

## **FINAL REPORT**

# **MUNITIONS AND EXPLOSIVES OF CONCERN SITE A** *NASA Crows Landing Flight Facility* *Crows Landing, California*

*Initial Geophysical Survey Results*  
*Contract Number N62474-98-D-2076*  
*Contract Task Order 0110*

*August 17, 2005*

Submitted to:

*Naval Facilities Engineering Command (NAVFAC)*  
*Southwest Division*

Submitted by:

  
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# TRANSMITTAL

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**To:** Ellen Casados  
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**Date:** 22 August, 2005

**From:** Charles So, P.E. *CS*

**Subject:** Final Report for Initial Geophysical Survey for MEC Clearance at Site A (Small Arms Firing Range), NASA Crows Landing Flight Facility, California

Transmitted herein is the final report for the initial geophysical survey conducted at Site A at NASA Crows Landing Flight Facility. The report describes survey procedures followed in the field and results, including graphical presentation of anomalies detected and a summary of the target list.

The geophysical survey was conducted in accordance with the requirements and procedures described in the MEC Verification and Clearance Work Plan<sup>1</sup> and the Unexploded Ordnance and Geophysical Quality Assurance/Quality Control Plan<sup>2</sup> submitted in June 2005. Prior to the geophysical survey, a Geophysical Prove-out (GPO) using a test plot was performed to determine the appropriate instrument for subsequent survey use. EM61-MKII was selected based on the test results. The GPO test was performed on June 27 and 28, 2005. On June 22, 2005, seed items for QA/QC, including the blind seeds, were placed at the site by the QA Geophysicist, in accordance with the QA/QC plan requirements.

The initial geophysical survey at Site A was initiated and completed in July 2005. Geophysical survey data were reviewed by the QA Geophysicist and no QA/QC issues were noted with the data or the final results. Based on the geophysical findings, 130 point source anomalies were identified. These anomaly locations will be established in the field following "Anomaly Location Reacquisition" procedures described in the QA/QC plan and will be investigated following procedures described in the MEC Verification and Clearance Work Plan.

Enclosure – MEC Site A Initial Geophysical Survey Results, Final Report, dated August 17, 2005

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<sup>1</sup> Shaw Environmental, Inc., 2005, *Munitions and Explosives of Concern Verification and Clearance, NASA Crows Landing Flight Facility, Crows Landing, California, Final Project Plans*, June 9.

<sup>2</sup> Shaw Environmental, Inc., 2005, *Final Unexploded Ordnance and Geophysical Quality Assurance/Quality Control Plan, Munitions and Explosives of Concern Verification and Clearance, NASA Crows Landing Flight Facility, Crows Landing, California*, June 15.

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## **Acronyms and Abbreviations**

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|               |   |
|---------------|---|
| Crows Landing | NASA Crows Landing Flight Facility          |
| EM            | Electromagnetic                             |
| EM61-MKII     | Geonics EM61-MKII Metal Detector            |
| GPO           | Geophysical Proveat                         |
| GPS           | Global Positioning System                   |
| IRP           | Installation Restoration Program            |
| MEC           | Munitions of Explosive Concern              |
| NOSSA         | Naval Ordnance Safety and Security Activity |
| TDEM          | Time-Domain Electromagnetics                |

## 1.0 Introduction

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This report presents the results of a geophysical investigation conducted by Shaw Environmental, Inc. at Munitions and Explosives of Concern (MEC) Site A, NASA Crows Landing Flight Facility (Crow Landing) in Stanislaus County, California. The fieldwork was conducted on June 29 through July 14, 2005, under Contract Number N62474-98-D2076, and Contract Task Order 0110. This report includes:

- Color maps of the geophysical data overlain by locations of site features
- A summary of the geophysical survey results
- Discussion of the survey results

In addition, a Compact Disc accompanies this hard copy containing the following files:

- The Site A geophysical report
- All of the raw and processed geophysical data in the appropriate ASCII file format
- Geophysical maps in PDF format

### 1.1 Site Description

Site A is located southwest of Installation Restoration Program (IRP) Site 11 (Figure 1, "Crows Landing Area Map with Survey Sites Posted"), within the area referred to as the Small Arms Firing Range. The firing range is also the location of the former IRP Site 18 North. A former airplane target berm is shown within the firing range on historic facility maps and aerial photographs. Aerial photographs show its presence in the late 1940s and its removal by the mid-1950s. The location and boundary of the former target berm are discussed in the Work Plan for Site A.

The former airplane target berm was used as a firing range backstop. Based on the photographs and other available records, small arms might have been fired from an area near the western edge of the site towards the berm, in the direction towards the runway. Sources also indicate that airplanes may have turned onto the concrete turnout located off the runway and fired towards the berm. Munitions used with the airplanes for training practices most likely were 20-mm projectiles. The area is presently a flat, open field and has been used for crop production since the mid-1950s.

The physical hazards, associated with unfired munitions, potentially remaining at the site requires consideration. A preliminary geophysical investigation was conducted in September 2001 at the former firing range to determine the distribution of metallic anomalies that might indicate the potential presence of munitions. Results indicate several small anomalies

that could represent ammunition distributed randomly across the investigation area. Several of the anomalies could also represent other buried features, including utilities associated with runway lights, utilities associated with agricultural water delivery (such as pipelines and air relief valves), and rebar in the concrete runway turnout. The data did not indicate a high density of metallic anomalies near the location of the former berm.

Naval Ordnance Safety and Security Activity (NOSSA) visited this site as part of the Facility inspection in August 2002 to evaluate closure of the ordnance and explosives material storage and usage areas. Inspection results recommended a ground sweep to clear the site of any potential ordnance and explosives. Because munitions items may exist at the site, a fence was installed around the perimeter of the former target berm area to limit public access in the summer of 2003. This fenced area is currently the site subject to verification and clearance of MEC and MEC-related scrap

## **1.2 Objectives**

The main objective of the investigation was to conduct a geophysical investigation at MEC Site A to assess the nature and extent of geophysical anomalies that may represent buried MEC or related MEC items. A Geophysical Proveout (GPO) was conducted at Crows Landing (in accordance with MR DID 005-05A) to assess the most appropriate instrument to use for the geophysical survey. A GPO was conducted in late June 2005 by Shaw prior to the onset of fieldwork. The instrument selected was the Geonics EM61-MKII Metal Detector (EM61-MKII) combined with a Global Positioning System (GPS) for navigation. The geophysical surveys performed on MEC Site A were conducted to detect any potential metallic anomalies that may represent MEC or related MEC items. Total area coverage for this survey was 2.08 acres.

## **2.0 Technology and Approach**

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This section presents the theoretical background and rationale for using time domain electromagnetics (TDEM) metal detection and GPS.

### **2.1 Time Domain Electromagnetics (Geonics EM61-MKII)**

The Geonics EM61-MKII is a unique type of electromagnetic (EM) metal detector. Most standard types of metal detectors are TDEM tools or magnetometers of some simple type. The EM61-MKII utilizes time domain theory to explore for both ferrous and non-ferrous buried metal objects. By using time domain theory the EM61-MKII is capable of discriminating between conductive earth materials and metallic targets such as buried metallic waste, underground storage tanks, and ordnance.

The EM61-MKII is the latest model of metal detection instrument from Geonics, Ltd. It generates several EM pulses per second in a general square wave configuration. The system takes readings during the off time between square wave pulses. During each EM pulse, eddy currents, with associated secondary magnetic fields, are induced in earth materials and in any buried metallic objects that are present (Faraday's Law). The system measures the decay of secondary magnetic fields associated with the eddy currents using two horizontally mounted coils. The system measures these fields in milliVolts.

By using time domain theory, the EM61-MKII is capable of discriminating between conductive earth materials and metallic targets. In general, the secondary magnetic field associated with the induced current dissipates much faster in earth materials than in buried metal objects. Between each pulse, the EM61-MKII allows for the response from the earth materials to dissipate and subsequently measures the prolonged buried metal response at 4 different time gates. By sensing only the buried metal response, the EM61-MKII can distinguish between conductive soils or rock and metal targets.

The EM61-MKII system consists of a backpack, data logger, and a wheeled two-coil transmitter/receiver cart that is pulled by the operator. The data logger, which is attached to the backpack, runs the entire system. The purpose of the EM61-MKII survey is to evaluate the presence of buried metal objects and debris. The EM61-MKII can detect a single 55-gallon drum at a depth of 3 meters (10 feet). The high sensitivity and ability to detect all metals make the EM61-MKII a valuable tool for highly accurate detection of subsurface metallic objects.

EM61-MKII survey data are typically presented as plan-view contour maps. The maps are color-enhanced to aid in interpretation of subtle anomalies. The data can also be presented as profile data along any given profile.

## **2.2 Navigational Technology (Trimble Pro-XRS)**

Differential GPS technologies provide location data at approximately one and one-half foot, real time horizontal accuracy. For this project, Shaw utilized the single frequency, Trimble Pathfinder Pro-XRS with the EM61-MKII system. For the EM61-MKII survey, GPS data was obtained in conjunction with the geophysical data. This assures that every data point has an associated northing and easting coordinate. Therefore, positional accuracy is tied into each geophysical map.

The availability of sufficient satellite coverage dictates the appropriate use of GPS. Two factors dictate sufficiency of satellite coverage: (1) the view of the sky from the survey site, and (2) the number and height of GPS satellites above the survey site. Tree coverage and proximity to buildings and topographic features such as cliffs and steep hills affect access to a clear view of the sky. The orbits of the GPS satellites can be readily viewed through use of GPS planning software such as Trimble's Quick Plan software. By reviewing the satellite availability on a daily basis, optimal survey periods can be defined, and periods of poor satellite visibility coordinated with rest times, preventative maintenance, data downloading, and travel.

## **3.0 Geophysical Survey Procedures**

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### **3.1 Calibration Test Area**

Prior to conducting the geophysical surveys in MEC Site A, a small area outside of the site boundary was tested and established as having “little or no noise”. This area was employed for use as a calibration test area for instrument calibration and quality control checks for the EM61-MKII. A calibration test was performed prior to fieldwork each day and at the end of the day. A trailer hitch ball was used as an anomaly source for the calibration test. The calibration line was conducted in two directions and the resulting anomaly was within 10 percent of the measured magnitude for each test.

As described in the following additional calibration tests were performed:

- Static Background Test
- Static Spike Test
- Personnel Test
- Cable Shake Test
- Data Repeatability Test

### **3.2 EM61-MKII Electromagnetic Survey**

EM61-MKII data were collected with the GPS antenna centered above the coils 5.6 feet above the ground surface. Data within MEC Site A were collected North-South with a line spacing of approximately 2.5 feet. This guarantees that the entire surface of the field area was covered with the sensor. For this survey, each traverse was marked by lines spray painted by a second geophysicist traveling at a minimum of ten (10) feet behind instrument. The GPS data streamed from the remote control unit directly into the Allegro data logger. The four-channel electromagnetic and GPS data were stored in the EM61-MKII’s Allegro data logger and were downloaded following the field activities.

### **3.3 GPS Survey**

Upon completion of the geophysical survey a GPS survey was conducted. GPS data were obtained to delineate all of the surface features on site. This data is typically used in conjunction with the geophysical data to enhance interpretation of the data. Virtually every surface feature and surface structure was outlined with the GPS system.

## **4.0 Geophysical Data Processing**

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### **4.1 EM61-MKII Data Processing**

Geonics DAT-61 for Windows software was used to download the EM61-MKII data to a laptop in the field. The EM data sets were verified and subsequently backed up prior to system demobilization. A file was created from DAT-61 that integrated the geophysical and GPS data to create a location for every EM data point. The EM data sets were then merged and processed. Geosoft's Oasis Montaj was used for leveling, gridding, target picking, analysis, and map creation.

Data was leveled by shifting the data by the amount of the minimum value and a color contour map was created using the California State Plane Coordinates. Site feature locations such as surface metal and fence boundary were then plotted over the top of the map in order to distinguish between buried and surface metals. Final maps were exported from Oasis Montaj to ESRI's ArcMap for ease of compatibility with other agencies

## 5.0 Results

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The following section presents the results of the EM61-MKII surveys over MEC Site A. Figure 1 presents a location map of the area. Figure 2, "Site A Map of Leveled Sum of EM61MK2 Channels with Targets Posted," depicts the EM61-MKII data. Figure 3, "Site A Map of Leveled Sum of EM61MK2 Channels with Targets Posted and Sub-Target Amplitude Grayed," depicts EM61 MKII data with background removed to visually observe the anomalies easier.

### 5.1 EM61-MKII Electromagnetic Results

As evident in Figure 2 and 3 the only surface interferences are caused by the fence surrounding the site, and the wells on the western side of the site. All data and objects are mapped in North American Datum 83 California State Plane Coordinates (US Feet).

Several point source anomalies were detected in the area. Each anomaly is marked with a cross and has a unique anomaly number. Each of these anomalies represents a metallic object or objects. In all, 130 anomalies were detected. Each of the anomalies has the potential to be a MEC item or an MEC related item (e.g., scrap, etc.).

A target list for all of these anomalies was constructed and is included in Appendix A. The target list includes each anomaly number, the associated California Coordinates for the anomaly location, and anomaly magnitude. The target list can be used for excavation purposes.

## 6.0 Discussion

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In general, 130 point source anomalies were detected in the EM61 MKII data. These anomalies, their locations, and anomaly magnitudes are included in Appendix A which can be used to waypoint and excavate each anomaly. These point source anomalies indicate the same character as anomalies generated by MEC items. It is suggested to use MEC excavation safety procedures during exploratory excavation activities at the site.

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## *Figures*

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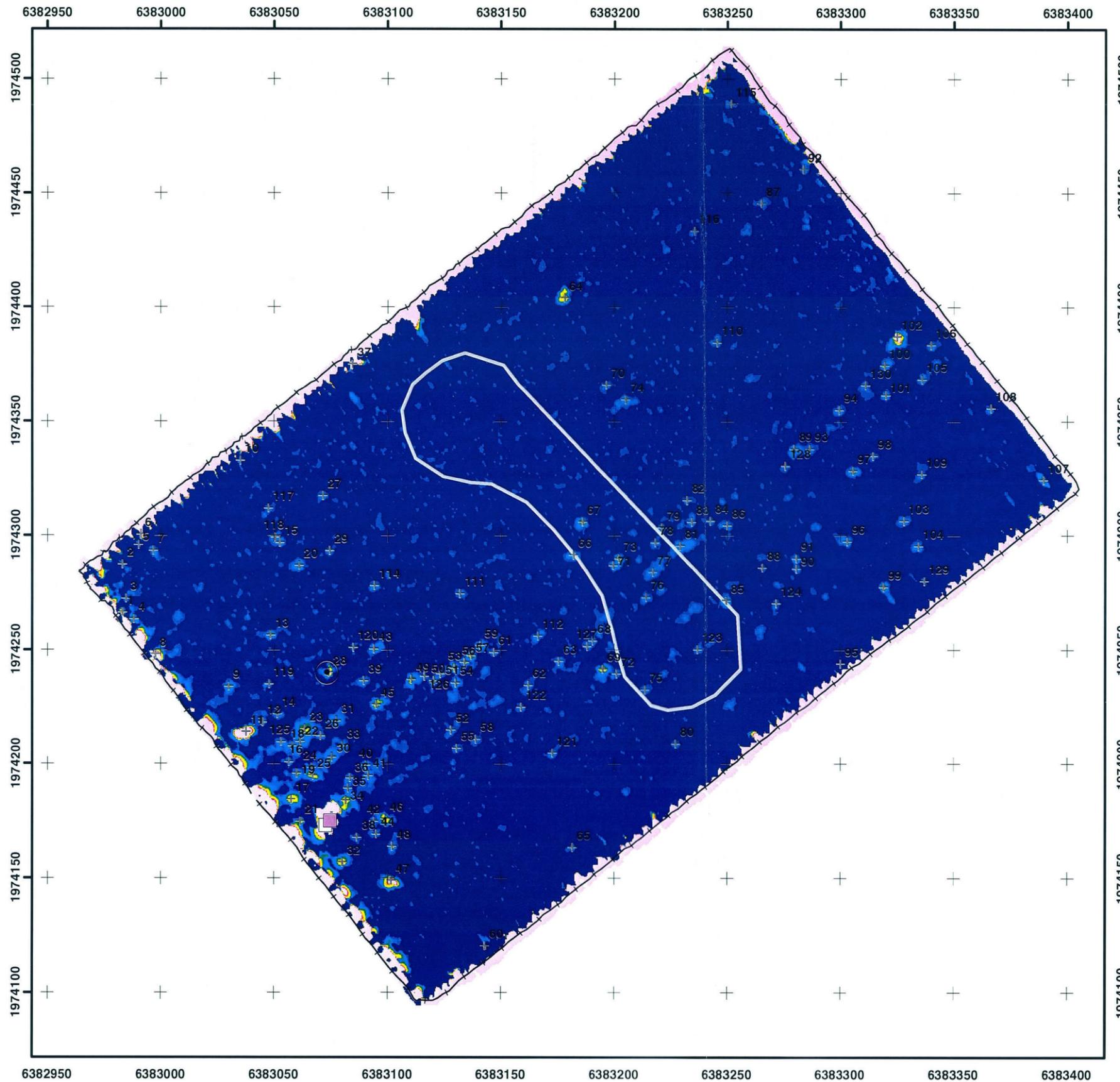
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**Crows Landing Flight Facility**

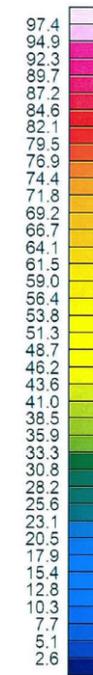
Figure 1 - Crows Landing Area Map with Survey Sites Posted

NAD83, California Zone 3, US Feet



### Legend

- 3 inch water well
- Known QC Point
- well tipped to side
- + Area A Targets
- Fence
- Location of former berm



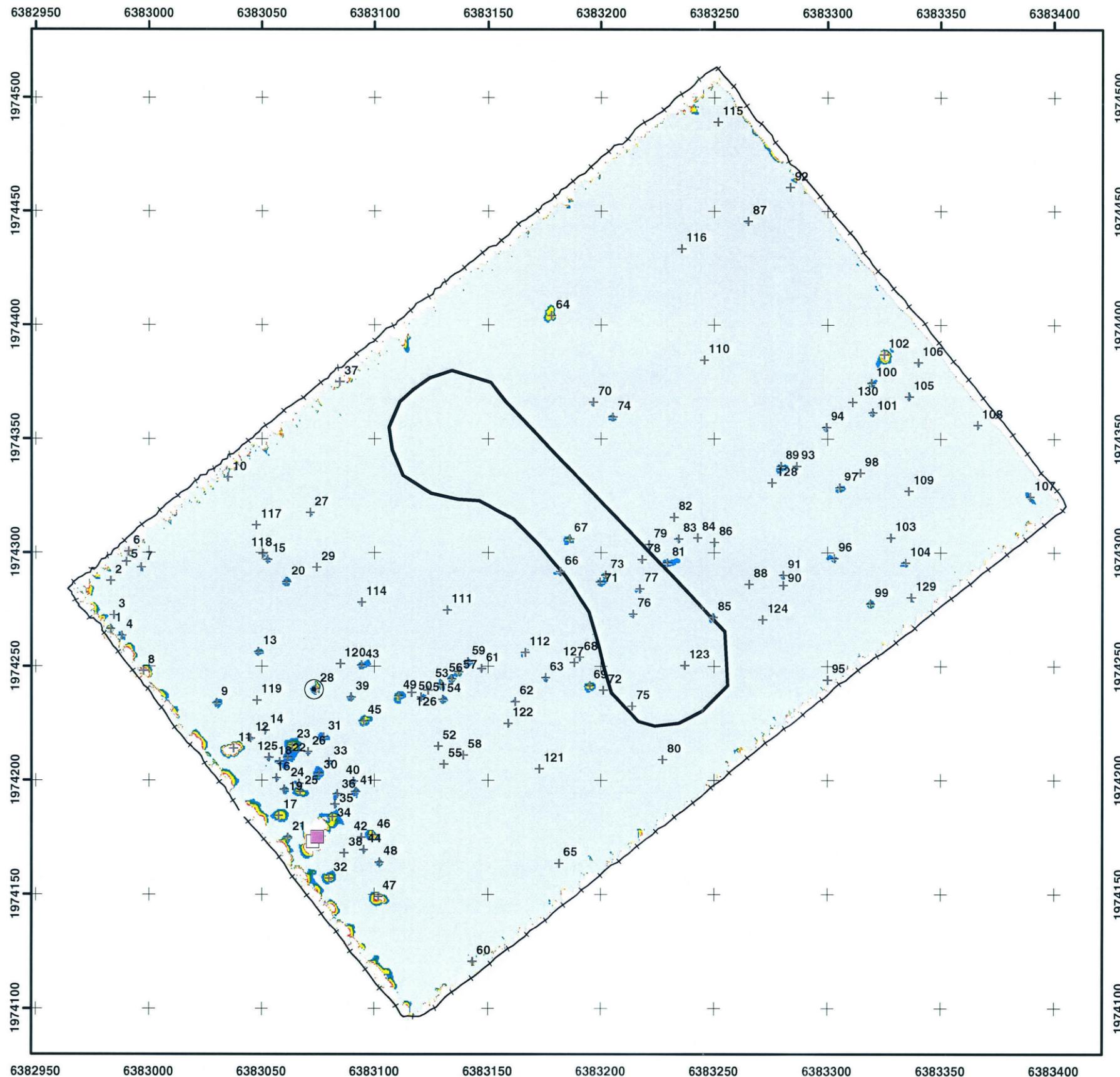
EM61MK2 Response  
(levelled mV)



### Crows Landing Flight Facility

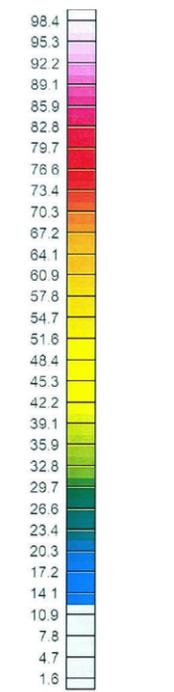
Figure 2 - Site A Map of Levelled Sum of EM61MK2 Channels with Targets Posted

NAD 83, State Plane California 3, US Feet



### Legend

- 3 inch water well
- ⊙ qc known pt
- well tipped to side
- + Area\_A\_Targets Events
- +— Fence
- ▭ Location of former berm



EM61MK2 Response  
(levelled mV)



### Crows Landing Flight Facility

Figure 3 - Site A Map of Levelled Sum of EM61MK2 Channels with Targets Posted and sub-target amplitude grayed

NAD 83, State Plane California 3, US Feet

***Appendix A***  
***Target List for MEC Site A***

**Crows Landing Flight Facility  
Site A Target List**

| Target # | Easting (US feet) | Northing (US feet) | Response (mV) |
|----------|-------------------|--------------------|---------------|
| 1        | 6382983.0         | 1974266.5          | 83.9          |
| 2        | 6382983.0         | 1974287.5          | 14.7          |
| 3        | 6382984.5         | 1974272.5          | 15.1          |
| 4        | 6382988.0         | 1974263.5          | 30.8          |
| 5        | 6382990.0         | 1974296.0          | 14.5          |
| 6        | 6382991.0         | 1974300.5          | 505.5         |
| 7        | 6382996.5         | 1974293.5          | 18.2          |
| 8        | 6382997.5         | 1974248.0          | 257.0         |
| 9        | 6383030.0         | 1974234.0          | 35.9          |
| 10       | 6383035.0         | 1974333.0          | 16.4          |
| 11       | 6383037.5         | 1974214.0          | 623.4         |
| 12       | 6383045.0         | 1974218.5          | 22.9          |
| 13       | 6383048.5         | 1974256.5          | 35.6          |
| 14       | 6383051.5         | 1974222.0          | 21.3          |
| 15       | 6383052.5         | 1974297.0          | 29.9          |
| 16       | 6383056.5         | 1974201.0          | 25.1          |
| 17       | 6383057.5         | 1974184.5          | 84.6          |
| 18       | 6383058.0         | 1974208.0          | 19.4          |
| 19       | 6383060.0         | 1974196.0          | 59.8          |
| 20       | 6383061.0         | 1974287.0          | 27.8          |
| 21       | 6383061.5         | 1974175.0          | 50.4          |
| 22       | 6383061.5         | 1974210.0          | 25.4          |
| 23       | 6383063.5         | 1974215.5          | 41.6          |
| 24       | 6383066.5         | 1974198.5          | 23.8          |
| 25       | 6383067.0         | 1974195.0          | 45.8          |
| 26       | 6383070.5         | 1974212.5          | 16.6          |
| 27       | 6383071.5         | 1974317.5          | 16.2          |
| 28       | 6383074.0         | 1974240.0          | 84.9          |
| 29       | 6383074.5         | 1974293.5          | 14.6          |
| 30       | 6383075.5         | 1974203.0          | 23.0          |
| 31       | 6383077.5         | 1974219.0          | 25.9          |
| 32       | 6383080.0         | 1974157.0          | 105.0         |
| 33       | 6383080.0         | 1974208.0          | 21.9          |
| 34       | 6383081.5         | 1974184.0          | 87.7          |
| 35       | 6383082.5         | 1974189.5          | 20.9          |
| 36       | 6383083.5         | 1974194.0          | 33.3          |
| 37       | 6383084.5         | 1974375.0          | 144.8         |
| 38       | 6383086.5         | 1974168.0          | 14.4          |
| 39       | 6383089.5         | 1974236.5          | 35.5          |
| 40       | 6383090.5         | 1974199.5          | 24.1          |
| 41       | 6383091.5         | 1974195.0          | 19.6          |
| 42       | 6383094.0         | 1974175.0          | 15.7          |
| 43       | 6383094.0         | 1974250.5          | 40.8          |
| 44       | 6383095.0         | 1974169.5          | 33.9          |
| 45       | 6383095.0         | 1974226.0          | 41.0          |
| 46       | 6383099.0         | 1974176.0          | 57.5          |
| 47       | 6383101.5         | 1974149.0          | 173.3         |
| 48       | 6383102.0         | 1974164.0          | 64.2          |
| 49       | 6383110.5         | 1974237.0          | 49.1          |
| 50       | 6383120.5         | 1974236.5          | 25.9          |
| 51       | 6383123.5         | 1974239.5          | 14.0          |

**Crows Landing Flight Facility  
Site A Target List**

| Target # | Easting (US feet) | Northing (US feet) | Response (mV) |
|----------|-------------------|--------------------|---------------|
| 52       | 6383128.0         | 1974215.0          | 19.2          |
| 53       | 6383129.5         | 1974242.0          | 30.8          |
| 54       | 6383130.0         | 1974235.5          | 32.9          |
| 55       | 6383130.5         | 1974207.0          | 17.7          |
| 56       | 6383134.0         | 1974244.5          | 51.3          |
| 57       | 6383137.0         | 1974247.5          | 52.9          |
| 58       | 6383139.0         | 1974211.0          | 14.5          |
| 59       | 6383141.0         | 1974252.0          | 23.4          |
| 60       | 6383143.0         | 1974120.5          | 30.8          |
| 61       | 6383147.0         | 1974249.0          | 28.6          |
| 62       | 6383162           | 1974234.5          | 21.1          |
| 63       | 6383175.5         | 1974245            | 20            |
| 64       | 6383178           | 1974404            | 75.7          |
| 65       | 6383181.5         | 1974163.5          | 19.5          |
| 66       | 6383182           | 1974291.5          | 23.6          |
| 67       | 6383186           | 1974306            | 35.5          |
| 68       | 6383190.5         | 1974254            | 14.7          |
| 69       | 6383195           | 1974241.5          | 46.1          |
| 70       | 6383196.5         | 1974366            | 16            |
| 71       | 6383199.5         | 1974287            | 28            |
| 72       | 6383201           | 1974239.5          | 14.7          |
| 73       | 6383202           | 1974290            | 66.9          |
| 74       | 6383205           | 1974359.5          | 26.5          |
| 75       | 6383213.5         | 1974232.5          | 15.9          |
| 76       | 6383214           | 1974273            | 19.1          |
| 77       | 6383217           | 1974284            | 15.2          |
| 78       | 6383218           | 1974297            | 18.1          |
| 79       | 6383221           | 1974303.5          | 15.2          |
| 80       | 6383227           | 1974209            | 14.4          |
| 81       | 6383229           | 1974295.5          | 23.7          |
| 82       | 6383232           | 1974315.5          | 14.3          |
| 83       | 6383234           | 1974306            | 20.5          |
| 84       | 6383242.5         | 1974306.5          | 14.7          |
| 85       | 6383249.5         | 1974271.5          | 36.1          |
| 86       | 6383250           | 1974304.5          | 16.2          |
| 87       | 6383265           | 1974445.5          | 14.3          |
| 88       | 6383265.5         | 1974286            | 14.1          |
| 89       | 6383279.5         | 1974338            | 33.1          |
| 90       | 6383280.5         | 1974285.5          | 21.1          |
| 91       | 6383280.5         | 1974290            | 21.8          |
| 92       | 6383283.5         | 1974460.5          | 14.4          |
| 93       | 6383286.5         | 1974338            | 16            |
| 94       | 6383299.5         | 1974355            | 27.4          |
| 95       | 6383300           | 1974244            | 14.6          |
| 96       | 6383303           | 1974297.5          | 28.7          |
| 97       | 6383305.5         | 1974328.5          | 47.1          |
| 98       | 6383314.5         | 1974335            | 19.1          |
| 99       | 6383319           | 1974277.5          | 42.1          |
| 100      | 6383319.5         | 1974374.5          | 29.3          |
| 101      | 6383320           | 1974361.5          | 22            |
| 102      | 6383325           | 1974387            | 897.7         |

**Crows Landing Flight Facility  
Site A Target List**

| <b>Target #</b> | <b>Easting (US feet)</b> | <b>Northing (US feet)</b> | <b>Response (mV)</b> |
|-----------------|--------------------------|---------------------------|----------------------|
| 103             | 6383328                  | 1974306.5                 | 18.6                 |
| 104             | 6383334.5                | 1974295.5                 | 20                   |
| 105             | 6383336                  | 1974368.5                 | 22.5                 |
| 106             | 6383340                  | 1974383.5                 | 26.2                 |
| 107             | 6383389.5                | 1974324.5                 | 28.8                 |
| 108             | 6383366.4                | 1974355.9                 | 15.6                 |
| 109             | 6383335.9                | 1974327                   | 14                   |
| 110             | 6383245.5                | 1974384.6                 | 15.2                 |
| 111             | 6383132                  | 1974274.7                 | 14.5                 |
| 112             | 6383166.4                | 1974256.1                 | 14.5                 |
| 114             | 6383094.2                | 1974278.1                 | 15.3                 |
| 115             | 6383251.6                | 1974489.1                 | 14.8                 |
| 116             | 6383235.3                | 1974433.4                 | 12.8                 |
| 117             | 6383047.5                | 1974312                   | 17                   |
| 118             | 6383050.5                | 1974299.4                 | 18.5                 |
| 119             | 6383047.8                | 1974235.1                 | 14.3                 |
| 120             | 6383084.9                | 1974251.1                 | 14.3                 |
| 121             | 6383172.7                | 1974204.9                 | 11.9                 |
| 122             | 6383158.9                | 1974225                   | 12.9                 |
| 123             | 6383236.8                | 1974250.3                 | 12.8                 |
| 124             | 6383271.6                | 1974270.4                 | 9.9                  |
| 125             | 6383053.1                | 1974209.9                 | 13                   |
| 126             | 6383116.3                | 1974238.4                 | 11.7                 |
| 127             | 6383188                  | 1974251.6                 | 15.5                 |
| 128             | 6383275.6                | 1974330.6                 | 13                   |
| 129             | 6383337                  | 1974280.2                 | 21.3                 |
| 130             | 6383311.2                | 1974365.9                 | 11.3                 |