaccessible areas remain	Steep inaccessible terrain prevented full MEC investigation coverage
Bannon	Cultural features remain	An oil well and pipeline as well as surrounding cultural features prevented full MEC investigation coverage
Bonnett	Complete	Full coverage was achieved at Bonnett using both DGM and mag & dig surveys.
Chino Hills State Park	Complete	Full coverage was achieved at the State Park using mag & dig surveys.
Galstian #1	No MEC investigation performed	No access agreement was secured.
Galstian #2	No MEC investigation performed	No access agreement was secured.
Lee #1	Complete	Full coverage was achieved at the Lee #1 using mag & dig surveys.
Lee #2	Complete	Full coverage was achieved at the Lee #2 using mag & dig surveys.
Lee #3	Inaccessible areas remain	Steep inaccessible terrain prevented full MEC investigation coverage
Lee #4	Cultural features remain	Surface and buried cultural debris prevented full MEC investigation coverage.
Lee #5	Inaccessible	Steep terrain prevented access.
Lee #6	Inaccessible	Steep terrain prevented access.
Lee #7	Complete	Full coverage was achieved at the Lee #7 using mag & dig surveys.
Lower 7/7B #1	Complete	Full coverage was achieved at the Lower 7/7B #1 using mag & dig surveys.
Lower 7/7B #2	Cultural features remain	Asphalt roadways prevented full MEC investigation coverage.
McDermont	Cultural features remain	Chain link fence and roadway prevented a MEC investigation
North of 7D #1	Cultural features remain	Buildings, asphalt roadways and parking areas prevented full MEC investigation coverage.
North of 7D #2	Complete	Full coverage was achieved at the North of 7D #2 using mag & dig surveys.
North of TR 1C #1	Inaccessible	Steep terrain prevented access.
North of TR 1C #2	Inaccessible	Steep terrain prevented access.
North of TR 1C #3	Inaccessible	Steep terrain prevented access.
Oil Lease Area #1	Complete	Full coverage was achieved at the Oil Lease Area #1 using mag & dig surveys.
Oil Lease Area #2	Complete	Full coverage was achieved at the Oil Lease Area #2 using mag & dig surveys.
South of Area 16	Complete	Full coverage was achieved at the South of Area 16 using mag & dig surveys.
South of Test Range (TR) 1C #1	Complete	Full coverage was achieved at the South of TR 1C #1 using mag & dig surveys.
South of TR 1C #2	Complete	Full coverage was achieved at the South of TR 1C #2 using mag & dig surveys.

Data Gap	Status	Discussion
South of TR 1C #3	Complete	Full coverage was achieved at the South of TR 1C #3 using mag & dig surveys.
South of TR 1C #4	Complete	Full coverage was achieved at the South of TR 1C #4 using mag & dig surveys.
South of TR 1C #5	Complete	Full coverage was achieved at the South of TR 1C #5 using mag & dig surveys.
South of TR 1C #6	Complete	Full coverage was achieved at the South of TR 1C #6 using mag & dig surveys.



Aerojet Property Line
OBOD Kick-Out Radius
Existing Buildings
Former Buildings
Fence
Drainage Gullies

Data Gaps

Inaccessible Terrain
Cultural Feature Interference
Accessible Terrain

N W E S

0 300 600 1,200
Feet

Figure 5-1
Site Features
Aerojet Chino Hills Study Area
Chino Hills, California

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SECTION 6

CONCLUSIONS

6. CONCLUSIONS

Between 5 January and 13 February 2009, WESTON and Aerojet completed the MEC detection and removal operations over approximately 39-acres of accessible data gaps located on the facility and study area. The data gaps included areas where previous MEC investigations were not performed. Both DGM and mag & dig surveys were used to detect and recover MEC.

Throughout the project, a robust seeding program as well as quality measurement criteria were used to demonstrate the Pd of the geophysical instrumentation. This process allowed for the verification of detection capabilities to ensure DQOs were being achieved.

A total of 55 MPPEH items were recovered during the investigation. These items could not be adequately inspected for explosives or explosives components due to their condition. MPPEH were predominately recovered in the Area 16 and South of Area 16 data gaps. MPPEH were also recovered in Lee and Bonnett. Data gaps and quantities of MPPEH are provided in **Table 6-1**. All MPPEH is stored within locked explosive storage magazines until they can be treated.

Table 6-1 MPPEH Quantity and Recovery Location

Data Gap	Quantity of MPPEH Recovered	Quantity - Type of MPPEH Recovered	Data Gap Summary Status
Area 16	47	15 - Fuze (M505) 15 - Projectile (20mm) 02 - Projectile (25mm) 13 - Projectile (30mm) 01 - Base (Tracer) 01 - Frag (unknown)	Inaccessible areas remain
Bannon	0		Cultural features remain
Bonnett	2	02 - Base (40mm)	Complete
Chino Hills State Park	0		Complete
Galstian #1	0		No MEC investigation performed
Galstian #2	0		No MEC investigation performed
Lee #1	0		Complete
Lee #2	0		Complete
Lee #3	0		Inaccessible areas remain
Lee #4	1	01 - Base (40mm)	Cultural features remain
Lee #5	0		Inaccessible
Lee #6	0		Inaccessible
Lee #7	0		Complete
Lower 7/7B #1	0		Complete

Data Gap	Quantity of MPPEH Recovered	Quantity - Type of MPPEH Recovered	Data Gap Summary Status
Lower 7/7B #2	0		Cultural features remain
McDermont	0		Cultural features remain
North of 7D #1	0		Cultural features remain
North of 7D #2	0		Complete
North of TR 1C #1	0		Inaccessible
North of TR 1C #2	0		Inaccessible
North of TR 1C #3	0		Inaccessible
Oil Lease Area #1	0		Complete
Oil Lease Area #2	0		Complete
South of Area 16	5	02 - Fuze (M505) 03 - Projectile (30mm)	Complete
South of Test Range (TR) 1C #1	0		Complete
South of TR 1C #2	0		Complete
South of TR 1C #3	0		Complete
South of TR 1C #4	0		Complete
South of TR 1C #5	0		Complete
South of TR 1C #6	0		Complete

Several areas were identified as inaccessible to the geophysical instrumentation due to terrain. In addition, cultural features within the data gaps prevented the ability to detect MEC. These areas were not fully investigated.

6.1 LESSONS LEARNED

Based upon the results from the Chino Hills GPO (Geomatrix, 2004), an EM61-MK2 sensor deployed on the standard manufacturer cart was found to be capable of detecting target MEC items as presented in Table 3-1 Detection Depth and Probability of Detection. To increase detection performance, a mutli-EM61-MK2 sensor towed sled was used to reduce the sensor height and to increase the signal to noise ratio of buried conductive items. In addition, the GPO found that the standard EM61-MK2 cart could be deployed across the site at an across line spacing of up to 3-ft. The multi-EM61-MK2 sensor towed sled provided an effective across line spacing of 1.5-ft, increasing the likelihood of traversing directly over a target item. By changing these parameters, the Project Team observed an increased signal response of digitally detected items.

Use of the multi-EM61-MK2 sensor towed sled was limited due to steep and rugged terrain within the data gaps. Vehicle usability and size and weight of the sled and sensors limited accessibility for DGM in these areas.

SECTION 7

REFERENCES

7. REFERENCES

Geomatrix Consultants, Inc., 2006. Draft Conceptual Site Model for Munitions and Explosives of Concern, Aerojet Chino Hills Property, Chino Hills, CA, 24 August.

Geomatrix Consultants, Inc., 2005. Final Geophysical Prove-Out Report, Aerojet Chino Hills Facility, Chino Hills, CA, 5 October.

Weston Solutions, Inc., 2008. Final MEC Data Gap Investigation Work Plan, March.

APPENDIX A

WORK PLAN APPROVAL LETTER

APPENDIX B

DAILY QUALITY/SAFETY LOGS

APPENDIX C

TEST STRIP MEMORANDUM

APPENDIX D

SEEDING PROGRAM MAPS

APPENDIX E

PROJECT PHOTOGRAPH LOG

APPENDIX F

DGM QC FORMS

APPENDIX G

DGM DATA PLOTS AND RAW DATA (ATTACHED ON CD)

APPENDIX H

DIG LIST

APPENDIX I

MEC DATA GAP INVESTIGATION RESULTS

APPENDIX J

TEST STRIP RESULTS

APPENDIX K

STATE PARK COVERAGE GAPS MEMORANDUM