CONVENTIONAL EXPLOSIVES SAFETY SUBMISSION
FOR
~~ORDNANCE AND EXPLOSIVES~~MUNITIONS AND EXPLOSIVES OF CONCERN
REMOVAL ACTIVITIES IN THE
LIMESTONE HILLS, MONTANA
AMENDMENT ~~1~~2

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ACRONYMS AND ABBREVIATIONS

AHA	Ammunition Handling Area
AP	Armor Piercing
BLM	U.S. Department of the Interior, Bureau of Land Management
cm	centimeters
DDESB	Department of Defense Explosive Safety Board
DoD	Department of Defense
~~DPDO~~	~~Defense Property Disposal Officer~~
EOD	Explosive Ordnance Disposal
ESS	Explosives Safety Submission
G-tek	G-tek Australia Pty Limited (formerly GTL)
GW	Graymont Western US, Inc. (formerly Continental Lime, Inc.)
HE	High Explosive
HEAT	High Explosive Anti-Tank
Hz	Hertz
LHTA	Limestone Hills Training Area
MEC	Munitions and Explosives of Concern
~~MPM~~	~~Most Probable Munition~~
MGFD	Munition with the Greatest Fragmentation Distance
mm	Millimeter
MPPEH	Material Potentially Presenting and Explosives Hazard
MSD	Minimum Separation Distances
MSL	Mean Sea Level
MTARNG	Montana Army National Guard
NOFA	Naturally Occurring False Alarms
nT	Nanotesla
~~OE~~	~~Ordnance and Explosives~~
QA	Quality Assurance
QC	Quality Control
Q-D	Quantity-Distance
SUXOS	Site UXO Supervisor

ACRONYMS AND ABBREVIATIONS
Continued)

Tetra Tech	Tetra Tech EM Inc.
TSD	Team Separation Distance
USGS	United States Geological Survey
UXO	Unexploded Ordnance
WP	White Phosphorus

CONVENTIONAL EXPLOSIVES SAFETY SUBMISSION
~~ORDNANCE AND EXPLOSIVES REMOVAL~~ MUNITIONS AND EXPLOSIVES OF CONCERN
ACTIVITIES IN THE
LIMESTONE HILLS TRAINING AREA, TOWNSEND, MONTANA
AMENDMENT ~~1~~2

The Montana Army National Guard (MTARNG) has prepared this conventional Explosives Safety Submission (ESS) to conduct ~~ordnance and explosives (OE)~~ munitions and explosives of concern (MEC) removal activities at the Limestone Hills Training Area (LHTA) in Townsend, Montana. Changes from the original ESS are indicated in redline/strikeout.

Amendment 1 text changes to this ESS are shown in blue. Amendment 1 expanded~~s~~ the original clearance area to 454 acres to accommodate eastward mine expansion, based on revised estimates of ore reserves from Graymont Western U.S. Inc. (GW). The exclusion zone ~~h~~was ~~been~~ extended in proportion to the expansion of the ~~ordnance and explosives (OE)~~MEC clearance area (see Figure 1)~~ (see Map #1, Amendment 1)~~. The clearance area has been delineated into five clearance "zones" so as to allow for a phased clearance by zone~~ (see Map #5, Amendment 1)~~. Zone Remediation Reports will be submitted upon completion of remediation in each zone.

Amendment 2 text changes to this ESS are shown in red. Amendment 2 addresses the following: (1) expands the boundary of the MEC clearance area by 1.7 acres for a total clearance area of 455.7 acres to allow for GW to construct a road in an area south and west of the Amendment 1 boundary, (2) amends fragmentation hazard distances based on DDESB's revised fragmentation database, and (3) adds a materials potentially presenting an explosives hazard (MPPEH) processing site (See Map #3, Amendment 2).

This ESS has been organized in accordance with preparation instructions provided in Data Item Description identification number ~~O~~MEC-060 to ~~"~~provide ~~O~~MEC "removal action safety criteria for approval by an appropriate U.S. Department of Defense (DoD) element." ~~Both hard and~~An electronic copy~~ies~~ of this report ~~are~~is being submitted for review. ~~The hard copy contains only the text and supporting maps.~~ Because a large number of additional reference materials are included (these documents and maps are highlighted in blue), the electronic copy of this document has been formatted similar to a web site for ease of use and contains all text, maps, and supporting documentation.

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1.0 INTRODUCTION

Past live-fire training by the MTARNG in support of a federal mission has resulted in ~~OE~~ MEC contamination of public (U.S Department of the Interior, Bureau of Land Management [BLM]) land in the Limestone Hills, Montana (see Figure 1). The clearance is proposed for approximately 455.7~~277~~ acres that are immediately adjacent to an active limestone quarry and lime plant. The area proposed for clearance is a closed range that is currently under the safety control of the MTARNG. The purpose of this proposed clearance activity is to remove the ~~O~~MEC hazard so as to allow a transfer of control from the MTARNG back to the BLM. Pending successful completion of the clearance as determined by the Department of Defense Explosives Safety Board (DDESB), an end use of mining is proposed by the BLM.

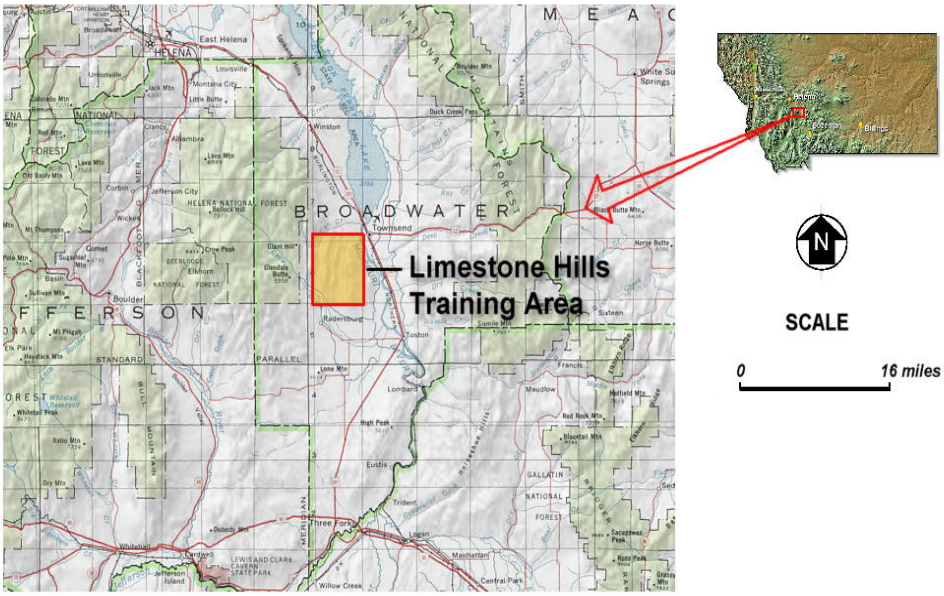

Figure 1. Site Location Map

Map 1 shows the location of the LHTA site within the State of Montana (see interactive portion of CD). ~~In this submission, we present evidence from in-field surveys that the area in question is contaminated with unexploded ordnance (UXO) (see Section 3).~~ ~~Figure~~ Map 2, Amendment 2 ~~(see interactive portion of CD)~~ depicts the area proposed for clearance in this submission. Note the feature identified as the 2.75 inch rocket safety fan line in ~~Figure~~ Map 2, Amendment 2 ~~(see interactive portion of CD)~~. This line demarcates the boundary between the area north where active mining is currently permitted by the State of Montana and BLM and the area south that is contaminated with UXO. Graymont Western US, Inc. (GW) of Salt Lake City, Utah (formerly known as Continental Lime, Inc.), has a pre-existing life of mine permit that has been granted with a provision that the mine cannot proceed past a point designated in this figure and referred to as the 2.75 inch rocket safety fan line until the area is cleared of the ~~OE~~ MEC hazard. Without removal of the ~~OE~~ MEC hazard, GW faces premature exhaustion (10 years vs. 30 years) of ore reserves. To mitigate the ~~O~~MEC hazard and to avoid the

economic impact the closure of the mine would have on the surrounding community, the MTARNG ~~proposes to begin~~ is implementing a multi-year ~~O~~MEC clearance of the affected mine claims. ~~It is to this end that we are submitting this plan. Our goal is to clear all surface and subsurface OE hazards.~~ To date, we have submitted zone remediation reports to DDESB for Zones 1, 2, and 3; these three zones have been approved for transfer by DDESB (see interactive portion of CD for zone remediation reports and DDESB approval memoranda).

1.1 ~~TRAINING~~ SITE LOCATION

Limestone Hills is located in Broadwater County west of the Missouri River and about two miles west of Townsend, Montana (see Figure 1). The range's 20,080 acres ~~is~~ are comprised primarily of federally owned land, which is managed by the BLM (88 percent). Approximately six percent of the remainder is state-owned land and another six percent is privately owned. Several private individuals hold mining claims on the range and GW holds claims for limestone deposits. (See interactive portion of CD for a property ownership map) Several structures and other capital improvements have been made to the range~~, totaling $1.5 million~~. Structures and capital improvements are largely located within the cantonment area, which it outside of the 2,894~~600~~ foot zone of exclusion for intentional detonation. (Refer to section 3.1 for further descriptions of exclusion zones) Structures within the cantonment area include a full-scale maintenance shop; a fenced, concrete yard for vehicle storage; and concrete containment pads for refueling and storage of fuel trucks. Capital improvements outside of the 2,894~~600~~ foot exclusion zone area include storm water compliance structures, targeting systems, and road improvements. The range tower and the new Ammunition Holding Area (AHA) are no longer ~~No structures are located~~ within ~~the 2,600 foot area. An Ammunition Holding Area (AHA) is located approximately 1,000 feet beyond~~ the 2,894~~600~~ foot exclusion zone for intentional detonation due to the release of Zones 1, 2, and 3 ~~(Refer to section 13.3).~~ Concurrent operations will not occur during clearance operations.

1.2 ~~O~~MEC CLEARANCE SITE LOCATION

The Limestone Hills Training Area is located in the foothill region of the east slopes of the Elkhorn Mountains, approximately 30 miles south and east of Helena (see interactive portion of CD for ~~Figure~~Map 2, Amendment 2 and ~~Figure~~Map 3, Amendment 2). UXO survey work occurred along the ridge labeled "Limestone Hills" on the Townsend United States Geological Survey (USGS) 7.5-minute series provisional map (1986). The terrain along the ridge is rugged, with massive limestone outcrops forming pediment spur ridges, interspersed with terraces, fans and foothill slopes. A series of rock walls, cliffs and terraces associated with this massive ridge rise steeply from the valley floor (4,840 feet mean sea level [MSL]) to the top of the ridge (5,767 feet MSL). See interactive portion of CD for photographs showing the terrain of the LHTA.

The area south of the rocket safety fan line within the GW proposed life of mine disturbance "footprint" is widely contaminated with UXO (see interactive portion of CD for ~~Figure~~ Map 2, Amendment 2). D~~O~~oD regulations prohibit the transfer of control of

this area until the area is cleared to the Department of Defense Explosives Safety Board (DDESB) clearance standard and DDESB has approved the transfer.

~~From 1998 to 2001, MTARNG conducted a 10 percent digital geophysical survey on a 210-acre site within the mine footprint at the LHTA. See interactive portion of CD to view the 10 percent survey area. Work was conducted along a massive limestone outcrop that is geologically complex. MTARNG conducted this survey work to estimate the extent and distribution of OE contamination. The survey was conducted to collect information on the presence or absence of OE contamination so as to complete an explosives safety submission. See interactive portion of CD for additional data on instrument in-field methodology in Youmans et al., 2002.~~

2.0 REASON FOR ~~O~~MEC

The MTARNG began using the LHTA in 1958 under a series of special use permits and temporary use permits ranging in term from one to five years. In the early 1980s, both BLM and the MTARNG agreed that a longer term authorization was a prudent course of action. On March 26, 1984, BLM granted a 30-year Right-of-Way for the construction and maintenance of improvements and military training exercises. It provided for the safety of the public and stewardship of the land through numerous restrictions.

Since 1958, the MTARNG has managed the LHTA to ensure that soldiers received live fire training with both individual rifle and crew served weapons, and helicopter, tank, artillery, mortar, and Bradley Infantry Vehicle gunnery. The types of weapons ranged from small arms to 155 millimeter (mm) artillery, all of which have been fired into the impact area. The training site has been used for maneuver and live-fire training for Infantry, Armor, Artillery, Engineer, Aviation, and Special Operations units during the ensuing years. As a result of these activities, ~~O~~MEC remains within portions of the LHTA.

3.0 AMOUNT AND TYPE OF ~~O~~MEC

The entire ridge south of the existing GW plant and quarry was swept for surface UXO several times (see interactive portion of CD for ~~Figure~~Map 2, Amendment 2). Surface sweeps/surveys of the area in 1993, 1994, and 1995 by the Corps of Engineers' Mandatory Center of Expertise for Ordnance and Explosive Waste along with Explosive Ordnance Disposal (EOD) teams from Fort Lewis, Yakima, and Great Falls, located and disposed of the following types of munitions: 76mm, 90mm, 105mm, 155mm projectiles and 4.2 inch mortars, filled with High Explosive (HE) and Illumination materials; 2.75 inch rocket HE warheads; 76mm and 90mm Armor Piercing/Target Practice rounds; and 105mm and 165mm practice rounds. In the three years of surface sweeps, the following rounds were located and disposed: 155mm HE rounds (13), 155mm Illumination rounds (10), 105mm HE rounds (11), 105mm Illumination rounds (4), 2.75 inch HE rocket warheads (11), 4.2 inch HE mortars (3), 4.2 inch Illumination mortar (1), 76mm HE rounds (3), and 90mm HE projectiles (2). These sweeps also covered areas outside of the area of concern but these items were located either in the area or close to the area. See

interactive portion of CD for information on the surface sweeps that were conducted by the Corps of Engineers.

Between 1998 and 2001, the subsurface was then sampled to estimate ~~O~~MEC contamination. The digital geophysical surveys of 87 100 by 100 feet sample grids were conducted. Grids were established on sites considered representative of varying soil depths, slopes and aspects. G-tek Australia Pty Limited (G-tek [formerly GTL]) of Armidale, Australia conducted the survey under a subcontract to Tetra Tech EM Inc. of Helena. The total area encompassed by the grids amounts to a 10 percent subsurface sample of the area proposed for mining. See interactive portion of CD for a copy of G-tek's reports (written in 1998, 1999, and 2000) and the corresponding anomaly contour maps.

The geophysical survey produced anomaly contour maps for each grid and each grid was cleared by UXO technicians and the data recorded on validation sheets and incorporated into a GIS-based tracking system. This validation work was completed in November of 2001. See interactive portion of CD to view an Excel spreadsheet which presents a compilation of what was found during validation of all 87 grids that were surveyed and validated between 1998 and 2001.

During the excavation of the anomalies, 38 ~~O~~MEC items were found and two of those items contained explosive or hazardous fillers. The items were one 4.2 inch HE mortar and one 105mm, Smoke, Red Phosphorus projectile. See interactive portion of CD for additional information on the 38 ~~O~~MEC items that were found. Following is a complete list of the types of ~~O~~MEC that were found during the validation of all 87 grids:

- 4.2-inch HE and illumination mortars
- 76-mm HE, Armor Piercing (AP) rounds
- 90-mm HE, armor piercing, and white phosphorus (WP) rounds
- 2.75-inch rockets, HE, WP
- 105-mm High Explosive Anti-Tank (HEAT), WP rounds
- 155-mm HE, WP, Illumination rounds

During surface and subsurface investigations MTARNG documented evidence that the ridgeline south of the rocket safety fan line had received direct fire from a variety of dud-producing munitions. Fragments that were the result of high explosive detonations were located throughout the survey area. Evidence of impacts from smoke/WP ordnance was also present in the form of large pieces of fragmentation with nomenclature often discernible on larger fragments. Illumination canisters were found throughout the area. Functioned impact fuzes were found on the surface and at depths of 0.5 meters over the entire ridge. Blast impact craters were located within the survey area. The east-facing slope is the most heavily impacted area. We concluded that the top of the ridgeline and the west-facing slope also received high explosive impacts.

MTARNG began unexploded ordnance (UXO) clearance work at LHTA in 2002 following several years of in-field investigation on the feasibility of a UXO clearance in

such difficult, inaccessible terrain. MEC clearance work has been ongoing, as weather and funding has permitted, since 2002. As of January 2012, 318 acres have been cleared, and the following items have been found and removed:

- 59 UXO/MEC
- 1,295 Expended Rounds
- 550 Expended Fuzes

The deepest that we had to excavate was a 4.2" expended illumination round located at 330~~80~~ centimeters (cm)~~ (31.50 inches)~~ and the majority of the rounds were located at less than 70~~30 to 50~~ cm ~~(11.81 to 19.69 inches)~~ in depth (Click here to see an analysis of LHTA round depth information by round type). ~~Noted during this intrusive sampling was the presence of 4.2 inch WP fragmentation. WP has been added as a filler to all of our probable munitions.~~

3.1 ~~MOST PROBABLE~~ MUNITION WITH THE GREATEST FRAGMENTATION DISTANCE (MGFD)

The 155mm M107 HE projectile is the ~~most probable~~ munition with the greatest fragmentation distance (MGFD~~PM~~) that will be encountered during this ~~O~~MEC action. MTARNG has made this determination based upon both historical data (training site records) and intrusive sampling data gathered between 1998 and 2011~~01~~. The maximum horizontal fragmentation distance of 2,894 feet is based on the the M107 HE (TNT-filled) projectile. The hazardous fragmentation distance of 450 feet is based on the 155mm M107 HE (Composition B-filled) because these are the greatest distances for the 105mm M107 round. The ~~safe exclusion zone~~team separation distance (TSD) during intrusive operations is ~~45~~105 feet for the MGFD~~PM~~, based on K40 for the 155mm HE M107 (Composition B-filled) round in accordance with fragmentation data review form revision date 10/18/11 (see interactive CD for relevant fragmentation data review forms). ~~This distance was previously calculated in conjunction with other projects by Huntsville Engineering and Support Center. Calculations were performed IAW DDESB approved "Method for Calculating Range to No More than One Hazardous Fragment per 600 Square Feet", January 1998 (see interactive portion of CD). The safe exclusion zone during intentional detonations is 2,600 feet in accordance with DoD 6055.9 STD, Table C5.T3 (see interactive portion of CD), for items that cannot be safely removed from the site to the current LHTA disposal area.~~ Minimum separation distances (MSD) for the MGFD are summarized in Table 1 below.

TABLE 1 MINIMUM SEPARATION DISTANCES			
MGFD	**TSD [1] (feet)**	**MSD [2] Unintentional (feet)**	**MSD [3] Intentional (feet)**
155mm HE M107(Comp B)	**105**	**450**	N/A
155mm HE M107(TNT)	N/A	N/A	**2,894**

The MGFD is a 155mm HE M107 projectile. The M107 HE projectile that is TNT filled has a greater MFD-H for intentional detonations than the Comp B filled M107 and therefore the MSD for intentional detonations is based on the 155mm M107 HE (TNT filled). The unintentional and TSD are based on the 155mm M107 HE (Comp B filled) projectile.

Team separation distance: 105 feet.
MSD for unintentional detonations: 450 feet.
MSD for intentional detonations: 2894 feet

Notes:

[1] Based on a K40 of the MGFD (Comp B filled)
[2] For nonessential personnel based on HFD of the MGFD (Comp B filled)
[3] For nonessential personnel based on MFD-H of the MGFD (TNT filled)

HE	High Explosive
HFD	Hazard Fragmentation Distance
K40	Inhabited building distance
M	Model
mm	Millimeter
N/A	Not applicable
MFD-H	Maximum fragmentation distance - horizontal
MGFD	Munition with the Greatest Fragmentation Distance
MSD	Minimum separation distance
TSD	Team separation distance

If a round with a greater fragmentation distance is encountered during the course of ~~O~~MEC clearance activities, the Quantity-Distance (Q-D) arcs will be adjusted and an amendment to this ESS will be submitted for approval. Explosive contaminated soil is not present within the LHTA and is not applicable to this safety submission. However, raw or bulk explosives found during the clearance operations will be disposed of by responding military EOD teams. In addition, explosive contaminated buildings are not relevant to this ESS because there are no buildings located within the clearance area.

3.2 MAXIMUM CREDIBLE EVENT

No explosives contaminated soil, explosives contaminated buildings, or Chemical Warfare Material have been found within the project area. Therefore, no Maximum Credible Event is specified.

4.0 START DATE

Clearance activities have commenced within the ~~O~~MEC clearance area in accordance with the ESS as approved 2 May 2003 by DDESB (see interactive portion of CD). Clearance activities within the area described in Amendment 1 ~~will~~ commenced as approved in June 2004 (see interactive portion of CD).~~upon approval of this amended plan.~~ Activities as described in the Amendment 2 will commence upon approval.

5.0 FROST LINE

MTARNG consulted various sources within Broadwater, Jefferson, and Lewis and Clark counties to obtain frost depth data. These included the National Resource Conservation Service, the Farm Service Bureau, the University of Montana-Agricultural Extension Agents, the U.S. Forest Service, and several Conservation Districts. None of the agencies had collected or knew of any detailed published data on the frost line within Limestone Hills Training Area. MTARNG also consulted published soil surveys for each area, and frost data was not published. MTARNG determined that very little data (mostly from Montana State University) exists on frost depth throughout the state of Montana.

The general guide is that the maximum frost depth within the inter-mountain valleys is conservatively estimated to be 60 inches (5 feet). Realistically, however, the maximum depth is more dependent on soil moisture content rather than temperature, so frost depth may be as shallow as 2 to 3 feet during drought years. Early snow cover is also a factor: a large snowfall early in winter will often insulate the soil from deep freezing, particularly if it remains in place and accumulates throughout the winter. With the steep slopes and dry conditions at the Limestone Hills elevation, MTARNG estimates the maximum frost depth is closer to 4 feet.

Frost line data is important for ~~O~~MEC operations where UXO may potentially lie above the frost line and could surface over time. However, because the LHTA project is a UXO clearance to the maximum depth of penetration, UXO should be cleared both above and below the frost line and frost line data is irrelevant.

6.0 ~~CLEARANCE~~ REMOVAL TECHNIQUES

MTARNG has contracted to Tetra Tech EM Inc. (Tetra Tech) to serve as prime contractor for the work described in this amendment. Tetra Tech has subcontracted to Geolex, Inc. to provide geophysical survey support, including data collection and data processing. The geophysical survey is a specialized UXO clearance process that detects buried MEC items up to the stated maximum depth for the equipment used. For this project, the MTARNG has approved of a four-sensor magnetometer array as the primary instrument used to collect magnetic data. The array consists of four Geometrics Model 823a cesium vapor sensors. Sensor separation on the array is 0.5 meter, and sensor height must be approximately 0.5 meter above the ground surface while a survey is conducted. The raw sample rate is 10 Hertz (Hz) with resolution to 0.1 nanoTesla (nT). Maximum consistent detection depth for this equipment is approximately 2.5 meters for a

155mm round. Previous experience by the MTARNG indicates that the detection depth can vary with UXO size and the geophysical technology used. In addition, signal attenuation for total field magnetometry varies as a function of the inverse cube root of the vertical distance between the UXO and sensor positions.

MTARNG approves of the use of the FieldRanger thread odometer for positioning at LHTA. A thread odometer can be operated in thick over-story vegetation, but has limitations. It will be employed as follows: Non-metallic survey chains will be stretched from west to east across the top (north) and bottom (south) boundaries of the corners of a pre-existing survey grid, typically 25 meters square. Navigation will be by line of sight to an orange traffic cone placed along the survey chain at both the top and bottom chains to serve as a sighting reference for the person carrying the magnetometer array. With the end of the thread tied off behind the array, the operator will walk forward and pull out the thread, which turns an odometer wheel. Rotation of the odometer wheel will be calibrated via a capacitance encoder and microchip over a distance of 25 meters. The cone will be moved at 2-meter increments along the top and bottom survey chains as the survey progresses west to east. North-south positioning will be recorded by the FieldRanger to +/- 0.5 meters or approximately 2 percent accuracy.

Thread odometer positioning technology provides single axis (north-south) positioning information only. The cone placement along the chains provides the only east-west positioning information for the survey. As a result, any deviations of 1 meter or more left or right (east or west) caused by obstacles such as trees or rock outcrops will not be automatically recorded in the position data. These course deviations must be noted in the data acquisition logger as "tree-east/west" or "rock-east/west" as appropriate.
~~will use the same clearance techniques, equipment, and contractors for this project as were used during the statistical sampling conducted between 1998 and 2001. Both total field and electromagnetic induction instruments will be used during the subsurface geophysical survey. The Montana Army National Guard will continue to use G-tek of Armidale Australia as its sole contractor for collecting geophysical data during this OE clearance. G-tek is a highly experienced and reputable firm that has been working successfully at the site since 1998. In these 5 years of working at the site, we have worked through issues of equipment operation, sensor configuration, and positioning of anomalies. These last 5 years have essentially served as a prove-out of G-tek's instrumentation. The principal geophysical survey instrument to be used will be the TM-4 magnetometer. The TM-4 is an array of four Geometrics™ model 822A "optically pumped" cesium vapor sensors coupled to a TM-4 magnetometer/data logger. Sensor separation will be 0.5 meter and sensor height will be approximately 0.5 meter. The raw sample rate will be 200 Hertz (Hz) to 0.05 nanotesla (nT) resolution. It is our understanding that Geometrics 858s sensors could be operated while not logging to data loggers. G-tek uses a TM-4 system that is configured so that it is immediately apparent to the geophysicist that the equipment is working properly and that it is collecting data on all sensors at all times. G-tek will run calibration grid at the beginning of the project each year. In addition, we have emplaced inert ordnance on approximately 30 percent of the grids. G-Tek will turn generate anomaly contour maps within 48 hours of data collection for review by MTARNG. If an emplaced round is missed, it will be apparent to~~

~~MTARNG immediately after reviewing G-tek's anomaly contour maps. See interactive portion of CD for a copy of G-Tek's set-up and calibration procedures.~~

~~As an added quality assurance measure, MTARNG will develop a form requiring G-Tek to certify, on a daily basis, that its equipment is working properly.~~

~~Certification records will be kept as part of the project records. One copy of the project records with the environmental office of the Montana Army National Guard and one copy with Tetra Tech EM office in Helena.~~

~~Positioning control for both technologies will be via cotton thread odometer between pre-survey control points (grid corners). Visual markers (sighting sticks) will be used to control cross line error. These markers will be moved along a tape at two-meter intervals as the survey progresses. The cotton survey thread will be tied off at the start of each line and will turn an odometer wheel attached to the TM-4 magnetometer array frame. As the thread turns the odometer wheel, an optical switch is triggered at fixed increments. This trigger will then be used to capture and record total magnetic intensity measurements at 10-centimeter intervals. Positioning will be achieved along a single axis. The second axis (typically the easting) will be provided by the non-metallic "chains" stretched perpendicular to the survey path to provide a constant positioning reference.~~

~~The EM instrument to be used by G-tek is a pulsed electromagnetic induction instrument referred to as the TM-4c (Minelab F1A4). The TM-4c is a single sensor coupled to a TM-4 magnetometer/data logger. Sensor elevation above ground is approximately 0.1 meter. Sampling rate was 70 Hz. The TM-4c was chosen because of its insensitivity to magnetite deposits and other geologic-based phenomena that are known to produce false alarms. A total of 28 grids were surveyed with EM 1in 1998. All 28 grids, were re-surveyed using a total field instrument so as to compare and contrast performance metrics.~~

6.1 CAPABILITIES AND LIMITATIONS OF DETECTION METHOD

The ~~TM-4~~quad-sensor cesium vapor magnetometer has ~~and the TM-4c have~~ detection capabilities that make ~~them~~ it well suited for the wide range of conditions present in the Limestone Hills. It should be emphasized that this site has very shallow soils over 90 percent of the area. ~~and that penetration depths have not exceeded 40 inches (center of mass depth) for any ordnance items validated to date.~~ Detection capability of the cesium vapor magnetometer has been empirically validated in the Limestone Hills on the smallest UXO expected (76mm HE) at a wide range of orientations and at the deepest depth expected given conditions and results from other sites with deeper soil. Calibration trials in the Limestone Hills with the magnetometer ~~TM-4~~ demonstrated the capability of the instrument to detect ordnance ~~(See interactive portion of CD for calibration results)~~. The magnetometer ~~TM-4~~ detected all items buried on the calibration grid and performed well against deep targets; for example, a 155-mm illumination round buried at 2.5 meters depth. The dipole fit for this deep emplaced round was 87 percent.

Limitations of the Device:

The cesium vapor magnetometer ~~TM-4~~ (like all total field magnetometers) is susceptible to false alarms due to iron-bearing rock and magnetite deposits. Between 5 and 10 percent of all geophysical anomalies validated were due to "naturally occurring false alarms" or "NOFA."

The ~~TM-4c or Emu~~EM-61 (a time-domain electromagnetic induction instrument) ~~will~~ may be used to discriminate between NOFA and ~~OE~~ MEC items as a quality assurance (QA) measure following validation. The ~~TM-4c~~EM-61 is virtually immune to geology ~~will~~ may be used as a QA check on anomalies suspected of being geologic in origin so as to ensure no UXO are left in the ground.

~~See interactive portion of CD to view technical Data for the TM-4 and TM-4c.~~

See interactive portion of CD for GTL Project Report No. PRCE 00107, August 2000, "Unexploded Ordnance Investigation Limestone Hills Area – Year 3" (appended).

6.2 QA/QC Standards and Criteria

This section describes MTARNG's quality assurance/quality control (QA/QC) procedures and pass/fail criteria and describes how emplacement of inert, intact rounds will be used as a QA/QC measure.

QA/QC Procedures and Pass/Fail Criteria

MTARNG will adhere to strict QA/QC procedures throughout this ~~OE~~ MEC clearance effort in accordance with the Montana Army National Guard titled "Quality Assurance Project Plan for Munitions and Explosives of Concern Activities in the North Helena Valley and Limestone Hills, Montana." The anomaly contour maps and raw data produced as a result of the geophysical survey will be reviewed and processed by an independent third party. If raw data and anomaly contour maps are found to be complete and the level of quality is high, MTARNG will go on to validation. If the data doesn't pass this review, the entire grid will be resurveyed.

During validation, MTARNG will also institute a series of pass/fail criterion. A grid will be resurveyed if any of the following conditions occurs: an emplaced anomaly isn't found during the geophysical survey, positional accuracy is in excess of one meter on more than two anomalies, or a large piece of fragmentation that is not noted by geophysical survey team. Individual anomalies suspected of being naturally occurring false alarms will be resurveyed using an electromagnetic induction device.

All of the anomalies on a grid that fall within the signal parameters of UXO will be noted on a dig sheet. The dig sheet is signed off by the UXO site technician and the UXO Site Supervisor ~~Site Safety Officer and Project Manager.~~ All data will be integrated into an Excel spreadsheet. Using Excel, we will run performance metrics for mismatches between amplitude and items that were actually found. We will also note anomalies with

large positional errors. These anomalies may be re-investigated. Once these QA checks are completed, we may also do a random resurvey of a percentage of the area.

All data collection and validation records will be maintained digitally. Copies of these records will be maintained by MTARNG and Tetra Tech.

Emplacement of Inert, Intact Rounds for QA/QC and Third Party Review

Emplacement or "seeding" is a simple QC measure that provides feedback on the ability of the geophysical survey and data processing to detect UXO. It also provides a quantitative assessment of the positional accuracy of the geophysical survey equipment under various field conditions. The validation team is also able to use this information to assess the positional accuracy of other anomalies in the grid. As a quality control measure, MTARNG will emplace expended, inert ordnance representative of the types of ordnance present in the Limestone Hills within 20 percent of all grids. Data documenting the round type and its location, depth, azimuth, and orientation will be accurately recorded in a field computer.

~~As a quality control method, MTARNG emplaced (buried) expended, inert ordnance on 62 of 87 grids surveyed in 1999 through 2001 as a measure of geophysical survey performance. These quality control measures were initiated in 1999, following the initial survey in 1998. This was done because the 1998 results indicated the site had a high potential to contain UXO and MTARNG wanted a direct and easy method to assess detection efficiency. These "seeded" rounds were of the same age, type and condition as the UXO found on the site in previous surface sweeps and were previously shown to exhibit the same signal parameters as actual UXO. Subsequent work by Billings et. al (See interactive portion of CD for 2002 UXO Symposium Proceedings, in press) indicate that the magnetic remanence of seeded rounds will be randomly oriented with respect to the Earth's inducing field while the remanence of actual or "undisturbed rounds" is more likely to be oriented parallel with the induced field. Thus the total field anomaly associated with seeded rounds is likely to be weaker and more difficult to classify than that associated with undisturbed rounds. A consequence of this finding is that detection of all the seeded items provides added assurance that all undisturbed items have also been detected. When intact/expended ordnance was found on the surface of a grid during the grid preparation phase, its position on the grid was recorded and the round was left as an additional QC measure.~~

~~Each QC ordnance item was buried at depths and orientations that we found to be the most realistic given the slope, aspect and soil type. Thirty of the emplaced QC rounds were 76mm projectiles. These projectiles were found to have the smallest magnetic response of the types of UXO suspected on the site. Average emplacement depth was approximately 25 cm (9.84 inches). The majority of orientations were unfavorable for easy detection (i.e., main axis of the projectile perpendicular to the earth's ambient field and positioned horizontal to the surface). Detailed measurements were recorded on each emplaced round on corresponding emplacement work sheets. Emplaced rounds were stamped or otherwise marked with a unique alphanumeric identifier as to avoid confusion~~

~~with non-emplaced projectiles recovered on the grid during the validation phase of the project in 2001. See interactive portion of CD to view emplacement worksheets.~~

~~G-tek detected and listed on the "dig" sheets all (100 percent) of our QC emplaced rounds as being within the signal parameters of UXO and therefore worthy of excavation. See interactive portion of CD for validation worksheets of emplaced rounds. In addition to listing on the dig sheet, G-tek provided a prediction of the anomaly. In two instances out of 62, G-tek incorrectly predicted an emplaced projectile to be "frag" or "junk." Both of the incorrectly classified rounds were 76-mm AP rounds of very low remnant magnetism. Both projectiles were emplaced nearly perpendicular to the ambient magnetic field and nearly horizontal in declination. This was the least favorable orientation of the projectile for detection. See interactive portion of CD to see a comparison of actual vs. G-tek's prediction for emplaced rounds over the 87 grids.~~

~~MTARNG proposes to use the same QA/QC process for survey activities conducted in conjunction with this project. In addition, MTARNG proposes to use a third party geophysical survey subcontractor to review the raw data for signal to noise and data gaps, including sensor drop-out.~~

6.3 PROCESS FOR DETERMINING THAT ~~OE~~ MEC SCRAP PRESENTS NO EXPLOSION HAZARD

MTARNG will determine that ~~OE~~ MEC scrap presents no explosion hazard in accordance with U.S. Army regulations. All ordnance-related scrap will be considered MPPEH. MPPEH will be inspected by a qualified UXO technician for any hazard prior to being disturbed to ensure that it is safe to move. MPPEH that is determined safe to move will be removed from field locations and transported to the MPPEH processing site for certification. All MPPEH will be processed and certified in accordance with DoD Instruction Document No. 4140.62 and the MTARNG MPPEH standard operating procedure to ensure that MDAS, MDEH, and cultural debris are segregated and properly certified prior to release. (see CD interactive portion of CD for DoD Instruction Document No. 4140.62 and the MTARNG MPPEH Management SOP with Attachments).

Fragmentation, shell bodies, etc. deemed to pose a potential explosive hazard or with internal cavities that cannot be inspected will be left on-site pending disposal action by EOD or an appropriately qualified contractor. The MPPEH processing site will be located adjacent to the MTARNG project trailer and conex for the LHTA UXO program at 452029.69E, 5125599.50N as shown on Q-D Map No. 3.
~~All items (UXO, OE scrap, junk, etc.) located on this site are inspected by an UXO technician for any hazards prior to being disturbed. The requirement to obtain information from most items located on the site and the small size of the teams ensures this requirement. The UXO Site Safety Officer enforces this requirement, one will be present during any and all operations conducted within the clearance area.~~

6.4 PROCESS FOR DEPOSITION OF ~~OE~~ MEC SCRAP

MTARNG will handle MEC scrap in accordance with DoD Instruction Number 4140.62 (see interactive portion of CD for this document~~All OE-related scrap (fragmentation, shell bodies etc) will remain on site and not be removed until certified by EOD as being free of explosive contaminants that present an explosion hazard.~~

~~It should be noted that the levels of fragmentation and OE-related scrap on the ridge is moderate to light in comparison to most impact areas. The east face of the ridge has the heaviest levels of fragmentation but these levels are still well below typical levels found on impact ranges. In the previous 5 years of survey activities at the Limestone Hills, it has been rare to find fragmentation, shell bodies, etc with visible explosives contamination. The consequence of this has been that we tend to find intact inert AP rounds or fragmentation that is free of residues that present explosion hazard; or we find UXO. We anticipate generating between 100 and 300 lbs of scrap per year at the current operational tempo.~~

~~We propose that all fragmentation, shell bodies, etc., encountered during clearance activity be handled one of two ways: (1) following inspection by the UXO Safety Officer (a licensed UXO technician) fragmentation, shell bodies, etc., deemed not to pose an explosion hazard will be containerized on site in a 55 gallon drum with a lock; and (2) fragmentation, shell bodies, etc., deemed a potential explosive hazard will be left in site pending disposal action by EOD. Before any OE scrap is removed from the area, it will be inspected again by an UXO/EOD technician and certified free of explosives hazards.~~

Site Access Control

~~Primary access to the site is controlled by the GW mine. All personnel must check in at the mine office, only personnel that have been given prior approval by either the SSO or the Project manager are allowed access. GW will contact the SSO or Project manager via radio if they feel that an individual may have justification to access the site. Personnel are held at the mine office until we arrive to escort or validate their need to access the site. Mine employees are required to contact the SSO or Project Manager for approval prior to entry into the exclusion zone. Unless escorted by the SSO or Project Manager, GW employees will never be allowed within the 450 foot buffer.~~

~~The alternative method of~~Primary access to the site is through the range complex. All access roads to the range are gated and locked. Limestone Hills training range procedures must be followed. There is a gate at the southern end of the ridge, this gate is also locked. The key for this gate is maintained by the Site UXO Supervisor (SUXOS) and the Project ~~m~~Manager. To gain access through this route the SUXOS or Project manager must come and unlock the gate.

While there are sometimes hikers in the area, the site is extremely remote and under an emergency closure by the U.S. Department of the Interior, Bureau of Land Management (BLM). Anyone accessing the area on foot would be trespassing.

7.0 ALTERNATE TECHNIQUES

The responding EOD team will make the decision on the proper disposition of ordnance items containing explosive or other hazardous fillers. The preferred destruction method is by detonation. If an item can be safely moved to the disposal area, MTARNG would prefer that it be transported and then disposed. If the EOD team prefers to attempt a Render Safe Procedure and then transport the item, this is authorized. If the preferred disposal of the encountered UXO is a method other than detonation (burning, for example), applicable precautions will be enforced. The EOD team chief will coordinate with the Senior UXO Supervisor and the Project Manager before attempting any EOD actions.

8.0 OFF-SITE DESTRUCTION

MTARNG does not anticipate conducting any off-site disposal activities. Because the clearance site is within the LHTA, transportation of explosive items to the disposal area would remain on range property. The LHTA is the only explosive disposal area in the state of Montana. If an item is encountered that requires unique disposal procedures outside of normal EOD capabilities, proper notifications through appropriate channel would be made.

9.0 TECHNICAL SUPPORT

Under the existing Memorandum for Understanding agreement between MTARNG and the Montana Air National Guard, the primary EOD assets will be the 120th EOD Flight of the Montana Air National Guard in Great Falls. In addition, the Fort Lewis EOD detachment has jurisdiction of the geographic area in which the LHTA resides and will be called upon if the Montana Air National Guard can not respond. The 341st EOD Flight from Malmstrom Air Force Base in Great Falls could be called upon if neither team could respond in a timely manner. In addition, MTARNG could request contractor support as a last resort, if required. MTARNG's prime contractor, Tetra Tech EM Inc., will provide a Senior UXO Supervisor, who will be the Site Safety Officer and control all field activities.

10.0 LAND USE RESTRICTIONS

The goal of the proposed ~~OE~~ MEC clearance is to clear all surface and subsurface ~~OE~~ MEC hazards on approximately 455.7~~277~~ acres. The MTARNG will institute the appropriate institutional controls in concurrence with DDESB based on the end use of the property and on the types of ordnance that are found within the area. If the end use is mining by GW, institutional controls will be established to augment safety. This will include safety briefings to GW personnel and distribution of UXO identification cards to individuals who may work in the area. Institutional controls may also include mounting special safety devices to mining equipment.

The MTARNG is in the process of a military land withdrawal of 18,644 acres of federal land within the Limestone Hills Training Area (LHTA). When completed administrative responsibility of all federal land within the LHTA will transfer from BLM to the Army for military training use by the MTARNG.
~~GW has indicated that they are willing to cede title to the DoD after completion of mining activities, if the area is mined.~~

11.0 PUBLIC INVOLVEMENT

MTARNG and BLM ~~are currently initiating an~~recently completed a legislative environmental impact statement ~~and~~ for a proposed "withdrawal" of the LHTA. As a result of this process, MTARNG and BLM ~~are~~ have worked~~ing~~ closely with the community. ~~To date,~~ MTARNG's contractor ~~has~~ conducted interviews with representatives of the community to obtain information on community concerns and to identify the best methods for communicating with the public throughout the process. Using information from the interviews, MTARNG and BLM developed a public affairs plan, which identified~~s~~ the steps that will be taken throughout this project to ensure public involvement.

12.0 MAPS

This section contains a regional map and several site maps and Q-D maps. Maps 1 through 4 are contained in the appendix and presented on the CD.

12.1 REGIONAL MAP

Map #1 (see interactive portion of CD) contains a regional map showing the location of the proposed project.

12.2 SITE MAP

This section contains a map (Map #2, Amendment ~~1~~2, see interactive portion of CD) depicting the ~~OE~~ MEC areas covered by the submission, the ~~OE~~ MEC removal depth, the location of any magazines used for storage of demolition explosives and/or recovered ~~OE~~MEC, the location of any planned or established demolition areas to be used to destroy recovered ~~OE~~MEC, ~~and~~ the planned use of the ~~OE~~ MEC area, and the MPPEH processing site location. Note that UXO removal depth is unrestricted. No magazines will be used for the storage of MEC recovered items or demolition explosives and ASPs are not planned for use in this MEC clearance.

12.2.1 ~~O~~MEC Areas Covered by Submission

As depicted in Map #2, Amendment ~~1~~2 (see interactive portion of CD), this is the only ~~OE~~ MEC area in the Limestone Hills currently planned for remediation.

12.2.2 ~~O~~MEC Removal Depth

The ~~O~~MEC removal depth for the ~~O~~MEC area is to the maximum depth of penetration. The limited soil depths are favorable to this outcome.

12.2.3 Location of Magazines

No magazines will be used for the storage of munitions, recovered ~~O~~MEC items, or demolition explosives. All explosive use will be conducted by MTARNG or Active Duty EOD teams. When an item is located that contains an explosive or chemical filler, the EOD team will be requested. They will bring what they will need at the time of response. Any excess will return with the EOD team. Any ~~O~~MEC item that contain explosives or chemical fillers will remain where it was found until an EOD team arrives and disposes of it.

12.2.4 Location of Demolition Areas

The established demolition area is located in the live impact area (Map #2, Amendment ~~1~~2, see interactive portion of CD); this area is currently used by the MTARNG and active duty units for demolition, training, and disposal activities. The Limestone Hills Training Range regulations will apply when using this site. If an item is located that cannot be safely transported to the demolition area, it will be disposed of on site. The 2,894~~600~~ feet exclusion zone for disposal operations will be enforced.

12.2.5 Existing or Planned Use of ~~OE~~ MEC Area After Clearance

The planned use of the ~~OE~~ MEC area after the clearance is open pit mining. Current mine planning is to remove the top soil from the site, using explosives, bulldozers, front-end loaders and dump trucks and dump it in the mine dump area. Once the ore is exposed it will basically be extracted in the same method as the top soil removal and~~,~~ the only difference is that it will be hauled to a crusher, and run through a kiln. See interactive portion of CD for an aerial photograph of GW's current mining operation.

12.3 Q-D MAPS

Maps #3, Amendment ~~1~~2 and #4, Amendment ~~1~~2 (see interactive portion of CD) contain Q-D maps scaled at 1 inch equals 400 feet. These maps depict~~s~~ the ~~OE~~ MEC area being cleared under this submission (Map #3, Amendment ~~1~~2), the location of magazines (Map #3, Amendment 1), and areas planned or established for detonation or burning of ~~OE~~ MEC (Map #4, Amendment ~~1~~2).

12.4 SOIL SAMPLING MAPS

The LHTA does not contain areas with explosives in soil. As a result, MTARNG did not conduct the soil sampling activities specified in Section 10.12.3.4 in Data Item Description OT-060.

13.0 QUANTITY DISTANCE

Two maps are required to show all the quantity distance requirements. Map #3, Amendment ~~1~~2 (see interactive portion of CD) shows all of the requirements for the ~~OE~~ MEC clearance site. Map #4, Amendment 2 (see interactive portion of CD) shows the Q-D requirements for the established demolition area.

13.1 ~~OE~~ MEC AREA

Map #3, Amendment 1 (see interactive portion of CD) shows the OE clearance area for this submission. It is the only area currently planned for clearance. The required distance for protection of personnel from intrusive operations is based on 450 feet MGFD for the ~~the "range" to no more than 1 hazardous fragment per 600 square feet. This distance is 450 feet for the MPM, the~~ 155mm HE M107 (Comp B) round. This distance is based of fragmentation data review forms as revised on 10/18/11. ~~This distance was previously calculated in conjunction with other projects by Huntsville Engineering and Support Center. Calculations were performed IAW DDESB approved "Method for Calculating Range to No More than One Hazardous Fragment per 600 Square Feet," January 1998 (see interactive portion of CD).~~

13.2 MAGAZINES USED TO STORE DEMOLITION EXPLOSIVES OR RECOVERED ~~OE~~ MEC

No magazines will be used to support this project. ~~OE~~ MEC items recovered during clearance will be left in place until an EOD team responds to and disposes of the items. EOD teams will bring the required explosives when they respond.

13.3 EXTERNAL POTENTIAL EXPLOSION SITES

The location of the ~~closed~~ new explosive transfer and storage location is depicted on Map #3, Amendment ~~1~~2 (see interactive portion of CD) (labeled as Ammunition Holding Area [AHA]). The AHA is DDESB Site-Approved for the hazard class/divisions and NEW limits shown on Map 3, Amendment 1. The MEC clearance area covered by this amendment is outside the approved inhabited building distance (IBD) arc of this AHA. DDESB approved the AHA siting via DDESB-KO Memorandum, 20 February 2004, Subject: Resubmittal for Approval of Explosives Safety Site Plan for the Ammunition Holding Area (AHA), Limestone Hills, MT (EST File Number 1718) (see interactive portion of CD). ~~This facility has been closed by the safety office and is not used to support training operations at Limestone Hills. This facility does not effect the execution of the clearance operation in any way.~~

13.4 PLANNED OR ESTABLISHED DEMOLITION AREAS

The established demolition area is depicted in Map #4, Amendment ~~1~~2 (see interactive portion of CD). This area is the disposal location for all ~~OE~~ MEC items that are determined acceptable to transport by the responding EOD team. The demolition area exclusion zone is 4,000 feet. Access is under control of range control personnel. The established 4,000 foot exclusion zone exceeds the maximum case fragment range of 2,894~~600~~ feet for the MGFD~~PM~~, the 155mm M107 HE (TNT-filled) projectile (click here to see a copy of relevant fragmentation data review forms~~Table C.5.T.3, DoD 6055.9-STD see interactive portion of CD~~). If multiple rounds are detonated in a consolidated shot, then the DDESB approved "Procedures for Demolition of Multiple Rounds (Consolidated Shots on Ordnance and Explosives (OE) Sites," August 1998 see interactive portion of CD) will be used to control interaction effects among projectiles to ensure the fragment range remains within 2,894~~600~~ feet. For protection from blast, the NEW limit of each shot is limited to an amount commensurate with 2600 feet. Using the blast formula for intentional detonations Distance in Feet "D" = 328 times the Cube Root of the net explosives weight "W" (D = 328 W**1/3), the NEW limit for each shot shall not exceed 498 lbs.

13.5 INTENTIONAL DETONATIONS IN THE ~~OE~~ MEC WORK AREA

Items discovered within the ~~OE~~ MEC area that are deemed unsafe to move will be disposed of on-site. They will not be consolidated in the ~~OE~~ MEC work area but will be individually detonated. An exclusion zone for intentional detonations of 2,894~~600~~ feet has been established around the entire ~~OE~~ MEC clearance area (see interactive portion of CD to view Map #3, Amendment 1). This exclusion zone is established by fragmentation data review forms dated 10/18/11. ~~table C5.T3 of DoD 6055.9-STD, Maximum Case Fragment Range for Selected Single Item Detonations (M107, 155mm projectile, 2,580 feet). The closest inhabited building located to the OE clearance area is the Limestone Hills Training Range Tower. Although tThis tower is located outside ofwithin the OE intentional detonation exclusion zone; it is depicted in the Q-D Map #3, Amendment 1 (see interactive portion of CD).~~

There are two possibilities for occupied areas: the Graymont Western active mining location and personnel conducting training on the Limestone Hills training site. For intentional detonations, coordination will be established between the Site Safety Officer, Training Site (Range Control) and Graymont Western. During this coordination, the time frame for personnel withdrawal and safe withdrawal locations will be established. The ~~O~~MEC clearance team has continuous radio contact with both Graymont Western and Training Site. The MTARNG Site Safety Officer will ensure that Training Site and Graymont Western personnel are clear of the exclusion zone prior to allowing EOD to conduct any disposal operation. Inside the 2,894~~600~~ exclusion zone, we will not have concurrent activities. One low density p~~P~~ublic transportation route resides within the 2,894~~600~~ foot exclusion zone. This route will be closed to traffic during on-site disposal operations~~s do not reside within the exclusion zone~~. This area is closed to public access due to a BLM emergency closure of the area.

13.6 FOOTPRINT AREAS

(see interactive portion of CD to view Table 1)

APPENDIX

Maps 1 through 4