YPG-029

RESPONSE TO COMMENTS ON DRAFT FINAL VERSION OF RFI REPORT DATED NOVEMBER 2011

Date: April 10, 2012
Comments from the State of Arizona Department of Environmental Quality

Comment #	Comment	Reference	Response to Comment
General Comments			
1	**Removal of Site from the RCRA Permit.** In a letter, dated November 16, 2011, accompanying the RFI report, USAGYPG requested that this site be removed from the RCRA permit (the results of the RFI show that YPG-29 has not released hazardous constituents in quantities sufficient to pose a threat to human health or the environment). ADEQ notes that YPG-29 is a solid waste management unit (SWMU) described in the hazardous waste permit (the Permit). In lieu of removing the SWMU from the Permit, ADEQ believes that USAGYPG should submit a permit modification request that summarizes the results of the RFI and recommends that no further action is warranted. The permit modification request should be submitted by USAGYPG after final acceptance of the RFI Report. Upon approval of the permit modification request, if requested by USAGYPG, ADEQ may also send an acknowledgement that no further actions are required at this SWMU.		**Response –** Rather than a permit modification request and based on June meeting with ADEQ, USAGYPG proposes that YPG-29 moves forward to a Corrective Measures Study (CMS). The CMS will focus on a limited number of corrective measures aimed at preventing exposure to solid waste. No ecological or human health risk was identified at the site and the only concern is the solid waste.
2	**Hazardous Waste Deposition.** On page viii of the Executive Summary, and at other		**Response:** Text in the Executive Summary and Section 4.4 has been revised to state, "No **visual** evidence of hazardous waste or

Comment #	Comment	Reference	Response to Comment
	locations in the report, USAGYPG states that there was no evidence of hazardous waste disposal in the landfill. However, the report notes the presence of constituents like zinc, lead, copper, and poly-aromatic hydrocarbons (PAHs) above background levels, so the executive summary and the other sections of the report should also note these findings. Revise all the relevant sections of the permit to address this concern.		munitions debris was identified in the excavation pits at the site **and analytical data indicates that there are no hazardous constituents above rSRLs, nrSRLs, or GPLs; therefore, no further sampling is required.**
3	**Line numbers.** Delete the line numbers that appear on the side of each page.		**Response –**Line numbers have been removed from this and subsequent reports.
4	**Non-Residential SRLs.** YPG-29 is a solid waste landfill and may not be used for residential purposes. The report must reference non-residential SRLs		**Response –** As stated in Section 4.3.1 of the RFI Work Plan (Parsons, 2010), "As a first tier, detected soil contaminant concentrations will be compared to residential SRLs; however, since there are no current or planned future residential developments at these sites, the non-residential SRLs will be used as a second tier in the screening process." Since there were no COPCs that exceeded the residential SRL (rSRL), the second tier comparison to the non-residential SRL (nrSRL) was not needed. At the request of ADEQ nrSRLs have been added to Tables 4.3 and 4.4, 5.1 and applicable text throughout the document.
Specific Comments:			
1	**Executive Summary. Hazardous Waste Deposition.** In the fifth line of the fourth paragraph on page viii, USAGYPG has concluded that there was no evidence of hazardous waste in the excavation pits.	**Executive Summary Page viii**	**Response** – See Response to Comment #2.

Comment #	Comment	Reference	Response to Comment
	Refer to general comment 2 and revise the discussion.		
2	**Description and History of USAGYPG**. The phrase "50 years of experience" in the first sentence of the first full paragraph on page 1-3 should be replaced with "a 50 year history"	**Page 1-3 Section 1.2**	**Concur** – Text has been revised to state, "with **a 50-year history** of experience".
3	**Groundwater**. It should be specified that the "1-4 ft per mile" is the gradient.	**Page 2-8, Section 2.2.4.2**	**Concur** – Text has been revised to state, "at **a** 1-4 ft per mile **gradient**."
4	**Section Title.** The section title is listed as "Nature and Extent Investigation." Change it to "Nature and Extent of Contamination Investigation."	**Page 4-1, Section 4.0**	**Concur** – The title for section 4.0 has been revised to "Nature and Extent **of Contamination** Investigation".
5	**Investigation Activities.** It is stated that the soil borings were drilled to determine if chemical constituents were released from the waste. Also, state that soil borings were installed to assess the vertical extent of contamination.	**Page 4-1, Section 4.1**	**Concur –** Text has been revised to state, "…to determine if chemical constituents were released from the waste **and to assess the vertical extent of solid waste**."
6	**Evaluation of Soil Analytical Results. Background Threshold Value (BTV) Comparison.** In the second paragraph on page 4-8, it is stated that select VOCs, SVOCs, explosives and metals were detected in surface and subsurface samples. Specify the compounds that exceed the BTVs.	**Page 4-8, Section 4.2.3**	**Concur –** Section 4.2.3 has been modified to include a list of metals exceeding their corresponding BTV under the sub-heading "Step 1 – Background Threshold Value Comparison".

YPG-029

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7	**Evaluation of Soil Analytical Results. Steps 1 and 2.** The first paragraph on page 4-9 references organics and inorganics that exceed the BTVs. Please list all the compounds that exceed the BTVs. The second paragraph in this section discusses comparison of COPC concentrations to residential SRLs and GPLs. The discussion must also reference non-residential SRLs. Also, refer to general comment 4.	**Page 4-9, Section 4.2.3**	**Response –** The metals that exceed the BTVs have been added to Section 4.2.3 (Step 1) and the discussion has been revised to reference the nrSRLs in addition to the rSRLs and GPLs.
8	**Contamination Assessment.** Please list all the organic and inorganic compounds that exceed the BTVs. Also, refer to general comment 4 and include nonresidential SRLs in the discussion.	**Page 4-9, Section 4.3**	**Concur –** The metals exceeding the BTVs (arsenic, chromium, copper, lead, molybdenum, vanadium and zinc) have been added to the third paragraph of Section 4.3. The nrSRLs have also been added to the discussion.
9	**Nature and Extent Recommendations.** Revise the title of this section to "Nature and Extent of Contamination Recommendations."	**Page 4-1, Section 4.4**	**Concur –** The title of Section 4.4 has been revised to "Nature and Extent **of Contamination** Recommendations".
10	**Site Description and Land Use.** It is stated that the future use of the site will be "undeveloped/vacant land". Since USAGPYG is leaving the waste-in-place, this site is a solid waste landfill, and therefore it is not clear if the future use of this site can be simply labeled as "undeveloped/vacant land."	**Page 5-5 Section 5.2.1.2**	**Response –** Text in Section 5.2.1.2 has been revised to state, "The future use of the YPG-29 site is expected to continue as undeveloped land. **Any proposed change to the future land use will be addressed in the CMS.**"
11	**Summary and Recommendations. Post Closure Plans.** The report offers	**Section 6**	**Response –**Post-closure measures will be submitted as part of the CMS and may include a discussion considering the stated

Comment #	Comment	Reference	Response to Comment
	suggestions for management of the landfill that include surface runoff controls, annual inspections, and incorporation of the landfill in the USAGPYG Master Plan. In addition, USAGYPG can also consider standard solid waste landfill post closure measures like capping, grading, and vegetative cover.		corrective measures alternatives. Text regarding the suggestions for management of the landfill will be removed.
12	**Comparison of Maximum Detected Concentrations to Background and SRLs.** Reference general comment 1 and include the non-residential SRLs in this table.	**Table 5.1**	**Response –** The nrSRLs have been added to Table 5.1.
13	**Cross Section View of Test Pits.** What is the meaning of the arrow located between the horizontal scale and the title block of this cross-section?	**Figure 4.2**	**Response –** The arrow on Figure 4.2 has been removed.

FINAL

RCRA FACILITY INVESTIGATION REPORT FOR INACTIVE LANDFILL YPG-029 U.S. ARMY GARRISON YUMA PROVING GROUND

Submitted To:

U.S. ARMY GARRISON YUMA PROVING GROUND

Prepared By:

PARSONS

March 2013

FINAL

RCRA FACILITY INVESTIGATION REPORT FOR INACTIVE LANDFILL YPG-029 U.S. ARMY GARRISON YUMA PROVING GROUND

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ACRONYMS AND ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
AGFD	Arizona Game and Fish Department
AMSL	Above Mean Sea Level
bgs	Below Ground Surface
BTV	Background Threshold Values
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COC	Chemical of Concern
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
CSM	Conceptual Site Model
DoD	Department of Defense
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
°F	Degrees Fahrenheit
ft	Feet
GPL	Groundwater Protection Level
GPS	Global Positioning System
HI	Hazard Index
HQ	Hazard Quotient
HRA	Human Risk Assessment
HSWA	Hazardous and Solid Waste Amendment
IA	Impact Assessment
km	Kilometers
LOAEL	Lowest Observable Adverse Effects Level
Ma	Million Years
mg/kg	Milligram per Kilogram
mph	Miles Per Hour
MSWLF	Municipal Solid Waste Landfill
NA	No Action
NA	Not Applicable
ND	Non Detect
NOAEL	No Observable Adverse Effects Level
NRCS	National Resource Conservation Service
nrSRL	Non-Residential Soil Remediation Level
OB/OD	Open Burn/Open Detonation
PAH	Polycyclic Aromatic Hydrocarbon
QAPP	Quality Assurance Project Plan
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
rSRL	Residential Soil Remediation Level
SVOC	Semivolatile Organic Compound

ACRONYMS AND ABBREVIATIONS (CONTINUED)

SWMU	Solid Waste Management Unit
TRV	Toxicity Reference Value
UCL	Upper Confidence Level
U.S.	United States
USAGYPG	U.S. Army Garrison Yuma Proving Ground
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
yd^3	Cubic Yard(s)

EXECUTIVE SUMMARY

This report presents the results of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) activities conducted for the inactive landfill YPG-029 at U.S. Army Garrison Yuma Proving Ground (USAGYPG), Yuma Arizona. This report also includes a human health and ecological risk assessment, which evaluates the potential for human health and ecological impacts from assumed exposures to chemicals of potential concern (COPCs) within the site.

The RFI activities at YPG-029 consisted of removal of surface debris followed by a geophysical survey, excavation of test pits, and drilling of soil borings to characterize the landfill and define its boundaries. Subsequent soil samples were also collected and analyzed from the test pits and soil borings.

The surface debris removal action at YPG-029 consisted of the removal and the recycling of metal debris, which included metal banding, empty steel drums, wire, nails and miscellaneous metallic items. Other surface debris removed at the time, included scrap wood and a variety of construction items. Following the removal action, a geophysical survey was conducted to outline the areas of subsurface metallic debris disposal. Geophysical survey results show magnetic anomalies in an area near the center of the site, which are believed to coincide with buried metallic debris. Based on the results of the geophysical survey, 22 biased test pits and two soil borings were excavated to define the vertical and horizontal extent of the buried waste. One background test pit and associated soil samples were also collected for use in calculating background threshold values (BTVs) for metals.

A total of 38 soil samples were collected from the test pits and analyzed to determine if chemical constituents have been released from the waste, and if so, do the constituents pose a threat to human health or the environment. At test pits where waste was encountered, subsurface soil samples were collected from within and below the waste. Of the 22 test pits excavated, seven test pits contained solid waste (029EP002, 029EP 007, 029EP010, and 029EP012, 029EP014, 029EP015, and 029EP018), which included glass and plastic bottles, wood, metal banding, small pieces of tar, metal pipe, aluminum cans, Styrofoam™ cups, food packaging, children's toys, clothing items, and a

1959 Arizona license plate. In addition to the samples collected from test pits, two subsurface soil samples were collected from the two soil borings drilled at the site (029SB001 and 029SB002).

The surface and subsurface soil samples collected from the test pits and soil borings at YPG-029 were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), explosives and metals. The vertical and horizontal extent of impacts to soil was determined by comparing soil concentrations of COPCs to remediation goals (State of Arizona residential soil remediation levels [rSRLs], non-residential [nrSRLs] and the groundwater protection levels [GPLs]). In addition, metals detections were evaluated using BTVs to determine if the detection is a result of site activities.

Analytical results from soil sampling at YPG-029 show that although inorganic compounds (arsenic, chromium, copper, lead, magnesium, molybdenum, silver, vanadium, and zinc) were detected in surface soils and in several waste zones that exceeded BTVs, none of these concentrations exceeded the Arizona Department of Environmental Quality (ADEQ) rSRLs, nrSRLs or GPL remediation goals. Numerous detections of organic compounds were also detected sporadically across the site; however, these detections were near the instrument detection level and were in most cases one to two orders of magnitude lower than the remediation goals (i.e., the rSRLs, nrSRLs and GPLs).

Surface and subsurface investigation activities conducted during the RFI delineated the extent of buried waste at the YPG-029, and determined that waste at the site consists of municipal mixed with industrial waste. The presence of charred wood and low levels of hydrocarbons and polyaromatic hydrocarbons (PAHs) suggests some of the waste may have been burned. No visual evidence of hazardous waste or munitions debris was identified in the excavation pits at the site and analytical data indicates that there are no hazardous constituents above rSRLs, nrSRLs or GPLs); therefore, no further sampling is required.

A human health and ecological risk assessment was performed for YPG-029 to assess potential risks and hazards from exposure to contaminants in soils and to recommend either no action (NA) (if the risks and hazards are acceptable) or of the

development of cleanup goals and remedial alternatives under a corrective measures study (CMS) task if unacceptable risks or hazards were identified. The results of the human risk assessment (HRA) indicate that there are no chemicals of concern (COCs) identified as potential hazards for human or ecological receptors; and therefore, the site does not pose unacceptable risks to potential human or ecological receptors. Although no ecological or human health risk has been identified at YPG-029, it is recommended that a CMS be conducted to prevent exposure to the buried waste and leaching of material.

SECTION 1.0
INTRODUCTION

This report was prepared by Parsons, Inc. (Parsons) for the U.S. Army Garrison Yuma Proving Ground (USAGYPG) located near Yuma, Arizona. The purpose of this document is to present activities, procedures, and results of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for YPG-029, an inactive landfill located approximately 3 miles south-southeast of the Main Administrative Area, south of Laguna Dam Road. This RFI was performed pursuant to contract number W91ZLK-05-D-0016, Task Order 0002.

The objectives of the RFI were to: 1) collect data to adequately identify and characterize the nature and extent of buried waste and contamination; 2) conduct a risk assessment (human and ecological) to determine if constituents have been released to the environment which pose a risk to human health or the environment; and 3) evaluate if chemical constituents are present at levels that pose a threat to groundwater.

1.1 REGULATORY FRAMEWORK

Six inactive landfills were identified during the RCRA Facility Assessment (RFA) at USAGYPG as potentially containing hazardous waste; therefore, regulatory procedures regarding the landfills have followed the RCRA process as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984. Under Subtitle C of RCRA, the State of Arizona has the authority to implement the RCRA program and many of the HSWA requirements. The Arizona Department of Environmental Quality (ADEQ) monitors RCRA compliance and enforces its provisions at USAGYPG. For example, the USAGYPG is currently operating the open burn/open detonation (OB/OD) areas under a RCRA Part B permit issued in June of 2007. Primarily, RCRA regulations traditionally apply to active waste management facilities; however, HSWA added provisions to RCRA that enable inactive solid waste sites to be investigated and, if needed, remediated through a “corrective action” program. Based on these provisions, the inactive landfill sites at USAGYPG have been included within the USAGYPG Part B Permit and currently fall under the administration of RCRA and ADEQ.

The regulatory framework under which RFIs are completed is the RCRA corrective action process. The authority for RCRA corrective action is derived from RCRA Section 3004(u) and is comprised of four phases:

- RFA - Identifies releases and potential releases of hazardous wastes or constituents from the site.
- RFI - Verifies release(s) from the site and characterizes the nature and extent of contaminant migration.
- Corrective Measures Study (CMS) - Determines appropriate corrective measures for the site.
- Corrective Measures Implementation (CMI) – Provides the design, construction, operation and maintenance, and monitoring of the corrective measures.

An RFA was previously conducted at the six inactive landfill sites (Tetra Tech EM Inc., 1998). This RFA report was completed to satisfy the requirements of the RCRA permit issued by the state of Arizona. Based on the recommendation of the RFA, an RFI has been completed for each of the six inactive landfills.

The six abandoned landfills were identified in the RFA as solid waste management units base records and interviews indicating a potential history of solid waste disposal, which could include the presence of regulated waste such as munitions and solvents. Facility engineering drawings, results of the RFA, and personnel interviews indicate that three of the landfills (YPG-027, YPG-029, and YPG-141) had previously been used by USAGYPG as municipal landfills.

1.2 DESCRIPTION AND HISTORY OF USAGYPG

The USAGYPG installation is located in a remote area of southwestern Arizona, bordered on the west by the Colorado River (Figure 1.1). It lies 37 kilometers (km) (23 miles) northeast of the city of Yuma along U.S. Highway 95, between Interstate Highways 8 and 10, and is approximately 200 km (125 miles) west of Phoenix, Arizona and 288 km (180 miles) east of San Diego, California. The nearest major population center to USAGYPG is the city of Yuma, which has a population of approximately 91,000 inhabitants (U.S. Census Bureau, 2009). The USAGYPG is one of the Department of Defense's (DoD's) largest installations, and encompasses an area of

approximately 830,000 acres in size, or roughly 1300 square miles. Comparatively, it is slightly larger than the state of Rhode Island.

The USAGYPG is a general purpose facility with a 50–year history of experience testing weapon systems of all types and sizes. Equipment and munitions tested at the installation consist of medium and long-range artillery; aircraft target acquisition equipment and armament, armored and wheeled vehicles, a variety of munitions, and personnel and supply parachute systems. Testing programs are conducted for all U.S. military services, friendly foreign nations, and private industry. The USAGYPG is the Army's center for desert natural environment testing; the management center of cold weather testing at the Cold Regions Test Center (Alaska); and tropic testing at the Tropic Test Center (various locations). It is one of 22 major test ranges that comprise the DoD Major Range Test Facility Base.

Military use of USAGYPG began in 1942 for training desert troops (USAEHA, 1988). The mission changed in January 1943 when the site began to be used as a testing ground for bridges, river crossing equipment, boats, vehicles, and well drilling equipment under the designation Yuma Test Branch, Corps of Engineers. On October 1, 1947, it was designated the Engineering Research and Development Laboratories, Yuma Test Branch, Sixth Army. This installation was deactivated in January 1950 because of a military austerity program; however, on April 1, 1951, it was reactivated as the Yuma Test Station for desert environmental testing of equipment ranging from tanks to water purification units. On August 1, 1962, the station was assigned to the U.S. Army Materiel Command, and on July 1, 1963, it was renamed Yuma Proving Ground (USAEHA, 1988).

Today, USAGYPG has a working population of approximately 3000 people, including test and support soldiers, civil service employees, and supporting civilian contractors. It hosts about 23,000 visitors per year, including test customers, training units, U.S. government and foreign dignitaries, local organizations, and school groups (USAGYPG, 2009).

1.3 REPORT ORGANIZATION

This report contains the results of the RFI activities, including results of a nature and extent evaluation and human health and ecological risk assessment. The report is divided into seven sections and five appendices, and contains the necessary elements as required by the RFI program.

Section 1 **Introduction** – Presents the project overview including the regulatory framework and a description and history of USAGYPG.

Section 2 **Environmental Setting** – Provides a description of the environmental settings of the USAGYPG installation and the YPG-029 inactive landfill site. This section also includes an overview of the site location, description, and history of waste disposed of at the site.

Section 3 **Previous Investigations** – Describes previous investigations and activities conducted at YPG-029.

Section 4 **Nature and Extent Investigation** – Identifies the RFI approach and strategies along with investigation results and recommendations.

Section 5 **Human Health and Ecological Risk Assessment** – Provides an evaluation of the risks associated with potential waste buried at YPG-029.

Section 6 **Summary and Recommendations** – Summarizes human health and ecological risk screening results along with a corrective action evaluation and recommendations.

Section 7 **References** – Provides information resources cited in the report.

Appendix A Field Logs

Appendix B Site Photographs

Appendix C Analytical Data and Quality Control Tables

Appendix D Calculation of Background Threshold Values

Appendix E Ecological Risk Assessment

Appendix F Removal Action Photographs

SECTION 2.0

ENVIRONMENTAL SETTING

2.1 U.S. ARMY GARRISON YUMA PROVING GROUND FACILITY

2.1.1 Topography

The USAGYPG installation is located within the Sonoran Desert Southern Basin and Range Physiographic Province. The distinctive topography within this province consists of elongate low rugged uplifted mountains trending north-northwest with intervening sediment-filled valleys. The majority of the basins are structural depressions filled with alluvial sediments from the river systems that dissect the area and locally derived sediments from the surrounding mountains (Entech Engineers, Inc., 1988; Argonne, 2004).

Four major landforms are present: 1) alluvial fan (47% of the total area); 2) mountain highlands (27% of total area); 3) active washes (14% of the total area); and 4) alluvial plain (8% of the total area). The remaining 4% of the total USAGYPG land area consists of badlands, pediment, alluvial terrace, old terrace, and dunes (DRI, 2009).

The relief of the mountain ranges is relatively low but the topography is rugged, with slopes locally exceeding 40%. The maximum elevation of 2,822 feet (ft) above mean sea level (AMSL) occurs in the Chocolate Mountains and the lowest elevation, 195 ft AMSL, is just south of the Main Administrative Area. Surface drainage in the northern and western portion of USAGYPG flows west into the Colorado River while the remainder flows south into the Gila River. Most of the surface flow occurs on lowland washes that generally have slopes on the order of 1% to 3% and are dry except during occasional periods of intense rainfall (Entech Engineers, Inc., 1987).

2.1.2 Climate

Because the USAGYPG is in the Sonoran Desert, its climate is typical of a low elevation, hot, arid desert. It is characterized by high daytime temperatures with large daily temperature variations, low relative humidity, and very low average precipitation.

The average monthly air temperature ranges from a low of 47.6 degrees Fahrenheit (°F) in January to a high of 106.8°F in July (NWS, 2011). The average annual precipitation in Yuma and other areas along the lower Colorado River is very low, approximately 3.5 inches per year (NWS, 2011). Rainfall occurs predominantly in the form of summertime thunderstorms, which are sometimes very intense and produce local flash flooding. Evaporation in the arid climate is very high. The Yuma Citrus Station, located eight miles southwest of the city of Yuma, has an average annual pan evaporation rate of 99.2 inches per year, approximately 30 times the average annual precipitation (2.6 inches per year) (WRCC, 2011).

The wind speed averages from 3 miles per hour (mph) during September through February to nearly 6 mph from March through August. The prevailing direction is from the north-northwest from late autumn until early spring. As temperatures warm, winds shift to a more southerly direction. Winds associated with the summer monsoons shift toward the southeast (Woodcock, 1992).

2.1.3 Soils

Eight distinct soil types based on textural description, in accordance with the National Resource Conservation Service (NRCS), occur over the entire USAGYPG facility. These soil types, along with their corresponding percentages (DRI, 2009) are described in Table 2.1.

2.1.4 Hydrology

2.1.4.1 Surface Water

No perennial lakes or streams are present within USAGYPG, however, two major rivers flow through the adjacent desert. The Colorado River traverses a generally north-south direction, west of USAGYPG. The mostly dry Gila River drainage traverses an east-west direction, south of USAGYPG. Surface drainage on the northern and western part of USAGYPG flows into the Colorado River, with the central and eastern parts of USAGYPG flowing into the Gila River.

Both rivers have breached their banks during wet years and caused property damage. However, upstream dams and reservoirs, such as Mittry Lake, Martinez Lake, Squaw Lake, Imperial Dam, Ferguson Lake, and Senator Wash Reservoir (all located along the Colorado River west of USAGYPG) and Painted Rock Dam (on the Gila River) have decreased the severity of recent flood events.

Surface water within USAGYPG is limited to brief periods during and after intense rainfall events which produce flash flooding and ponding in low areas (Argonne, 2004). Infrequent rainfall produces localized flash-flooding and temporary surface water, especially during thunderstorms in August and September. Rainfall averages 3.5 inches per year, and the evaporation pan rate is 99.2 inches per year (WRCC, 2011). The combination of low precipitation and high evaporation prevents surface water from infiltrating deeply into the soil. Thus, most of the year, desert washes are dry. The dry washes vary in size, from less than 3 ft in width and depth, to more than a half mile in width and 30 ft in depth. Each wash contains numerous smaller channels that can change course during major flood events.

The USAGYPG has few natural, year-round sources of water. Some natural water sources have been modified to provide year-round water to wildlife. The four types of natural and artificial water sites are described below (Palmer, 1986):

- Tinajas are naturally occurring, bowl-shaped cavities scoured out of bedrock. Tinajas are usually found at the base of waterfalls where the bedrock formation that created the waterfall changes from harder to softer rock. Rocks trapped in the cavity increase scouring. Tinajas are usually located in the mountain canyons.
- Enhanced tinajas are tinajas that have been artificially improved to increase and prolong water storage capacity. Most enhanced tinajas retain water throughout the year.
- Water catchments are storage tanks, sized from 1500 to 34,500 gallons, constructed by Arizona Game and Fish Department (AGFD). These tanks are located in the Cibola and Kofa Regions.
- Other artificial water sources have developed over the years as a result of leaking landscape irrigation pipes, excess water released by stand pipes, or by pumping water into impoundments (Morrill, 1990). These include Lake Alex, which is a well-pumped impoundment near Pole Line Road and north of Red Bluff

Mountain in the eastern Kofa Region, and Ivan's Well, which is a well-pumped impoundment near Growl Road and Kofa Mohawk Road in the Kofa Region.

2.1.4.2 Groundwater

The principal water-producing aquifer within USAGYPG is the unconsolidated alluvial aquifer. This aquifer varies in thickness from tens of feet at the margins of the basins to hundreds of feet in the center of the basins. Based on the results of a hydrogeologic study of this aquifer conducted in the early 1980s (Entech Engineers, Inc., 1988), the top of the groundwater aquifer ranges in elevation from approximately 155 to 200 ft AMSL. The depth to groundwater ranged from 30 ft below ground surface (bgs) in Well X (located in the main Cantonment area near the Colorado River) to greater than 600 ft bgs in Well M (located near the Castle Dome Heliport). Water levels in these wells did not substantially change over a one-year period in 1987 (Entech Engineers, Inc., 1988). The potentiometric surface data suggest that the direction of groundwater flow is southwest toward the Colorado and Gila Rivers. The groundwater gradient is about 4 to 5 ft/mile upgradient of the major pumping wells, and less than about 4 ft/mile near the rivers. Near the rivers, the groundwater elevation becomes shallower, and it may be within 10 ft of the surface in floodplain deposits (Click and Cooley, 1967). Local precipitation and runoff are very minor sources of groundwater recharge.

Groundwater was also observed in the underlying bedrock (Entech Engineers, Inc., 1988). However, in the bedrock the water quality is more mineralized and groundwater flow is much slower than the overlying unconsolidated aquifer due to fracture flow and lack of permeability. According to the U.S. Geological Survey (USGS), the estimated recoverable groundwater in the aquifer of the basin is 50 million acre-ft. The estimated annual inflow and outflow to the aquifer is 65 thousand acre-ft (Freethey and Anderson, 1986).

2.1.5 Geology

The USAGYPG is located within the Sonoran Desert Southern Basin and Range Physiographic Province. The distinctive topography within this province is uplifted mountains with intervening sediment-filled valleys associated with the tectonic extension

which started approximately 19 Million years (Ma) ago. The majority of the basins are structural depressions filled with alluvial sediments from the river systems that dissect the area and locally derived sediments from the surrounding mountains (Anderson et al, 1992).

The basement rocks in the vicinity of the USAGYPG and surrounding areas are Pre-Tertiary metamorphic and igneous rocks consisting of schist, gneiss, granite, and weakly metamorphosed sedimentary rocks, all intruded by dikes of diorite porphyry and overlain by a thick series of lavas cut by dikes of rhyolite porphyry. Later Tertiary non-marine red-bed sedimentary rocks and volcanics overlie the basement sequence. The Laguna Mountains and Chocolate Mountains are made up of 33 Ma Tertiary volcanics. The late Tertiary, Miocene-Pliocene Bouse Formation overlies a 5.47 Ma tuff. The Bouse Formation is a massive siltstone unit with a basal limestone and is lacustrine/estuarine in origin.

The Palomas and Tank Mountains contain mostly extrusive igneous rocks with lesser amounts of metamorphic rocks. Intrusive igneous rocks are also found in the southern part of the Palomas Mountains. The Muggins Mountains are made up of metamorphic and extrusive igneous rocks with some sedimentary rocks. The Middle Mountains are composed of mostly extrusive igneous rocks with metamorphic and sedimentary rocks. The Trigo and Chocolate Mountains are largely extrusive igneous rocks with some metamorphic rocks. The basins or lowlands between mountain ranges are composed of alluvium which is typically comprised of sand, silt, and clay layers of Quaternary origin. The depth of the sediments is not known; however, wells 1,300 ft in depth have not reached the basin's bedrock floor (Entech Engineers, Inc., 1987). Sand dunes are visible features along the base of some mountains in the USAGYPG vicinity. Also, there is evidence in the Materiel Test Area that sand dunes existed in the geologic past. Cross-bedded sands, indicating the presence of buried sand dunes, were found by the U.S. Bureau of Reclamation in soil borings at the petroleum, oil, and lubricants bladder test spill site (USBR, 1993).

2.2 YPG-029 INACTIVE LANDFILL

2.2.1 Location and Site Description

The YPG-029 site is located on the Kofa Firing Range east of US Highway 95, approximately 1¼ miles south-southeast of the Kofa Fire station and within 200 yards of the new Kofa sewage lagoon. The YPG-029 site encompasses an area approximately 5.17 acres in size (Figures 2.1 and 2.2). There is conflicting information regarding the dates the site was in operation as a landfill; however, disposal activities at the site may have occurred during the late 1960s. Wood and metal debris surrounded a large pile of washed gravel that is located on the northern portion of the site. This gravel and surface debris appears associated with the construction of two wastewater ponds that are located to the north of the site. Prior to the surface debris removal action in November 2009, numerous pieces of scrap metal, including a metal box and drum, were present on the ground surface in the northeastern portion of the site. Scrap wood and metal strapping/banding and other metal debris were present across the site, especially along the northwestern and western areas of the site. Depressions and disturbed vegetation also have been noted in the south central region of the landfill, and these coincide with metallic anomalies identified during a previously conducted geophysical (magnetometer) survey (Jason, 2007).

2.2.2 Topography

The YPG-029 site is generally flat with a slight rise in elevation to the east. There are also several small drainage areas immediately north and south of the site. The elevation of the site is approximately 340 ft AMSL.

2.2.3 Geology

The shallow subsurface lithology at YPG-029 was obtained from 22 test pits excavated throughout the site and two soil borings drilled to 30 ft bgs (Section 4.1.3). The generalized lithology at YPG-029 consists of a sequence of unconsolidated silty sand and gravel, strongly cemented sandy clay, and white sand units. These unconsolidated deposits are light reddish-brown in color and poorly sorted. The sand is fine to medium-grained. The gravel ranges from pea- to cobble-size, and from angular to subround.

The uppermost unit, in which the test pits were excavated, consists of a weakly interbedded sand and gravel, with some silt. This unit is reddish-brown in color with pea- to cobble-sized gravel of subangular to subround clasts. Beneath this unit lies a fine to medium light beige to white, well-graded sand. While the dominant sediments are sand and gravels, isolated clay horizons have been observed in both test pits and drill core.

The alluvium at YPG-029 is likely the result of two distinct sources: the nearby paleo-Colorado River alluvial deposits; and, secondarily, locally-derived alluvium from Muggins Mountain to the east.

2.2.4 Hydrology

2.2.4.1 Surface Water

The YPG-029 site is located within 600 ft of the new Kofa sewage evaporation lagoons, and is adjacent to several small natural drainages. During periods of intense rainfall, the drainage area may experience surface water flow for short periods of time.

2.2.4.2 Groundwater

No groundwater was observed in the test pits or soil borings at YPG-029. However, based on the regional potentiometric surface, groundwater would be anticipated to occur at approximately 197 ft bgs and flow southwest at a 1-4 ft per mile gradient (Jason, 2007).

2.2.5 Vegetation and Wildlife

Vegetation at YPG-029 is sparse, and much of the site has been disturbed due to the landfill disposal activities (Figure 2.3). The undisturbed areas are scattered with small bushes and trees that include bursage, creosote, and paloverde. Wildlife at USAGYPG and YPG-029 includes numerous mammals including herbivores, omnivores, predators, and reptiles. Vegetation and wildlife at the site are presented in more detail in the ecological risk assessment (Section 5.2).

2.2.6 Land Use

At the present time, YPG-029 is no longer operational as a landfill. The future use of the YPG-029 site is expected to continue as undeveloped/vacant land. The site is located on the active Kofa Military Training Range and access to the site is controlled by range control. No physical controls such as fences are present.

SECTION 3.0
PREVIOUS INVESTIGATIONS

This section describes previous investigations and activities conducted at the YPG-029 abandoned landfill. These activities were performed to determine the contents of the landfill and define the shape and size of the landfill area. Investigations conducted at the site include an RFA performed in 1998, a release assessment conducted in 2001, and a geophysical survey performed in 2006.

3.1 1998 RCRA FACILITY ASSESSMENT

A records review was conducted for YPG-029 during the 1998 RFA (Tetra Tech, 1998). The following list summarizes previous investigations at the site as described in that review:

- The 1978 Impact Assessment (IA) stated that the landfill was a 1-acre area that was active only during 1968.
- The 1980 USATHAMA II-A report stated that the landfill was active from 1960 to 1971 and was used to dispose of sanitary wastes, sludge from the Building 2060 Holding Tank (Solid Waste Management Unit [SWMU] 17), and empty pesticide containers.
- The 1988 USAEHA report stated that the landfill was active from 1948 to 1949, and during the associated site visit there no visible trace of the landfill.

The 1998 RFA report concluded that the dates when the YPG-029 landfill began operation and was closed are not clear due to conflicting information in various reports. It was also concluded that the unit managed domestic and administrative solid waste, which probably included construction and maintenance wastes. It was not known if the landfill had any release controls; however, given the dates of operation, it is not likely that the unit was lined. At the time of the report, there was no documented evidence of release, and no indication that sampling had ever been performed at this landfill (Tetra Tech, 1998).

3.2 2001 RELEASE ASSESSMENT

During the 2001 Release Assessment, a field team visited YGP-029 and observed debris at the surface of the landfill. According to the Release Assessment Report (Argonne, 2001), it was presumed that the landfill was unlined, and the report recommended that information be obtained on the landfill contents, and that geophysics, soil sampling, and if warranted, groundwater monitoring be performed at the site.

3.3 2006 GEOPHYSICAL SURVEY

In 2006 a geophysical evaluation was performed at YPG-029 to assess the apparent lateral limits of buried landfill debris within accessible areas of the site (Jason, 2007). The study included the use of a Geonics EM31 terrain conductivity meter and a Geomtrics 858 cesium magnetometer in conjunction with a Trimble Pro XRS global positioning system (GPS) for spatial control. Results of the geophysical survey indicated the presence of several areas that may contain buried metal or relatively conductive materials. Surface metal debris was not removed prior to the 2006 geophysical survey and in many of the anomalous areas surface metal debris was identified as a potential source of the geophysical anomaly.

SECTION 4.0
NATURE AND EXTENT OF CONTAMINATION INVESTIGATION

A nature and extent investigation was conducted at YPG-029 as part of the RFI. A description of the investigation activities and the results of these activities are presented in the following sections. This section also presents an evaluation of whether sufficient sampling was conducted to adequately characterize the nature and extent of chemicals detected in site media, and provides data to support a human health and ecological risk screening evaluation.

4.1 INVESTIGATION ACTIVITIES

The investigation activities at YPG-029 consisted of removing surface debris, performing a post-surface removal geophysical survey, excavating 22 exploratory test pits, and drilling two vertical soil borings. Magnetometer geophysical surveys were conducted to outline the areas of subsurface metallic debris disposal. Exploratory test pits were excavated to determine the vertical and horizontal extent of buried debris, and soil borings were drilled to confirm the horizontal extent. Soil samples were collected from the test pits and soil borings to determine if chemical constituents have been released from the waste and to assess the vertical extent of solid waste. Table 4.1 presents the investigation activities conducted during the RFI and the characterization objectives of each activity.

4.1.1 Surface Debris Removal

Approximately 1.5 cubic yards (yd^3) of recyclable metal debris was removed from the site in November 2009. This debris included metal banding, empty steel drums, a locker, steel cables, wire, nails, and other smaller pieces of rusted metallic debris. The metal debris was taken to the U.S. Marine Corps Yuma facility for inspection and recycling. Other surface debris included scrap wood and a variety of construction items. One inert 40mm practice grenade was also found on the surface of the landfill. Based on the condition of the practice grenade, it was determined to be more recent than the other scrap metal that was found. Depressions and disturbed vegetation were also noted in the

south central portion of the site. These depressions coincided with metallic anomalies identified during the previously conducted geophysical survey (Jason, 2007). Photographs of the debris removal are shown in Appendix F.

4.1.2 Geophysical Survey

A magnetometer G-858 geophysical survey was conducted on the site following the surface debris removal. The G-858 was also used for the previous magnetic geophysical survey (Jason, 2007). Geophysical results show linear magnetic anomalies extending east to west across the center of the site that may indicate the shallow burial of metal debris (Figure 4.1). These anomalies also coincide with a series of depressions observed during the surface debris removal action. Based on the geophysical survey, it is unlikely that there is significant metal debris buried in the north and south end of the site. A dirt road runs through the southwest corner of the site, which appears to have been constructed after the landfill was closed. This is based on the presence of geophysical anomalies present beneath and on either side of the road. This road is used for ongoing training and is regraded as needed.

4.1.3 Test Pit Excavations and Soil Borings

Twenty-two test pit excavations and two soil borings were used to define the vertical and horizontal extent of potential buried waste. Associated surface and subsurface soil sampling activities were conducted to define the nature and extent of potential chemical contamination. Additionally, one background test pit was excavated and one associated surface and one subsurface soil sample were collected for use in background threshold value (BTV) calculations for metals at the inactive landfills (Appendix D).

Test pit locations were selected following the general strategy outlined in the RFI Work Plan (Parsons, 2010). Based on the results of geophysical survey (Section 4.1.2), the area of YPG-029 was divided into thirteen 200 ft by 200 ft grids, and one or two biased test pits were excavated within each grid cell (Figure 4.1). Eight test pits (029EP002, 029EP003, 029EP005, 029EP008, 029EP010, 029EP012, 029EP014, and 029EP015) were excavated at the locations of linear dipole magnetic anomalies found

during the geophysical surveys. Two additional test pits (029EP009 and 029EP011) were excavated within the anomalous zone, but were not associated with a specific anomaly, to determine if there were buried wastes without metallic geophysical signatures between the linear anomalies. Twelve test pits (029EP001, 029EP004, 029EP006, 029EP007, 029EP013, 029EP016, 029EP017, 029EP018, 029EP019, 029EP020, 029EP021, and 029EP022) were excavated in areas outside the anomaly zone to determine the horizontal extent of the buried waste and define the footprint of the landfill. The depth, width, length, and number of soil samples collected from each of the test pits are presented on Table 4.2.

Test pits were excavated using a wheeled backhoe with an extension arm allowing a 15-ft maximum depth of excavation. Debris and soil excavated during the test pit operations were visually inspected by unexploded ordnance (UXO)-qualified technicians for the presence of munition debris. Test pits were oriented perpendicular to the linear geophysical trends in order to cross-cut the suspected burial trenches. Once the soil was inspected by the UXO technicians, the on-site geologist prepared a geologic log of the test pit showing depth of waste, soil type and soil sample locations. Test pit excavation logs are presented in Appendix A. Representative photographs of the test pit operations are presented in Appendix B. Of the 22 test pits excavated, seven test pits contained solid waste (029EP002, 029EP007, 029EP010, and 029EP012, 029EP014, 029EP015, and 029EP018), which included glass and plastic bottles, wood, metal banding, small pieces of tar, metal pipe, aluminum cans, Styrofoam™ cups, food packaging, children's toys, clothing items, and a 1959 Arizona license plate (Table 4.2). It should be noted that the solid waste zone in test pit 029EP018 was found to converge, and no waste was encountered in the south end of the pit; therefore an additional exploratory test pit was not excavated at that location.

Test pits 029EP003 and 029EP005 were excavated in an area containing geophysical anomalies; however, no waste was encountered during the excavation of these two test pits. Test pits were excavated to 8 and 7 ft bgs, respectively (Table 4.2). Although there were geophysical anomalies in these areas based on the Parsons 2009 survey, the survey conducted by Jason shows these areas are anomaly free (Appendix B Parsons, 2010).

Based on geophysical data, waste was not expected to be found in test pits 029EP007 and 029EP018; however, during the excavation waste was encountered between 2-7 ft bgs at 029EP007 and between 1-5 ft bgs at 029EP018. The thickness of waste did not extend the entire length of 029EP018 and had a maximum thickness of four feet in the center of the test pit and rapidly thinned to the south end of the pit. No waste was present in the south end of the pit. Since waste was encountered at these locations additional test pits were added to the program to delineate the horizontal extent of waste and define the boundaries of the landfill. Test pits 029EP019 and 029EP020 were added to define the western boundary of the landfill due to the waste encountered at 029EP007. No waste was found in these two step-out test pits. Two additional step-out test pits (029EP021 and 029EP022) were added to define the southern boundary of the landfill due to waste found within 029EP014 and 029EP018.

Two soil borings were drilled near the locations of two of the test pits where debris was identified (029SB001 near 029EP002 and 029SB002 near 029EP015) to define the vertical extent of contamination and determine if waste extended beyond the vertical boundary of the landfill as shown in the test pit logs (Appendix A). The soil borings were completed adjacent to test pit locations where the greatest depth of waste was identified. Each soil boring was completed to a depth of approximately 30 feet past the bottom of the adjacent test pit excavation.

Split spoon cores were collected from the soil borings so that the soil texture would remain in-place as much as possible. The drill core appeared to contain the original layered texture and is believed to be native below the waste. Soil borings confirmed the depth of the waste identified in the corresponding test pits.

A geologic cross-section showing the relationship between the test pits and the soil boring is presented in Figure 4.2. The cross-section A-A’ (Figure 4.1), shows that waste does not extend below 15 ft bgs.

4.1.4 Soil Sampling Activities

A total of 38 soil samples and one field duplicate were collected from within the 22 test pits 029EP001 through 029EP022 and from two soil borings (029SB001 and 029SB002). Surface (i.e., 0.2-0.7 ft bgs) soil samples were collected from each of the 22

test pit locations. At test pits where waste was encountered, subsurface soil samples were collected from within and below the waste. In addition to the samples collected from test pits, two subsurface soil samples were collected from the two soil borings drilled at the site (029SB001 and 029SB002). Sample depths for each test pit and soil boring are detailed in Table 4.2.

Two soil samples were collected at the background test pit (029BG001), one from the ground surface (0.2-0.7 ft bgs), and one from the base of the excavation (7-7.5 ft bgs). These samples were analyzed for metals only. Data from the background test pit at YPG-029 were combined with background data from other inactive landfill RFI sites at USAGYPG to calculate BTVs (Appendix D).

Surface and subsurface soil samples from the test pit locations and soil borings were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), explosives, and metals. Default analytes specific to these test panels are provided in the Quality Assurance Project Plan (QAPP, Appendix A of the RFI Work Plan [Parsons, 2010]) and were based on the list of chemicals contained within the DoD Quality Systems Manual (QSM) version 4.1. Complete analytical results for the soil samples are provided in Appendix C (Table C.1). Test pit and soil boring logs are provided in Appendix A, and photographs of the investigation are presented in Appendix B. Test pit locations, including the background excavation, are depicted on Figure 4.1.

4.1.5 Planned Versus Completed RFI Activities

Test pit excavations, soil borings, and sampling activities proposed in the RFI Work Plan (Parsons, 2010) were conducted as planned with the following exception. Based on the geophysical survey, waste was not expected to be encountered at 029EP007. However, when the excavation was performed, waste was encountered from 2 to 7 ft bgs. Because of the thickness of waste and location of the 029EP007 test pit, two additional test pits were excavated to the west and southwest of 029EP007 (029EP019 and 029EP020) to confirm the extent of waste at the site. No debris was identified during the additional excavations, and one surface soil sample was collected from each pit. Two additional test pits (029EP021 and 029EP022) were added, which were not in the work plan, to define the southern boundary of the landfill (Figure 4.1).

4.2 INVESTIGATION RESULTS

4.2.1 Data Quality

The analytical data generated from the soil samples collected from the test pits and soil borings have been reviewed, verified and validated with regard to its quality and usability. No major quality control issues were discovered during the quality control assessment and therefore the data are considered complete and usable for decision making purposes. A more detailed analytical quality control summary report is included in Appendix C. Appendix C also contains a table of all analytical results (Table C.1).

4.2.2 Soil Screening Values

4.2.2.1 Background Threshold Values

The objectives of collecting soil samples at YPG-029 were to determine if soils were impacted by waste disposal activities, evaluate the vertical and horizontal extent of impacted areas, and provide data to support human health and ecological risk screening assessments (Section 5.0).

To evaluate metals results and determine if site activities have impacted soils, background test pits were excavated at each landfill and a surface and subsurface soil sample were collected and analyzed for 27 metals. These data were combined into a background soil database. Organic compounds were not analyzed in the background soils and detections of organic constituents are considered site related. The background inorganic data was processed using the statistical approach presented in Appendix A of the RFI Work Plan (Parsons 2010, Appendix A). Statistical calculations of the data were used to derive a BTV for each detected metal. The BTVs represent the ninety-five percent upper confidence level for the background value. The BTV calculation methods, background dataset, and the BTVs for inorganic compounds at the six abandoned landfills are presented in Appendix D.

The BTVs are used to establish background inorganic concentrations to identify soils that may have been impacted by waste disposal activities. If a soil concentration exceeds the BTV at the YPG-029 site, it is assumed that the concentration may be a result of waste disposal activities. Additionally, professional judgment and other information

such as; 1) soil types (e.g. sand versus clay), which may have elevated naturally occurring mineral content; or 2) inorganic concentration trends which are inconsistent with waste disposal and contaminant migration, may be used to determine if inorganic concentrations in site soils are likely representative of background levels. Soil sample results at YPG-029 with inorganic concentrations that exceed the BTV and all detections of organic compounds were identified as site related.

4.2.2.2 Remediation Goals

The vertical and horizontal extent of impacts to soil was determined by comparing soil concentrations to remediation goals. Remediation goals include the state of Arizona residential and non-residential soil screening values (rSRLs and nrSRLs) and the groundwater protection levels (GPLs). The rSRLs and nrSRLs are published in Appendix A of the Arizona Administrative Code R18-7-205. GPLs are based on state of Arizona guidance document *A Screening Method to Determine Soil Concentrations Protective of Groundwater Quality* (ADEQ, 1996). Vertical and horizontal extent of soil impacted by site activities is defined by soil samples that have concentrations that exceed remediation goals.

4.2.3 Evaluation of Soil Analytical Results

The purpose of this section is to present and evaluate inorganic and organic constituents detected during the investigation. The evaluation includes comparing soil metal concentrations to BTV and remediation goals and comparing organic constituents to remediation goals. The specific evaluation includes the following:

1. Identifying chemicals of potential concern (COPCs) detected in site soils with concentrations above BTVs for metals.
2. Determining which (if any) chemicals identified during Step 1 and any detected organic chemicals exceeded corresponding ADEQ rSRLs, nrSRLs, or GPLs.
3. Using professional judgment (consisting of an evaluation of the magnitude, frequency, and spatial distributions of chemical concentrations) to determine if adequate soil sampling was conducted for the chemicals identified in Step 2.

A total of 38 surface and subsurface soil samples and one field duplicate were collected from test pits and soil borings at YPG-029 and analyzed for VOCs, SVOCs, metals, and explosives (Section 4.1).

Detections in surface and subsurface soil samples consisted of select VOCs, SVOCs, explosives, and metals (Tables 4.3 and 4.4). Surface and subsurface soil samples were collected from soil borings and test pit excavations from biased locations with the greatest potential for contamination based on geophysical and visual survey results reported in Jason, 2007 [Appendix B] and Parsons, 2010. The BTV, rSRL and nrSRL comparison steps are presented below.

Step 1 – Background Threshold Value Comparison

The first step in evaluating impacts to soil at YPG-029 was to compare the analytical soil sample results to the BTVs. The BTV calculation method was identified in the RFI Work Plan and included background samples from YPG-027, -028, -029, -141 and -178 (Appendix D). Table 4.3 presents the inorganic soil sample results for samples collected during the field investigation. Soil concentrations were compared to the BTVs and results shown in bold font indicate values that exceed the BTV. Twelve of the 38 soil samples have inorganic concentrations greater than their respective BTV. These twelve samples were collected from the following locations and are followed by the inorganic constituent(s) that exceed the BTV in that location:

- 029EP002 (arsenic, lead, molybdenum, silver, and zinc)
- 029EP003 (chromium, magnesium, and vanadium)
- 029EP005 (arsenic)
- 029EP010 (zinc)
- 029EP012 (silver)
- 029EP014 (arsenic, lead, silver)
- 029EP019 (magnesium)
- 029SB001 (copper)
- 029SB002 (copper)

Of the twelve samples with inorganic concentrations greater than BTVs, four were collected from within debris zones.

Two of the samples (029EP002, and 029 EP014) collected within the debris zones had multiple inorganics (up to 5) that exceeded the respective BTV. Five surface samples (029EP002, 029EP003, 029EP005, 029EP014, and 029EP019) also had inorganics with concentrations that exceed BTVs. Test pit 029EP002 had concentrations of arsenic, lead, and zinc that exceeded BTVs in the surface sample (0.2–0.7 ft) and the sample collected from the waste zone below (4–4.5 ft). Test pit 029EP014 had concentrations of silver that exceed BTVs in the surface sample (0.2-0.7 ft), in the waste zone below (4.5-5 ft) and below the waste zone (8.5-9 ft).

Step 2 – rSRL, nrSRL and GPL Comparison

The extent of contamination was evaluated by comparing organic (Table 4.4) and inorganic (Table 4.3) analytical results to the ADEQ rSRL, nrSRL and GPL remediation goals. Detected organic compounds and inorganic results with concentrations above BTVs were included in this evaluation (i.e., potentially site-related inorganics). The evaluation showed that although several organic compounds were detected in site soils, and multiple inorganic compounds had concentrations above BTVs, no analyte had concentrations above their corresponding rSRL, nrSRL or GPL.

Step 3 – Professional Judgment

Based on the results of this evaluation, the horizontal and vertical extent of chemical impacts to soil from waste disposal activities at YPG-029 has been adequately delineated and additional soil sampling and analyses are not required.

4.3 CONTAMINATION ASSESSMENT

During the geophysical survey conducted in 2006 (Jason, 2007), a cesium gradiometer magnetometer was used to determine the extent of the metallic buried waste at the abandoned landfill YPG-029. The magnetometer was found to be effective in identifying suspect burial areas. Depressions and disturbed vegetation were also noted at the time that coincided with metallic anomalies identified during the geophysical survey.

In November 2009, a surface removal of 1.5 yd^3 of metal debris was completed. During the removal activities, one inert 40 mm practice grenade was found on the surface

of the landfill. Once the surface was cleared, a post-removal geophysical survey was conducted to obtain additional information about the potential locations of subsurface debris. The geophysics indicated a shallow burial area extending east to west across the site, and no significant buried metallic waste on the north and south ends of the site. Investigation of the area consisted of excavating 22 test pits and one additional test pit used to represent background conditions. Debris was encountered within seven of these pits and correlated with the location of geophysical anomalous zones. Debris identified within the test pits included glass and plastic bottles, wood, metal banding, small pieces of tar, metal pipe, aluminum cans, Styrofoam™ cups, food packaging, children's toys, clothing items, and a 1959 Arizona license plate. Each test pit excavation was supervised by UXO technicians who visually inspected the material for evidence of munition debris. No evidence of munition debris was identified during the excavations.

A total of 38 soil samples were collected from the test pit excavations and soil borings. These samples were collected from above the waste (surface), within the waste itself, and soils underlying the waste. Nine inorganic compounds (arsenic, chromium, copper, lead, magnesium, molybdenum, silver, vanadium and zinc) were detected in soils sampled from the surface and in several waste zones that exceeded BTVs; however, none of these levels exceeded the ADEQ rSRL, nrSRL or GPL remediation goals. Numerous detections of organic compounds were also detected sporadically across the site; however, these detections were near the method detection limit (i.e. trace levels) and were in most cases one to two orders of magnitude lower than the remediation goals (i.e., the rSRLs, nrSRLs and GPLs).

Two soil borings were completed adjacent to two test pits excavated where waste was encountered to define the vertical extent of contamination and determine if waste extended beyond the vertical boundary of the landfill. Each soil boring was completed to a depth of 30 feet past the bottom of the adjacent test pit excavation. Debris was not found in either boring past the bottom of the adjacent test pit. Split spoon samples were collected from the borings to retain as much of the in-place texture as possible. Soil samples appeared to contain the original layered texture and are believed to be native. The lack of any additional waste and the presence of the original soil layering indicate that the landfill burial was probably a cut and fill operation. A dozer was probably used

to cut a long linear trench and debris was buried in the trench and either burned or soil was pushed over the trench. This type of disposal operation was common for small landfill sites operating during the 1950-1960 time-frame.

4.4 NATURE AND EXTENT OF CONTAMINATION RECOMMENDATIONS

Surface and subsurface investigation activities conducted during the RFI indicate debris identified within the landfill consists of municipal mixed with industrial waste. The presence of charred wood and low levels of hydrocarbons and polyaromatic hydrocarbons (PAHs) suggests some of the waste may have been burned. No visual evidence of hazardous waste or munitions debris disposal was identified in the excavation pits at the site. The nature and extent of burial operations has been delineated at YPG-029. Soil sampling results show constituents did not exceed rSRL, nrSRL or GPL remediation goals and no further sampling is required.

SECTION 5.0

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

The objectives of the human health risk assessment (HRA) and ecological risk assessment (ERA) were to:

- Assess potential risks and hazards from exposure to site soils.
- Support development of either a no action (NA) decision (if no unacceptable risks or hazards are identified) or cleanup goals and remedial alternatives under the CMS task (if unacceptable risks and/or hazards are identified).

This Section presents the methods and results of the HRA and ERA performed as one of the steps of the RFI for YPG-029.

5.1 SCREENING LEVEL HUMAN HEALTH RISK ASSESSMENT

This screening level HRA evaluates the potential for human health impacts from assumed exposures to COPCs within YPG-029, an inactive landfill at USAGYPG in Yuma, Arizona. The results of this HRA provide a basis for decisions regarding further action, if necessary, with respect to the COPCs at the site.

Following U.S. Environmental Protection Agency (USEPA) (1989) guidance, the HRA process consists of six major components:

- Development of the Conceptual Site Model (CSM)
- Selection of COPCs
- Estimation of chemical exposure
- Toxicity assessment
- Risk characterization
- Uncertainty analysis

Each step of the HRA process is discussed in detail below. This HRA was conducted using methods consistent with USEPA (1989, 1990, 2002, 2010) guidance.

5.1.1 Development of the Conceptual Site Model

Developing a CSM is a critical step in properly evaluating potential exposures at a site. The CSM is a comprehensive representation of the site that documents the potential

for exposure (under current and future land use) to chemicals at a site based on the source of contamination, the release mechanism, migration routes, exposure pathways, and receptors either at the site or that may reasonably be anticipated to be at the site (USEPA, 2002).

As discussed in Section 2.2, YPG-029 is located on the Kofa Firing Range east of U.S. Highway 95, approximately 1¼ miles south-southeast of the Kofa Fire Station (Figure 2.1) and encompasses an area of approximately 5.17 acres. Although exact dates are not available, YPG-029 was believed to have been used as a municipal landfill in the late 1960s (Tetra Tech, 1998). Currently, the site is a vacant lot with no structures. A large pile of screened gravel is present in the northwest corner of the site. The future use of the YPG-029 site is expected to continue as undeveloped/vacant land. Although residents and industrial workers are not present at the site, and will not be present at the site in the future, they were selected for evaluation to evaluate whether the site qualifies for an NA determination or closure under an industrial use scenario. Therefore, two hypothetical human receptors were evaluated: 1) residents and 2) industrial workers.

5.1.2 Selection of Chemicals of Potential Concern

The COPCs are those chemicals detected in environmental media at the site for which human contact may result in adverse health effects. The selection of COPCs consisted of a three step process, as follows:

- Data review;
- Exclusion of essential nutrients;
- Identification of metals elevated above background; and
- Screening against risk-based screening levels.

Each of these steps is presented below.

The data collected at the site is presented in detail in Section 4. Briefly, 39 soil samples (including 1 field duplicate) were collected and analyzed for metals, VOCs, SVOCs, and explosives using the methods specified in the QAPP (Appendix A of the RFI Work Plan [Parsons, 2010]). Soil samples were collected from surface soils (0.2-0.7 ft bgs) at all sampling locations, with subsurface samples collected at depths up to 30 ft bgs (Table 4.2).

The validated data collected at 0-10 ft bgs was evaluated in the selection of COPCs. Data validation classified the data through the use of several qualifiers (Appendix C). Data without qualifiers and data with J qualifiers were considered appropriate for risk assessment purposes (USEPA, 1989, 1992). U and UJ qualified data were considered to be non-detect (ND) but usable for risk assessment purposes. NJ qualified data were treated as detections, although they were determined to be potentially false positives (Appendix C). The R qualified data were excluded from this risk assessment (USEPA, 1989, 1992).

Essential human nutrients that are toxic only at very high doses (i.e., much higher than those associated with exposure at a site) were excluded as COPCs. These include calcium, iron, magnesium, potassium, and sodium (USEPA 1989).

Next, metals were compared to the BTVs (see Appendix D). Metals detected at concentrations below the BTVs were assumed to be present at background concentrations and were not evaluated further, while metals detected at concentrations greater than the BTVs were evaluated in the next step. The following metals were detected at concentrations greater than the BTVs at 0-10 ft bgs (Table 5.1):

- Arsenic
- Chromium, total
- Copper
- Lead
- Magnesium
- Molybdenum
- Silver
- Vanadium
- Zinc

Last, the maximum detected concentrations of inorganics exceeding the BTVs and all detected organic compounds were compared to the ADEQ (2007) rSRLs, nrSRL and GPLs. Those chemicals detected at concentrations exceeding the rSRLs were identified as COPCs for evaluation in the HRA. No chemicals exceeded the ADEQ rSRLs and, therefore, no COPCs were identified.

Since no COPCs were selected for evaluation at this site, no further evaluation is required, as detailed in the approved work plan (Parsons 2010). Therefore, risks to human health from potential exposures to COPCs at YPG-029 are not anticipated and further action is not needed at the site on the basis of human health risk.

5.2 ECOLOGICAL RISK ASSESSMENT

This ERA evaluates the potential for ecological impacts from potential exposure to chemicals of potential ecological concern (COPECs) in soils at YPG-029. The results of this ERA provide a basis for consideration in making decisions regarding further action with respect to the COPECs in soils at the site. This section presents a summary of the ERA for YPG-029. The ERA is presented in detail in Appendix E.

Following USEPA (1997, 1998) guidance, the ERA process consists of four major components:

- Problem formulation
- Analysis
- Risk characterization
- Uncertainty analysis

This section presents a summary of the ERA for YPG-029. The ERA is presented in detail in Appendix E. Each step of the ERA process is summarized below

5.2.1 Problem Formulation

5.2.1.1 Habitat Characterization

USAGYPG is located in the Sonoran Desert, a low elevation, hot, arid desert. It is characterized by high daytime temperatures with large daily temperature variations, low relative humidity, and very low average precipitation. No perennial lakes or streams occur within USAGYPG; however, two major rivers flow through the adjacent desert; (i.e., the Colorado and Gila Rivers) See Section 2.1 for additional information regarding the climate and surface water hydrology of USAGYPG.

Approximately 62 species of mammals, 141 species of birds, 33 species of reptiles, and three species of amphibians have been observed at USAGYPG. No fish

have been recorded at USAGYPG. Numerous plant species have been recorded at USAGYPG, including eight Arizona special status species (Table E.1).

5.2.1.2 Site Description and Land Use

As discussed in Section 2.2.1 and 5.1.1, YPG-029 is 5.17 acres in size, and is located approximately 1¼ miles south-southeast of the Kofa Fire station and within 200 yards of the new Kofa sewage lagoon (Figures 2.1 and 2.2). Although exact dates are not available, YPG-029 may have been used as a landfill in the late 1960s (Tetra Tech, 1998). Currently, the site is vacant with no structures. The future use of the YPG-029 site is expected to continue as undeveloped land. Any proposed change to the future land use will be addressed in the CMS.

Much of the site has been disturbed by past landfill disposal activities and has little to no vegetation (Figure 2.3). In the undisturbed parts of the site, there are scattered small bushes and trees, including bursage, creosote, and paloverde. The site is relatively flat with depressions (i.e., sinkholes) located in the south central region of the landfill. Surface debris, including broken glass, metal, and a metal box, were removed in November 2009 (Parsons, 2010).

5.2.1.3 Selection of Representative Ecological Receptors

Ecological receptors (i.e., representative species) include non-domesticated plants and wildlife that may reasonably be expected to inhabit or regularly forage at the site, given current and anticipated future site conditions. As generally recognized by ERA guidance documents, it is impractical to evaluate all possible ecological receptors for a given site. Instead, a few species representative of the habitat functions and trophic structure present are selected for evaluation in the ERA. The representative species selected for evaluation are listed below in Table 5.2.

5.2.1.4 Selection of Chemicals of Potential Ecological Concern

Using the process presented in Appendix E, vanadium and zinc were the COPECs selected for evaluation in this ERA.

5.2.1.5 Exposure Pathways

Exposures to COPECs were quantitatively evaluated for the following pathways at YPG-029:

- Incidental ingestion of soils
- Ingestion of site-associated biota

These pathways are described in detail in Appendix E. Note that there is no surface water at YPG-029 and groundwater occurs at approximately 197 ft bgs. Therefore, the surface water, sediment, and groundwater exposure pathways were determined to be incomplete and were not evaluated.

5.2.2 Analysis

Toxicity reference values (TRVs) are used to evaluate the potential hazards from the exposure estimated for each COPEC. TRVs protective of reproductive and developmental effects were used in this ERA. The sources from which the TRVs were obtained are provided in Appendix E.

To estimate exposures, exposure point concentrations (EPCs) were calculated for the COPECs in soils as the lesser of the upper confidence level (UCL) and the maximum detected concentration. For plants and invertebrates, the soil EPC was used to evaluate exposures. For birds, mammals, and reptiles, dietary exposures were estimated using bioaccumulation models, estimated ingestion rates, and dietary composition. The models and parameters used to estimate dietary exposures are described in detail in Appendix E.

5.2.3 Risk Characterization

Risk characterization involves two components; hazard estimates and risk description. For vertebrates, hazard estimates are based on the comparison of average daily dose to the chemical- and receptor-specific TRVs and are expressed as a hazard quotient (HQ). For invertebrates and plants, the HQ is calculated by dividing the soil EPC by the benchmark concentration. The HQs greater than one indicate that adverse effects may occur. A no observable adverse effects level (NOAEL)-based HQ of 1 is the threshold at or below which the contaminant is unlikely to cause adverse ecological effects; NOAEL-based HQs greater than 1 indicate that exposures exceed a no-effect

dose and do not necessarily indicate that adverse effects will occur. Lowest observable adverse effects level (LOAEL)-based HQs better indicate the potential for adverse effects to receptors because they are based on effect-based toxicological data. Thus, LOAEL-based HQs greater than one indicate that adverse effects will probably occur, but whether or not significant effects would actually occur cannot be judged with certainty.

5.2.3.1 Plant and Invertebrate Receptor Hazard Estimates

The EPC for vanadium exceeded the benchmark concentration for plants (Table E.12 of Appendix E). However, based on an evaluation of exposures at the site compared to background conditions, there is no incremental increase in the HQ over background from exposures to vanadium at the site (Appendix E). For zinc, the EPC did not exceed the benchmark concentration for plants or invertebrates. Note that there is no benchmark concentration for vanadium protective of invertebrates.

5.2.3.2 Vertebrate Receptor Hazard Estimates

For the vertebrate receptors, the NOAEL and LOAEL-based HQs and hazard indices (HI; i.e., the summation of the HQs for all COPECs) for all receptors were less than one (Table E.13 of Appendix E), indicating that exposures to soil at YPG-029 are not likely to pose a threat to vertebrate receptors.

Based on the results of the ERA, concentrations of COPECs in site soils do not pose a threat to ecological receptors and further action is not needed at the site on the basis of ecological risk.

5.2.4 Uncertainty Analysis

All risk assessments involve the use of assumptions, professional judgment, and imperfect data to varying degrees, which results in uncertainty in the final hazard estimates. A complete discussion of the uncertainties associated with this ERA is presented in detail in Appendix E.

5.3 SOIL-TO-GROUNDWATER EVALUATION

Lead was detected at concentrations that exceeded the BTV in one location (029EP002) on the surface and within a debris zone. However, lead concentrations did

not exceed the ADEQ rSRL, nrSRL or GPL at the site; therefore, the horizontal and vertical extent of lead impacted soil at this location has been characterized, and no further sampling to characterize the extent of lead contamination is required.

5.4 CONCLUSIONS OF THE RISK ASSESSMENT

One of the final steps of an RFI includes an evaluation of the human health and ecological risks associated with potential exposure to hazardous constituents which may be present at a site. The objectives of this risk assessment were to assess potential risks and hazards from exposure to contaminants in soils and to recommend either NA (if the risks and hazards are acceptable) or of the development of cleanup goals and remedial alternatives under a CMS task if unacceptable risks or hazards were identified. The results of this risk assessment indicate that there are no chemicals of concern (COCs) identified as potential hazards for human or ecological receptors. A CMS is recommended to prevent future exposure to the buried waste.

SECTION 6.0
SUMMARY AND RECOMMENDATIONS

An RFI has been completed at YPG-029 to 1) collect data to adequately identify and characterize the nature and extent of buried waste and contamination, including to determine whether regulated waste is present in the abandoned landfill; 2) conduct a risk assessment (human and ecological) to determine if constituents have been released to the environment which pose a risk to human health or the environment; and 3) evaluate if chemical constituents are present at levels that pose a threat to groundwater.

There is conflicting information regarding the dates YPG-029 was in operation as a landfill; however, disposal activities at the site may have occurred during the late 1960s. Surface debris removed from the site consisted of metal banding, empty steel drums, a locker, steel cables, wire, scrap wood, and a variety of construction items.

Geophysical surveys were completed and outlined areas where subsurface metal debris burial occurred. Test pit excavations and soil borings were conducted to determine the nature of the waste and to collect soil samples. Debris encountered during test pit excavations was visually inspected by UXO technicians for the presence of military munitions. No munitions or munition debris were identified in the subsurface excavations, and debris was consistent with municipal and industrial waste. Waste identified in the excavated test pits included glass and plastic bottles, wood, metal banding, small pieces of tar, metal pipe, aluminum cans, Styrofoam™ cups, food packaging, children's toys, clothing items, and a 1959 Arizona license plate

A total of 39 soil samples (including one field duplicate) were collected from the surface and subsurface soils. Results of soil sampling performed at the site indicate nine inorganic compounds with concentrations above BTVs. As presented in the risk assessment (Section 5), these analytes were not retained as COCs. No inorganic or organic compounds were detected at concentrations above the ADEQ rRSLs, nrSRLs or GPLs. Based on the nature and extent evaluation presented in Section 4.0, the waste and associated soil contamination associated with the landfills has been adequately characterized and further characterization activities are not warranted.

Analytical results obtained from the site were used to complete an HRA and ERA. The risk assessment concluded that the site does not pose unacceptable risks to potential human or ecological receptors (Section 5.0). Buried waste is present at the site and it is recommended that a CMS be conducted for YPG-029 focused on preventing exposure to the waste.

SECTION 7.0

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SECTION 8.0
CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Richard T. Martin
Garrison Manager

TABLES

TABLE 2.1

SOIL TYPES AT USAGYPG

US ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Soil Type	Composition	Percent of USAGYPG	Landforms	pH
Rositas	sand	0.0019	dunes and sand sheets	8.0
Superstition-Rositas	sand	0.0843	sandy eolian deposits	7.8 to 8.4
Carrizo	extremely gravelly loamy coarse sand	0.1434	flood plains, alluvial fans, fan piedmonts and bolson floors	7.8 to 8.0
Riverbend	extremely cobbly sandy loam	0.0054	stratified fan alluvium	7.8 to 8.2
Cristobal-Gunsight	silty, clayey gravel with sand to extremely gravelly loamy fine sand to very gravelly silt	0.2897	fan alluvium	8.2
Gunsight-Chuckawalla	extremely gravelly sandy loam to extremely gravelly loamy fine sand to very gravelly silt	0.1764	fan terraces or stream terraces	8.3
Carsitas-Chuckawalla	extremely gravelly sand to extremely gravelly loamy fine sand to very gravelly silt loam	0.0262	alluvial fans, moderately steep valley fills and dissected remnants of alluvial fans	Unspecified, generally characterized as mildly to moderately alkaline
Lithic Torriorthents	extremely gravelly sandy loam	0.2728	steeper hillsides and mountain slopes	8.2 to 8.4

Source: DRI (2009)

TABLE 4.1
CHARACTERIZATION OBJECTIVES
RCRA FACILITY INVESTIGATION REPORT - YPG-029

YUMA PROVING GROUND, YUMA, ARIZONA

Field Activity	Characterization Objective of Field Activity				
	Determine Disposal Site Boundaries	**Evaluate Potential Surface Soil Contamination Source Areas**	**Evaluate Potential Subsurface Soil Contamination Source Areas**	**Determine if Contamination is Migrating from Source Areas**	**Determine Concentrations of Background Metals**
Surface Debris Removal	Surface debris removed to prevent possible geophysical survey interference	Surface debris removal assisted in determining possible areas of surface soil contamination			
EM Geophysical Survey	5.17 Acres		5.17 Acres		
Test Pits	029EP001 – 029EP022 36 Total Samples	029EP001 – 029EP022 22 Surface Soil Samples	029EP001 – 029EP022 14 Subsurface Soil Samples	Surface and subsurface soil samples collected from outside landfill boundary and below suspected waste	
Vertical Soil Borings	029SB001 and 029SB002 2 Subsurface Samples Vertical soil borings used to determine depth of waste/contamination			029SB001 and 029SB002 2 Subsurface Samples Vertical soil borings used to determine possible leaching of contaminants	
Background Test Pit					029BG001 1 Surface and 1 Subsurface Soil Sample

TABLE 4.2
SOIL SAMPLING SUMMARY - YPG-029
U.S. ARMY GARRISON YUMA PROVING GROUND, YUMA ARIZONA

Sample Location	Total Depth (ft)	Total Width (ft)	Total Length (ft)	Sample Depth (ft bgs)			Notes
				First	Second	Third	
EP001	8	2	18	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP002	8	2.5	60	0.2-0.7	**4-4.5**	7.5-8	Lots of surface debris at this location. Waste present from 2.5 ft bgs to 7 ft bgs. Waste included broken glass, wood, burned wood, rusted metal 1959 Arizona license plate, 12" x 12" 6" concrete block, chunks of tar to 18+" diameter, wire, pipe, aluminum cans, styrofoam, plastic bottles, plastics, child's tricycle, ducting, brick, sheet metal flashing, and metal banding.
EP003	8	2	16	0.2-0.7	NA	NA	Waste present on ground surface only and included metal shavings, tin cans, wire brush, radiation cap, and glass beer bottles. No stain, debris, or other evidence of contamination observed in the test pit.
EP004	11.5	2	15	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP005	7	2	24	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP006	9.5	2	14	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP007	9	2	30	0.2-0.7	**4-4.5**	8.5-9	Waste present from 2 ft to 7 ft bgs . Only household waste was present and included glass bottles, plastic bottles, plastic bags, a shoe, a shirt, rags, styrofoam, egg cartons, aluminum cans, part of a license plate.
EP008	8	2.5	16	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP009	10.75	2	16	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP010	10	3	16	0.2-0.7	**4.5-5**	9.5-10	Waste present from 3 ft to 7 ft bgs. Waste included steel banding, plastic bags, 35 mm film, burned wood, styrofoam, glass bottles, food wrappers, aluminum foil, plastic bottles, fast food cups and
EP011	10	2	13	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP012	8.5	3	18	0.2-0.7	**6-6.5**	8-8.5	Waste zone is approximately 1 ft thick 3 ft wide zone at approximately 6 ft deep. Waste included plastic bags, metal bandings, 35 mm film, and styrofoam cups.
EP013	9.5	2.5	17	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP014	9	6	18	0.2-0.7	**4.5-5**	8.5-9	Waste present from 3 ft to 7 ft bgs. Waste included glass bottles, steel banding, plastic bags, rope, rusted metal, wonderbread sacks, plastic wheel toy truck, styrofoam cups, aluminum cans, burned wood, milk carton, and fast food containers.

TABLE 4.2
SOIL SAMPLING SUMMARY - YPG-029
U.S. ARMY GARRISON YUMA PROVING GROUND, YUMA ARIZONA

Sample Location	Total Depth (ft)	Total Width (ft)	Total Length (ft)	Sample Depth (ft bgs)			Notes
				First	Second	Third	
EP015	10	4	16	0.2-0.7	**4-4.5**	9.5-10	Waste present from 1.5 ft bgs at the north end of test pit and 4 ft to 9.5 ft bgs at the south end. Waste included wire, plastic bags, VCR tape, glass bottles and jars, burned wood, plastic containers, wonderbread wrappers, styrofoam cups, aluminum cans, metal, slides, and paint conditioner bottle (Pakosol).
EP016	9	3	16	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed in test pit. Metal wires were locataed on ground surface.
EP017	9.5	3	16	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed in test pit.
EP018	10	2.5	17	0.2-0.7	**4-4.5**	9.5-10	Waste does not extend across the entire excavation only the west end and thins to the south of the test pit. Waste present from 1 ft to 5 ft bgs. Waste included plastic bottles, plastic bags, wire, glass bottles, plastic tubing, burned wood, and styrofoam.
EP019	7	3	16	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP020	9.5	3	16	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP021	7.5	2.5	16	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
EP022	9	3	16	0.2-0.7	NA	NA	No stain, debris, or other evidence of contamination observed.
SB001	29.5	NA	NA	27.5-28.5	NA	NA	See test pit 029EP002 for details from 0-8 ft bgs. From 8-11 ft bgs silty sand and gravel most likely slough from above, some waste encountered 50% recovery. No stain, debris, or other evidence of contamination observed below 11 ft bgs.
SB002	30	NA	NA	29.5-30.5	NA	NA	See test pit 029EP015 for details from 0-10 ft bgs. No stain, debris, or other evidence of contamination observed below 8.5 ft bgs.
Background (BG001)	9.5	2.5	16	0.2-0.7	7-7.5	NA	No stain, debris, or other evidence of contamination observed.

Notes: Bolded values indicate locations locations containing waste.

Definitions: NA = Not Applicable, ft = feet, bgs = below ground surface.

TABLE 4.3

INORGANIC ANALYTICAL RESULTS - DETECTIONS - YPG-029

US ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium (Total)	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Silver	Sodium	Vanadium	Zinc
			nrSRL	920,000	410	10	170,000	1,900	510	NA	140,000	1,400	41,000	NA	400	NA	32,000	310	5,100	20,000	NA	5,100	NA	1,000	310,000
			rSRL	76,000	31	10	15,000	150	39	NA	17,000	1,400	3,100	NA	400	NA	3,300	23	390	1,600	NA	390	NA	78	23,000
			GPL	NA	35	290	12,000	23	29	NA	590	NA	NA	NA	290	NA	NA	12	NA	590	NA	NA	NA	NA	NA
			Background Threshold Values	12,000	--	6.6	290	0.92	0.65	37,000	14	7.9	15	15,000	14	6,100	920	0.016	0.49	14	2,500	0.062	8400	26	44
029EP001	0.2-0.7	N	12/7/10	5,760	--	4.23	76	0.1 J	0.033 J	8,940	7.59	3.46	6.4 J	9,070	7.89	3,800	188	--	0.31 J	7.81 J	1,270	--	63.5	16.9 J	26.2
029EP002	0.2-0.7	N	12/7/10	7,510	--	**7.3**	116	0.035 J	0.19 J	12,600	11.8	4.89	11.8 J	12,700	**21.4**	5,300	259	--	0.42 J	10.8 J	1,930	--	108	24 J	**119**
029EP002	4-4.5	N	12/7/10	7,970	--	**7.66**	162	0.032 J	0.31	14,800	11.6	4.82	12.2 J	13,400	**16.4**	5,670	252	--	**0.55 J**	11.4 J	1,710	**0.1 J**	250	23.1 J	**180**
029EP002	7.5-8	N	12/7/10	1,820	--	1.23 J	35.9	0.033 J	--	8,810	2.22	1.53	1.42 J	3,750	2.94	717	77.1	--	0.09 J	2 J	371	0.042 J	95.8	9.63 J	8.97
029EP003	0.2-0.7	N	12/7/10	8,790	--	6.05	104	0.075 J	0.036 J	16,200	**15.5**	5.4	10.6 J	13,600	11.8	**6,390**	277	--	0.33 J	13.6 J	1,870	--	93.7	**26.5 J**	39.7
029EP004	0.2-0.7	N	12/6/10	6,740	--	5.06	82.4	--	--	15,200	11.2	3.99	8.51 J	11,300	8.53	4,870	229	--	0.27 J	9.41 J	1,540	--	94	22.5 J	30.3
029EP005	0.2-0.7	N	12/7/10	4,530	--	**7.41**	73.7	--	--	8,550	7.93	3.66	6.35 J	9,770	9.06	3,210	217	--	0.24 J	7.63 J	810	--	51	20.4 J	22.4
029EP006	0.2-0.7	N	12/6/10	5,270	--	4.74	110	0.026 J	--	7,270	9.8	5.33	6.93 J	9,910	9.84	3,840	277	--	0.4 J	9.41 J	913	--	57.9	22.4 J	23.8
029EP007	0.2-0.7	N	12/7/10	4,060	--	2.97	62.3	--	--	11,700	6.66	2.64	4.64 J	7,970	5.79	2,500	138	--	0.2 J	5.54 J	968	--	53.7	19.5 J	18.8
029EP007	4-4.5	N	12/7/10	6,980	--	6	137	0.19 J	0.023 J	8,470	9.53	4.09	7.83 J	10,900	9.68	3,990	249	--	0.34 J	9.29 J	1,400	--	170	21.6 J	28.4
029EP007	8.5-9	N	12/7/10	3,060	--	1.2 J	43	0.18 J	0.029 J	13,600	2.65	1.61	1.89 J	3,500	3.16	1,150	109	--	0.1 J	2.65 J	527	--	63.2	8.64 J	10.6
029EP008	0.2-0.7	N	12/8/10	6,680	--	5.64	91.5	0.036 J	0.017 J	12,900	9.41	3.92	8.68 J	10,500	9.99	4,150	209	--	0.33 J	8.62 J	1,580	--	81.9	20.7 J	29.5
029EP009	0.2-0.7	N	12/6/10	5,490	--	6.17	79.9	--	--	11,200	10.3	3.77	7.17 J	10,800	9.11	4,210	209	--	0.41 J	8.65 J	1,550	--	152	22.7 J	27.4
029EP010	0.2-0.7	N	12/8/10	5,980	0.17 J	3.45	86.4	--	--	12,000	9.24	3.48	10.8 J	9,630	9.59	4,200	205	--	0.21 J	7.97 J	1,460	--	81.9	20 J	26.4
029EP010	4.5-5	N	12/8/10	5,200	--	4.73	108	0.054 J	--	11,100	7.83	3.35	6.56 J	9,830	8.51	3,160	187	--	0.3 J	6.9 J	976 J	--	149	20.3 J	**47.6**
029EP010	4.5-5	FD	12/8/10	4,650	--	3	86.5	0.05 J	--	8,930	7.04	2.99	5.61 J	8,030	6	2,960	185	--	0.22 J	6.56 J	782	--	131	17.1 J	34.9
029EP010	9.5-10	N	12/8/10	2,840	--	1.3 J	66.2	0.15 J	--	23,300	2.46	1.43	1.53 J	3,490	3.19	1,070	114	--	0.082 J	2.28 J	403	--	214	9.63 J	9.5
029EP011	0.2-0.7	N	12/6/10	6,540	--	4.86	79	0.068 J	0.023 J	14,700	9.8	3.98	8.44 J	10,700	9.65	5,060	230	--	0.36 J	8.93 J	1,600	--	100	20.3 J	30.9
029EP012	0.2-0.7	N	12/8/10	5,210	--	3.91	70.8	--	--	11,700	7.89	3.2	6.09 J	9,320 J	7.23 J	3,520	186	--	0.14 J	6.72	1,080 J	--	73.2	21.2 J	23.3
029EP012	6-6.5	N	12/8/10	4,970	0.16 J	5.12	81.2	--	--	12,500	8.05	3.16	5.67 J	9,590 J	6.47 J	3,070	165	--	0.28 J	6.79	991	**0.13 J**	224	22 J	20.7
029EP012	8-8.5	N	12/8/10	4,090	--	2.22	68.2	0.052 J	--	12,600	7.7	2.49	4.12 J	6,350 J	5.52 J	2,510	136	--	0.12 J	5.61	758	0.054 J	161	16 J	16.1
029EP013	0.2-0.7	N	12/8/10	6,690	--	3.28	111	--	0.011 J	15,100	10.8	3.68	7.55 J	10,200 J	7.49 J	4,650	213	--	0.22 J	8.74	1,860	--	95.1	21.3 J	29.6
029EP014	0.2-0.7	N	12/8/10	6,110	--	4.71	84.8	0.019 J	--	11,300	10.9	3.78	7.08 J	10,600 J	7.59 J	4,100	206	--	0.27 J	8.55	1,280	**0.066 J**	68.4	22 J	26.3
029EP014	4.5-5	N	12/8/10	7,330	--	8.42	117	0.054 J	0.021 J	9,890	12.5	5.07	8.7 J	12,800 J	22.7 J	4,630	238	0.0076 J	0.39 J	10.6	1,310	**0.076 J**	236	24.2 J	32.4
029EP014	8.5-9	N	12/8/10	5,740	--	2.98	251	0.24	0.018 J	4,610	6.05	2.99	5.22 J	7,220 J	5.96 J	2,290	173	--	0.16 J	6.35	1170	0.083 J	130	15.5 J	19.1
029EP015	0.2-0.7	N	12/8/10	4,790	--	2.82	93.9	0.03 J	0.011 J	15,300	8.37	3.34	4.75 J	8,540 J	6.2 J	2,640	216	--	0.24 J	6.48	958	--	52.9	21.5 J	20.8
029EP015	4.5-5	N	12/8/10	4,310	--	3.59	90	--	--	13,400	7.11	3.11	4.73 J	8,800 J	6.1 J	2,500	174	--	0.17 J	5.65	968	0.057 J	83.7	22.5 J	21.6
029EP015	9.5-10	N	12/8/10	2,580	--	1.17 J	83.7	0.051 J	--	10,900	3.41	1.93	1.57 J	5,490 J	4.01 J	1,040	121	--	0.09 J	2.64	408	--	148	15.4 J	12.3
029EP016	0.2-0.7	N	12/9/10	3,540	--	2.34	75.8	0.049 J	0.089 J	16,700	4.79	2.23	4.08	5,740	4.61	2,420	162	--	0.19 J	4.59	802 J	--	58.2 J	14	20.7
029EP017	0.2-0.7	N	12/9/10	4,580	--	4.72	60.7	--	0.039 J	9,350	7.87	3.42	6.39	8,930	7.94	3,960	174	--	0.26 J	8.03	874 J	--	54.2 J	18.9	22.9
029EP018	0.2-0.7	N	12/9/10	4,880	--	4.88	153	0.16 J	--	9,340	6.54	2.88	5.23 J	8,220 J	6.56 J	2,530	185	--	0.21 J	5.93	919	0.045 J	83.7	18.5 J	18.9
029EP018	4-4.5	N	12/9/10	6,020	--	4.61	115	0.079 J	--	13,100	8.18	3.21	7.55 J	9,500 J	13.5 J	3,370	178	0.0081 J	0.34 J	7.14	1,130	--	582	19.7 J	25.5
029EP018	9.5-10	N	12/9/10	2,360	--	0.97 J	58.7	--	0.027 J	16,500	3.49	1.74	2.07 J	4,760 J	3.18 J	1,010	129	--	0.15 J	2.67	480	--	418	14.2 J	11.1
029EP019	0.2-0.7	N	12/9/10	9,540	--	3.73	163	0.077 J	0.13 J	27,000	11.7	5.11	12.9	12,100	12	**7,430**	296	0.0064 J	0.3 J	11.8	**3,130 J**	--	131 J	20.6	43.4
029EP020	0.2-0.7	N	12/9/10	5,330	--	3.35	107	0.043 J	0.045 J	14,200	8.09	3.15	6.45	8,330	6.89	4,300	190	--	0.22 J	7.58	1,480 J	--	75.5 J	16	24.3
029EP021	0.2-0.7	N	12/9/10	6,260	--	5.25	86.4	0.066 J	0.041 J	14,900	10.4	4.09	7.53	10,100	7.75	5,550	228	--	0.28 J	10.3	1,340 J	--	73.5 J	18.5	27.7
029EP022	0.2-0.7	N	12/13/10	5,230	--	3.12	80.2	--	0.068 J	14,600	7.37	3.21	7.11	8,300	8.47	4,390	189	--	0.26 J	7.47	1,340 J	--	81.2 J	16.1	24.7
029SB001	27.5-28.5	N	2/17/11	5,630	0.37 J	1.99	175	0.34	0.13 J	27,000	6.46	2.55	**20.8**	7,450	5.74	2,620	168	0.0087 J	0.16 J	5.73	1,160 J	--	367	14.6	28.3
029SB002	29.5-30.5	N	2/16/11	2,410	--	1.4 J	68.6	0.18 J	0.034 J	15,100	3.03	1.59	25.4	4430	3.26	1,060	111	0.0045 J	0.1 J	2.44	390 J	--	315	11.9	20.9

Notes: Results are reported in units of milligrams per kilogram (mg/kg). Sample depths are in feet below ground surface (ft bgs). Bolded values are above the background threshold value. Highlighted rows are samples collected within the debris zone.

Definitions: N = normal sample. FD = field duplicate. nrSRL = ADEQ non-residential soil remediation level. rSRL = ADEQ residential soil remediation level. GPL = ADEQ minimum groundwater protection level. 'NA' = not available. '--' = non-detect. 'J' = estimated value.

TABLE 4.4

ORGANIC ANALYTICAL RESULTS - DETECTIONS - YPG-029

US ARMY GARRISON YUMA PROVING GROUND, ARIZONA

Location ID	Sample Depth	Sample Type	Sample Date	Acetone	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	bis(2-Ethylhexyl) Phthalate	Chrysene	Dibenz(a,h)anthracene	Diethyl Phthalate	Fluoranthene	Hexahydro-1,3,5-Trinitro-1,3,5-Triazine	Indeno(1,2,3-c,d)pyrene	Nitroglycerin	Phenanthrene	Pyrene
			nrSRL	54,000	240,000	21	2.1	21	29,000	210	1,200	2,000	2.1	490,000	22,000	160	21	1,200	240,000	29,000
			rSRL	14,000	22,000	6.9	0.69	6.9	2,300	69	390	680	0.69	49,000	2,300	50	6.9	390	22,000	2,300
			GPL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
029EP002	0.2-0.7	N	12/7/10	--	0.035 J	0.24 J	0.24 J	0.25 J	0.12 J	0.16 J	--	0.30 J	0.030 J	--	0.36	--	0.45	0.052 J	0.15 J	0.36
029EP002	4-4.5	N	12/7/10	--	--	0.024 J	0.020 J	0.018 J	0.0099 J	0.020 J	--	0.029 J	--	--	0.033 J	--	0.38	--	0.021 J	--
029EP010	4.5-5	N	12/8/10	0.0067 J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
029EP013	0.2-0.7	N	12/8/10	--	--	--	--	--	--	--	--	--	--	0.033 J	--	--	--	--	--	--
029EP014	4.5-5	N	12/8/10	0.0064 J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
029EP019	0.2-0.7	N	12/9/10	--	--	--	--	--	--	--	--	--	--	--	--	0.037 J	--	0.052 J	--	--
029SB001	27.5-28.5	N	2/17/11	--	--	--	--	--	--	--	0.056 J	--	--	--	--	--	--	--	--	--

Notes: Results are reported in units of milligrams per kilogram (mg/kg). Sample depths are in feet below ground surface (ft bgs). Highlighted rows are samples collected within the debris zone. Thirty-four samples are not listed since there were no organic detections in these samples.

Definitions: N = normal sample. nrSRL = ADEQ non-residential soil remediation level. rSRL = ADEQ residential soil remediation level. GPL = ADEQ minimum groundwater protection level. 'NA' = not available. '--' means non-detect. 'J' = estimated value.

TABLE 5.1
COMPARISON OF MAXIMUM DETECTED CONCENTRATIONS TO BACKGROUND AND SRLs
YPG-029

U.S. ARMY GARRISON YUMA PROVING GROUND, YUMA ARIZONA

Group	Chemical	Max Detect[1] (mg/kg)	BTV (mg/kg)	rSRL[2] (mg/kg)	nrSRL (mg/kg)	GPL (mg/kg)	Exceeds				COPC
							BTV	rSRL	nrSRL	GPL	
Metals	Aluminum	9,540	12,000	76,000	920,000	-	No	No	No	-	No
	Antimony	0.17	-	31	410	35	-	No	No	No	No
	Arsenic	8.42	6.6	10	10	290	Yes	No	No	No	No
	Barium	251	290	15,000	170,000	12,000	No	No	No	No	No
	Beryllium	0.24	0.92	150	1,900	23	No	No	No	No	No
	Cadmium	0.31	0.65	39	510	29	No	No	No	No	No
	Chromium, total	15.5	14	17,000	140,000	590	Yes	No	No	No	No
	Cobalt	5.4	7.9	1,400	13,000	-	No	No	No	-	No
	Copper	12.9	15	3,100	41,000	-	Yes	No	No	-	No
	Lead	22.7	14	400	800	290	Yes	No	No	No	No
	Manganese	296	920	3,300	32,000	-	No	No	No	-	No
	Mercury	0.0087	0.016	23	310	12	No	No	No	No	No
	Molybdenum	0.55	0.49	390	5,100	-	Yes	No	No	-	No
	Nickel	13.6	14	1,600	20,000	590	No	No	No	No	No
	Silver	0.13	0.062	390	5,100	-	Yes	No	No	-	No
	Vanadium	26.5	26	78	1,000	-	Yes	No	No	-	No
	Zinc	180	44	23,000	310,000	-	Yes	No	No	-	No
Organics	Acetone	0.0067	NA	14,000	54,000	-	NA	No	No	-	No
	Anthracene	0.0348	NA	22,000	240,000	-	NA	No	No	-	No
	Benzo(a)anthracene	0.238	NA	6.9	21	-	NA	No	No	-	No
	Benzo(a)pyrene	0.236	NA	0.69	2.1	-	NA	No	No	-	No
	Benzo(b)fluoranthene	0.248	NA	6.9	21	-	NA	No	No	-	No
	Benzo(g,h,i)perylene[3]	0.123	NA	2,300	29,000	-	NA	No	No	-	No
	Benzo(k)fluoranthene	0.16	NA	69	210	-	NA	No	No	-	No
	Chrysene	0.299	NA	680	2,000	-	NA	No	No	-	No
	Dibenz(a,h)anthracene	0.0296	NA	0.69	2.1	-	NA	No	No	-	No
	Diethyl Phthalate	0.0326	NA	49,000	490,000	-	NA	No	No	-	No
	Fluoranthene	0.359	NA	2,300	22,000	-	NA	No	No	-	No
	Hexahydro-1,3,5-trinitro-1,3,5-triazine	0.037	NA	50	160	-	NA	No	No	-	No
	Indeno(1,2,3-c,d)pyrene	0.449	NA	6.9	21	-	NA	No	No	-	No
	Nitroglycerin	0.052	NA	390	1,200	-	NA	No	No	-	No
	Phenanthrene[4]	0.148	NA	22,000	240,000	-	NA	No	No	-	No
	Pyrene	0.358	NA	2,300	29,000	-	NA	No	No	-	No

Notes: 1 - For 0-10 ft bgs
2 - Lesser of the 10^{-5} risk and noncarcinogen based residential SRLs
3 - No SRL. Pyrene used as a surrogate
4 - No SRL. Anthracene used as a surrogate.

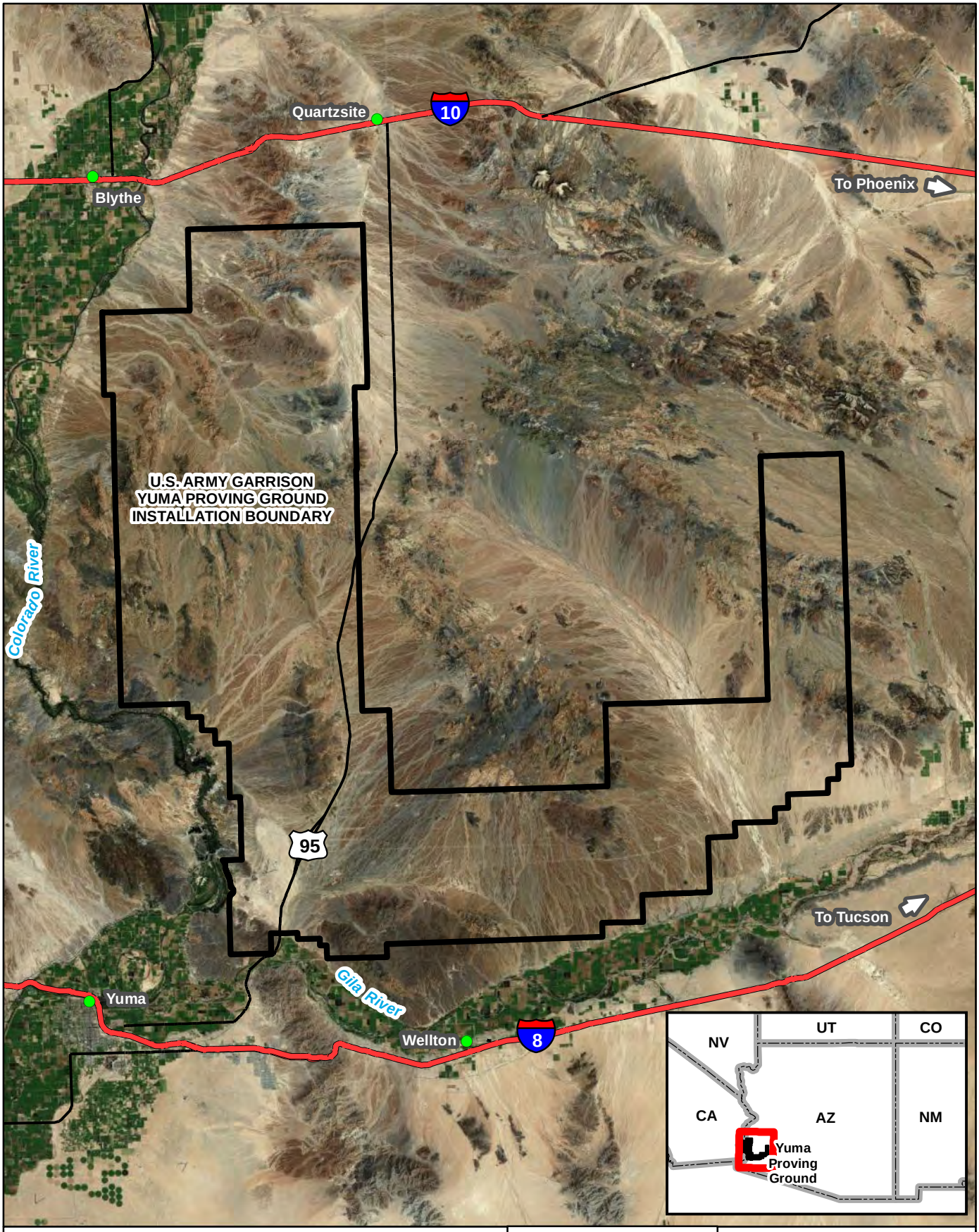
Definitions: BTV - Background threshold value (see Appendix D)
Max - maximum
NA - Not applicable
nrSRL - 2007 Arizona non-residential soil remediation level
rSRL - 2007 Arizona residential soil remediation level

TABLE 5.2
REPRESENTATIVE SPECIES

YUMA PROVING GROUND, YUMA, ARIZONA

Class	Species - Common Name (Scientific Name)
Plants	Terrestrial Plants
Invertebrates	Terrestrial (soil dwelling) invertebrates
Mammals	Desert shrew (*Notiosorex crawfordi*) Little pocket mouse (*Perognathus longimembris*) Kit fox (*Vulpes macrotis*)
Birds	Gambel's quail (*Callipepla gambelii*) Verdin (*Auriparus flaviceps*) American kestrel (*Falco sparverius*)
Reptiles	Sonoran desert tortoise (*Gopherus morafkai*)

FIGURES



Miles
0 5 10
0 8 16
Kilometers

FIGURE 1.1

REGIONAL LOCATION

U.S. Army Garrison Yuma Proving Ground

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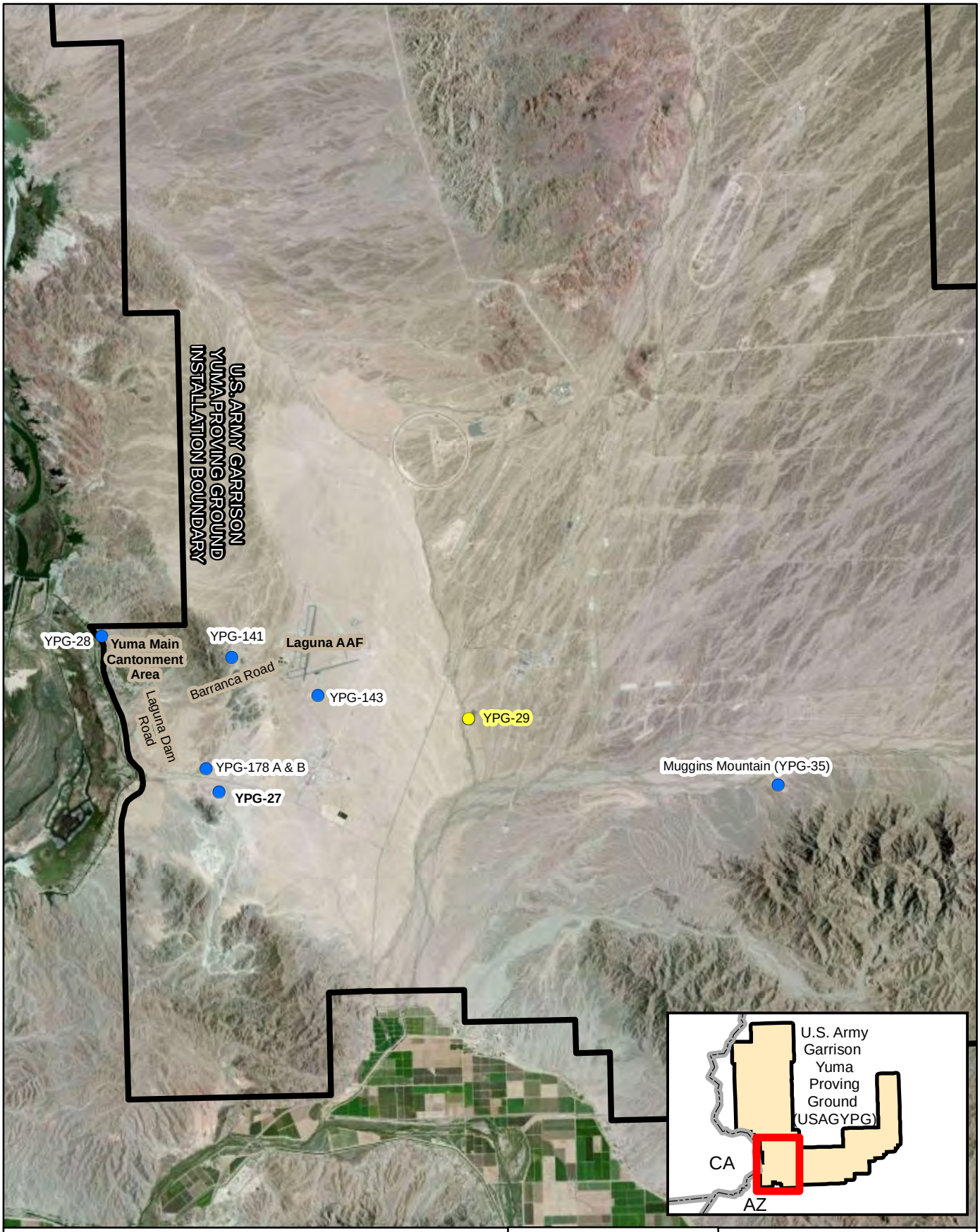

FIGURE 2.1

SITE LOCATIONS

U.S. Army Garrison Yuma Proving Ground

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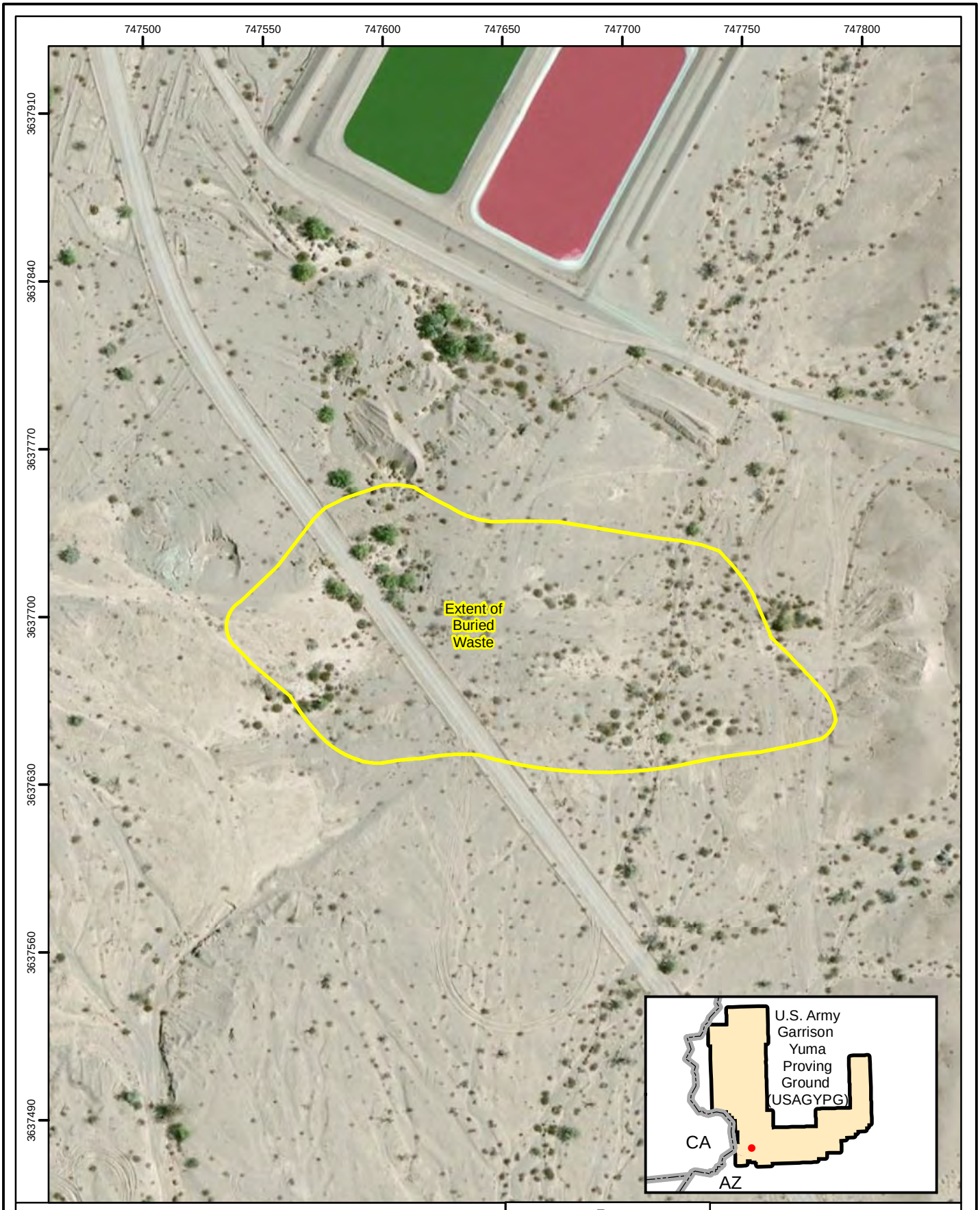

LEGEND

Extent of Buried Waste

Feet
0 90 180
0 25 50
Meters

North and East Coordinates in WGS 1984, UTM, Zone 11, Meters.

FIGURE 2.2

YPG-029
SITE MAP

U.S. Army Garrison Yuma Proving Ground

X:\GISCADD\projects\yuma\mapfiles\YPG_29\RFI_Draft\RFI_29_2009_extent_buried_waste.mxd 11/17/2011

PARSONS

FIGURE 2.3

Inactive Landfill YPG-029

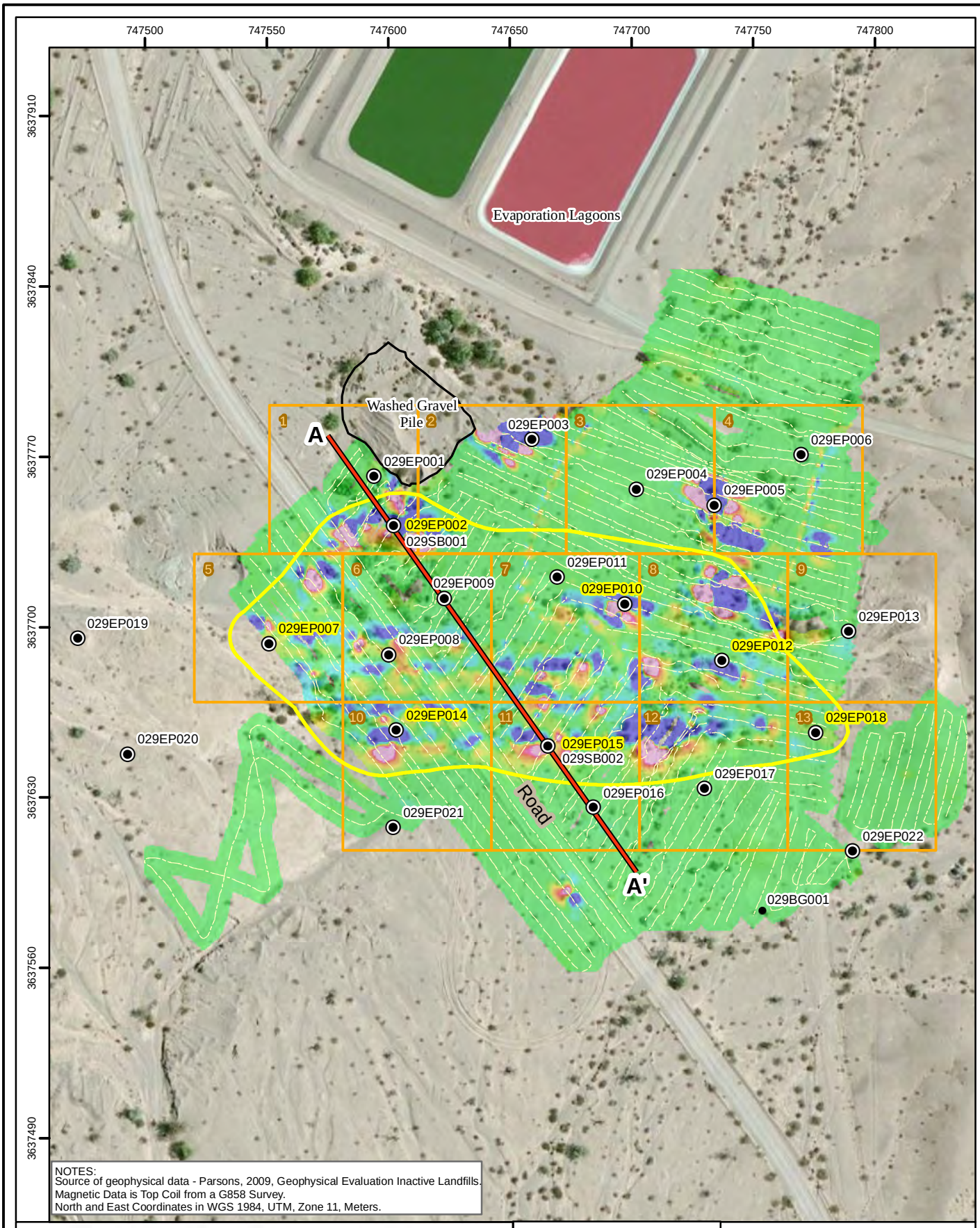

FIGURE 4.1

YPG-029
GEOPHYSICAL
SURVEY RESULTS

U.S. Army Garrison
Yuma Proving Ground

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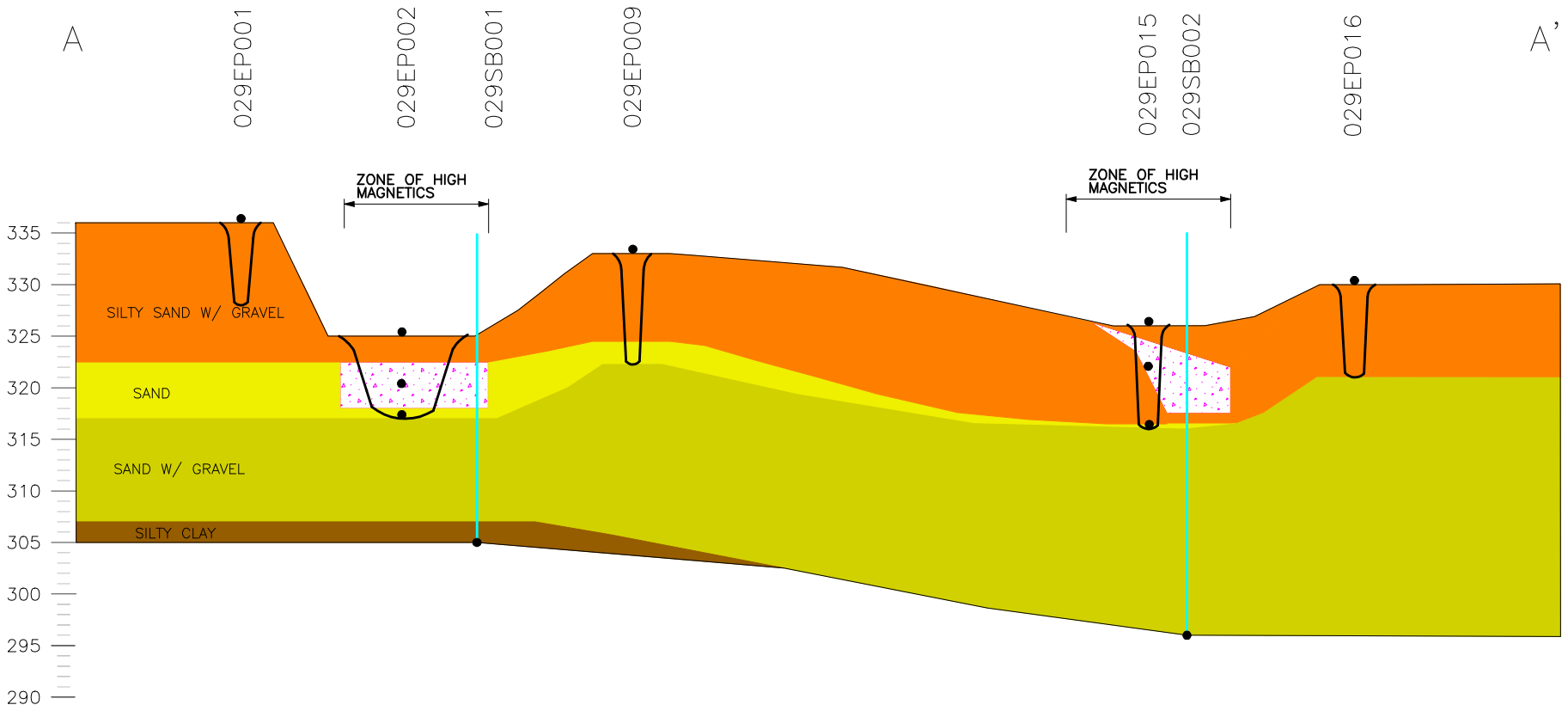

SAND, silty with gravel

CLAY, silty

SAND

SAND, with silt

WASTE

TEST PIT EXCAVATION

SAMPLE LOCATION

BORING LOCATION

40 20 0 40 80

SCALE IN FEET

FIGURE 4.2

YPG-029
CROSS SECTION VIEW
OF TEST PITS
FROM A TO A'

YUMA PROVING GROUND

$FILE$

$DATE$