CESPK-DE 29 September 2000

Memorandum for Record

Subject: Recommendations for Minimum Separation distances (MSD) for Tourtelot OE Removal Action, Former Benicia arsenal.

Summary: A technical evaluation of the Most Probable Munitions (MPM) and Minimum Safe Distance has been completed based on the latest available information, and the guidance that would apply if the Corps of Engineers were conducting the work as a Formerly Used Defense Site (FUDS). Guidance applicable to OE removals at FUDS sites includes guidance from the Department of Defense (DOD), Department of Army (DA), U.S. Army Corps of Engineers (USACE) and Corps Huntsville Center (HNC). The analysis and findings would be applicable to Sectors 3A and 3B that were recommended for a removal action in the Engineering Evaluation/Cost Analysis (EE/CA) prepared by HNC for the FUDS program.

We have identified the appropriate MPM and MSD for each of the work areas within Sectors 3A and 3B that the Corps of Engineers would use if it were executing the removal action. These are based on an un-armed 37 MM projectile and an un-armed 60 MM Mortar.

The City of Benicia is planning to do additional actions outside the areas recommended for removals in the EE/CA. These areas do not fall within the normal Corps of Engineers OE removal categories and the normal MSD definition process would not be applicable.

However, if the removal action in the EE/CA Sector 3A or Sector 3B removal areas resulted in finding live ordnance items at the edge of the planned removal areas, the normal Corps of Engineers procedure would be to incrementally expand the removal action into the adjacent area until no further OE items are located. During the search for OE items in such an expansion area, the MSD for the MPM in the adjacent Sector A or Sector B area would continue to be used.

The role of CESPK in these efforts is limited to that of providing guidance, technical reviews, site support, and advice to the City of Benicia as described in the MOA with the City of Benicia. Approval of work plans and the adoption of appropriate MSD will be up to the authorities responsible for conducting the OE removal and approving the actions.

Technical Evaluation: In Sector 3A, a 60 MM mortar has been identified as the MPM, and would have a fragmentation distance of 1080 feet. Since the munitions are not likely to be fuzed and armed, it would be appropriate to a 1 Hazardous Fragment in 600 Square Feet MSD with a minimum separation distance of 200 feet.

The prior Demolition area portions of Sector 3A Sector 3B is an area that has identified a 37 MM projectile as the MPM. A radius of 1250 feet from the demolition pit has been used to define the potential kick-out area from the pit. The 37 MM projectile has a fragmentation distance of 1181 feet. Since the munitions are not likely to be armed, it would be appropriate to a 1 Hazardous Fragment in 600 Square Feet MSD with a minimum separation distance of 234 feet.

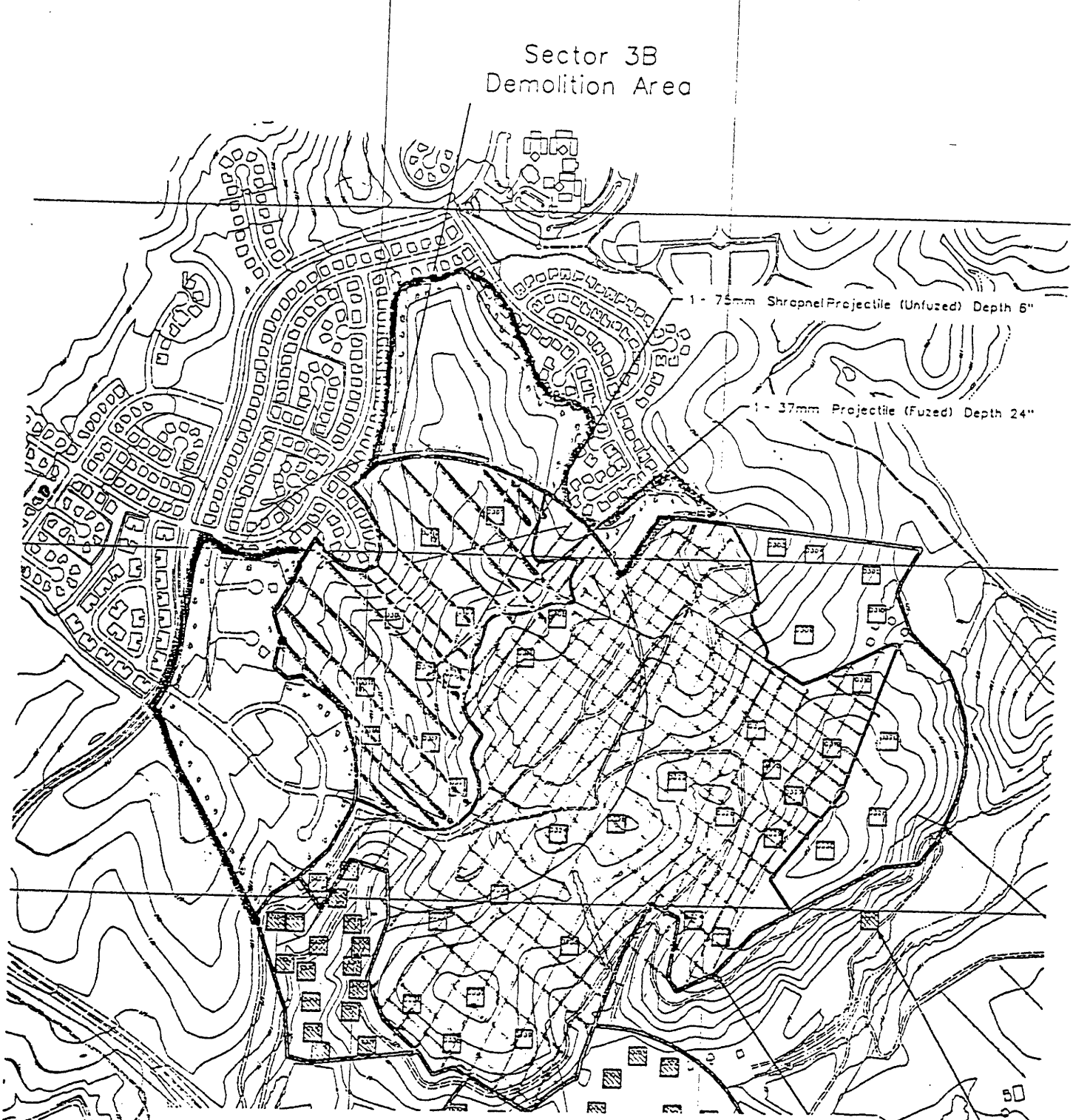


FIGURE 1. Most Probable Munitions (MPM) and Minimum Separation Distance(MSD) for Tourtelot Property, Sectors 3A and 3B.

KEY

...37 MM projectile MPM, 1 Hazardous Fragment in 600 Sq. Feet. MSD = 234 Feet

...60 MM mortar MPM, 1 Hazardous Fragment In 600 square Feet MSD = 200 Feet

...Additional DTSC Areas, use incremental
OE Expansion from Edge of EE CA Sector Area
Live OE at edge MSD same as edge of EE CA Sector

TRANSMITTAL SHEET

US Army Corps
of Engineers
Sacramento District

RECEIVED BY
CITY ATTORNEY'S OFFICE
DEC 20 2000
CITY OF BENICIA

DATE: 18 December 2000

TO: Heather McLaughlin
City of Benicia
250 East L Street
Benicia, CA 94510

PROJECT: Benicia Tourtelot Cleanup Project
CONTRACT NO: NA
INSTALLATION: Benicia Arsenal

THE ENCLOSED DOCUMENTS ARE BEING TRANSMITTED TO YOU FOR:

[X] COORDINATION [X] INCORPORATION [] INFORMATION

DOCUMENTS ENCLOSED:

1. Responses to DTSC's follow-up questions (email dated 18 October 2000) on USACE Memorandum For Record dated 29 September 2000. Subject: Recommendations for Minimum Separation Distance for Benicia Tourtelot OE Removal Action.

REMARKS:

Heather,

Attached are the USACE responses to DTSC's follow-up questions on the 29 September 2000 Memorandum for Record, Subject: Recommendations for Minimum Separation Distances for Tourtelot OE Removal Action. Please note that I have forwarded a copy of the attached Memorandum for Record to Stewart Black of the DTSC. Please forward to any interested parties.

If you have any questions regarding these responses, please call me at (916) 557-7906.

Bruce

cc: John Esparza, Technical Team Lead
Stewart Black, Project Manager, DTSC

If enclosures are not as listed, please notify us at once.

FROM: Bruce Handel
Project Manager

CESPK-PM-H
1325 J Street
Sacramento, CA 95814-2922
Tel: (916) 557-7906
Fax: (916) 557-7885

CESPK-PM-H (200a) 15 December 2000

MEMORANDUM FOR RECORD

SUBJECT: Response to follow-up questions (transmitted via email on 18 October 2000) on the 29 September 2000 Memorandum for Record, Subject: Recommendations for Minimum Separation Distances (MSD) for Tourtelot OE Removal Action, Former Benicia Arsenal.

1. REFERENCES:

a. DOD 6055.9-STD, DOD Ammunition and Explosives Safety Standards, July 1999.

b. Memorandum of Agreement (MOA) between the City of Benicia and the U.S. Army Corps of Engineers, District, Sacramento, February 1999.

c. HNC-ED-CS-S-98-1, Methods for Predicting Primary Fragmentation Characteristics of Cased Explosives, January 1998.

d. HNC-ED-CS-S-98-2, Method for Calculating Range to No More than One Hazardous Fragment per 600 Square Feet, January 1998.

e. Memorandum of Record, United States Army Corps of Engineers (CESPK-DE), 29 September 2000, subject: Recommendations for Minimum Separation Distances (MSD) for Tourtelot OE Removal Action, Former Benicia Arsenal.

f. Memorandum, United States Army Corps of Engineers (CEHNC-OE-CX), 02 March 2000, subject: Determination of Appropriate Safety Distances on Ordnance and Explosives (OE) Project Sites, OE Center of Expertise (CX) Interim Guidance Document 00-01.

g. Draft Work Plan for the Ordnance and Explosive Removal Actions, Sectors 2, 4 and 5, Former Benicia Arsenal, Benicia, CA, July 2000. Prepared by EODT on behalf of the U.S. Army Engineering & Support Center, Huntsville, Alabama.

h. Draft Remedial Investigation/Feasibility Study, Toutelot Cleanup Project, Benicia, California, November 16, 2000. Prepared by Earth Tech.

2. ATTACHMENTS:

A. United States Army Corps of Engineers, CEHNC-ED-CS-S, calculations of Minimum Separation Distances, 60 mm M49A3, 3 April 2000.

B. United States Army Corps of Engineers, CEHNC-ED-CS-S,

c. Areas of Concern. The analysis and findings originally presented would be applicable to Sectors that were recommended for a removal action by the USACE; Sectors 3A and 3B were recommended for a removal action by the USACE in the Engineering Evaluation/Cost Analysis (EE/CA) prepared under the FUDS program.

It is understood that OE/UXO investigation and removal activities may extend outside of Sector 3A and 3B. Furthermore, as originally outlined in reference (e), and as provided in attachment (e), USACE has established methods and procedures to address expansion (and/or reduction) of the area of concern; during the search of OE items in such an expansion area, the MSD for the MPM in the adjacent Sector A or B area would continue to be used (see figure 3 of attachment (e)). In general however, the minimum separation distance may be reduced to fit the situation but in no case will the minimum separation distance be less than the range to no more than 1 hazardous fragment per 600 square feet, 200 feet, or K50 based on overpressure, whichever is greater (reference (f)).

Under the aforementioned EE/CA, the USACE did not recommend a removal action at the D-1 Area, western portion of the south valley, the entire North Valley, the Ridge areas and/or surrounding community. Theses areas are identified under the on-going OE RI/FS and the USACE are providing recommended MSDs at the request of the City of Benicia (See attachment (e)).

4. POINTS OF CONTACT: If you need additional information, please contact Mr. AR Smith at 916.557.6973 or Mr. Bruce Handel at 916.557.7906, Project Manager, CESPK-PM-H.

cc: Project File

ATTACHMENT A

Minimum Separation Distances
Ft. Ord
60 mm M49A3
3 April 2000

REQUESTED BY: Patti Berry
PREPARED BY: Michelle Crull, PhD, PE

This form shows calculated distances only. It does not constitute approval. Concurrence of CEHNC-OE-S is required to determine the applicable distance for a specific site.

In accordance with (IAW) OE Center of Expertise Interim Guidance Document 98-08, use of the range to no more than 1 hazardous fragment/600 sq ft as the minimum separation distance for accidental detonations requires written justification, a risk analysis, calculation of this distance by CEHNC-ED-CS-S, and concurrence of CEHNC-OE-S.

CALCULATIONS FOR UNINTENTIONAL DETONATIONS

Maximum Fragment Range = 1080 ft
Range to No More Than 1 Hazardous Fragment/600 sq ft = 200 ft
Range to 0.9 psi Overpressure = 42 ft

IAW OE Center of Expertise Interim Guidance Document 98-08, the minimum separation distance for intentional detonations may not be less than the default distance provided in DoD 6055.9-STD or the maximum fragment range or the K328 overpressure distance.

CALCULATIONS FOR INTENTIONAL DETONATIONS

Maximum Fragment Range = 1080 ft
K328 Overpressure Range = 277 ft

The primary fragmentation characteristics used in the calculation of the values listed above were computed IAW CEHNC-ED-CS-S-98-1. The maximum fragment range was calculated using the maximum weight fragment and the initial velocity from these characteristics in the computer software TRAJ. The range to no more than 1 hazardous fragment/600 sq ft was calculated IAW CEHNC-ED-CS-S-98-2.

SIGNATURES:

Michelle Crull 4/3/00
Subject Matter Expert

William H. Robinson Jr. for
CEHNC-ED-CS-S Branch Chief

ATTACHMENT 4

Public Withdrawal Distance (PWD)
Camp Beale, California
31 August, 1999

MUNITION: 37 mm MKII
REQUESTED BY: Bill Sargent
PREPARED BY: Douglas E. Grant, P.E.

This form shows calculated distances only. It does not constitute approval. Concurrence of CEHNC-OE-S is required to determine the applicable distance for a specific site.

In accordance with (IAW) OE Center of Expertise Interim Guidance Document 98-08, use of the range to no more than 1 hazardous fragment/600 sq ft as the PWD for accidental detonations requires written justification, a risk analysis, calculation of this distance by CEHNC-ED-CS-S, and concurrence of CEHNC-OE-S.

ACCIDENTAL DETONATIONS

Maximum Fragment Range = 1181 ft
Range to No More Than 1 Hazardous Fragment/600 sq ft = 200 ft
Range to 0.9 psi Overpressure = 43 ft

IAW OE Center of Expertise Interim Guidance Document 98-08, the PWD for intentional detonations may not be less than the default distance provided in DoD 6055.9-STD or the maximum fragment range or the K328 overpressure distance.

INTENTIONAL DETONATIONS

Maximum Fragment Range = 1181 ft
K328 Overpressure Range = 282 ft

The primary fragmentation characteristics used in the calculation of the values listed above were computed IAW CEHNC-ED-CS-S-98-1. The maximum fragment range was calculated using the maximum weight fragment and the initial velocity from these characteristics in the computer software TRAJ. The range to no more than 1 hazardous fragment/600 sq ft was calculated IAW CEHNC-ED-CS-S-98-2.

SIGNATURES:

Douglas E. Grant
Subject Matter Expert

William H. Pohl Jr. 1 Sep 99
CEHNC-ED-CS-S Branch Chief

ATTACHMENT C[1]

DATE	PROJECT NAME	17600 DISTANCE	MPM
11 Jan 98	Camp Grant	219	3" Stokes
05 May 98	Castner	341	105 mm
15 Jul 98	Camp Bonneville	341	105 mm
13 Oct 98	Benicia - Ordnance Bunkers	400	MK II Grenade
13 Oct 98	Benicia - Revetment Area	200	37 mm
14 Oct 98	Fort Dix - Correctional Facility	234	81 mm
22 Jan 99	Panama - Ranges 7, 7A, 8 and 10	341	105 mm
19 Feb 99	Duck	302	2.75" rocket
26 Feb 99	Camp Grant	219	3" stokes
04 Mar 99	Spring Valley - OU3	200	75 mm Mk II
29 Apr 99	Jefferson Proving Grounds - Sulfur Area	341	105mm
24 Jun 99	Illinois Ord Plan	200	M1A1 AT Mine
06 Jul 99	Brooksville-Rocket Range	200	2.36" rocket
06 Jul 99	Brooksville- Mortar Range	234	81 mm
10 Sep 99	Mallinckrodt - Stockpile 2	310	100 lb parrot
15 Sep 99	Ft. McClellan - Eastern Bypass	200	60 mm
15 Oct 99	Papohaku	302	2.75" rocket
19 Oct 99	Nansemond - Tidewater Community College	200	No Ordnance
29 Oct 99	Nansemond - Area O	361	4.5" rocket
08 Feb 00	Nansemond-anomaly investigation	200	No Ordnance
11 Feb 00	Camp Ellis - Area B	200	60 mm
14 Mar 00	Conway-Ranges IV & VII	275	20 lb Frag Bomb
16 Mar 00	Guam	299	5"/38 cal
05 Apr 00	Hohenfels	250	90 mm
06 Apr 00	Ft. Benning	400	Mk II Grenade
19 Apr 00	Nansemond - Area O and Kick Out Area	361	4.5" rocket
20 Apr 00	CQS	200	No Ordnance

[1]U.S. Army Corps of Engineers, Ordnance and Explosive (OE) Design Center, Huntsville, CEHNC-OE-DC. Data is current through April 2000.

ATTACHMENT D

Response to Follow up Questions on the U.S. Army Corps of Engineers Recommended Minimum Separation Distance (MSD) for Ordnance and Explosives (OE) Removal Actions at the Tourtelot Site, Benicia, California.

DTSC has reviewed Colonel Walsh's letter and the attached Memorandum for Record and have the following questions and request for additional information:

General Comments/Questions

1. The map contained in the Memorandum for Record is unclear as to which MSD should be used in the areas where Sectors 3a and 3b overlap. Please clarify which MSD should be used in the overlap areas.

Response: To further clarify the MSDs, the single map contained in the 29 September 2000 MFR has been replaced with three separate color-coded maps (figure 1, 2, & 3). The maps reflect a MSD of 200 feet for Sector (3a) and Sector (3b). The original MSD Memorandum For Record (MFR) of 29 September 2000 has been revised by adding the three figures (see attachment (e)).

2. The ACOE has been involved in project meetings and is aware that the proposed OE/UXO scanning and clearance activities for the Tourtelot project extend outside of Sector 3a and 3b. However, the ACOE has not provided an approved MSD for a significant portion of the Tourtelot site targeted for OE/UXO investigation/remediation. Please provide DTSC with the ACOE approved MSD for UXO/OE clearance work to be performed on the entire Tourtelot Site including the D-1 Area, western portion of the south valley, the entire North Valley, the Ridge areas and surrounding community (if needed).

Response: A detailed response has been provided under section 3(c) of the 11 December 2000 MFR.

3. It appears that the MSD for remediation of TNT at the site has not been included in the this evaluation, as previously requested. Please provide this information.

Response: The USACE acknowledges DTSC's previous request for a MSD for remediation of TNT strips located at the Tourtelot site,

The USACE has recently received the information necessary to calculate the net explosive weight under reference (h). Also, the USACE-SPK has just received the necessary guidance to calculate an MSD for this situation. The calculations are currently being developed and will be provided to the City of Benicia at a later time under separate cover.

4. Please provide DTSC a copy of the color maps (including any necessary revisions as requested in 1, 2 and 3 above) identifying the MSD locations. It is difficult to understand the maps in black and white.

Response: See response to comment number 1 above.

5. It is unclear how the ACOE has established the approved MSD contained in Colonel Walsh's letter. Please provide the supporting documentation and calculations for the use of the "Range to No More Than One Hazardous Fragment per 600 Square Feet" calculation. Please include a list of similar projects which have been successfully completed using an MSD calculated using the reduced "Range to No More Than One Hazardous Fragment per 600 Square Feet" calculation recommended for the Tourtelot site. Also, please include the number of accidents that have occurred when clearing OE on similar sites?

Response: Supporting documentation and associated calculations have been provided (see attachment (A) and (B)). See attachment (C) for projects that have been successfully completed using a reduced 'Range to no more than one hazardous fragment per 600 square feet' MSD.

A survey of reported accidents that have occurred when clearing OE while employing a 'Range to No More Than 1 Hazardous Fragment per 600 square feet' MSD has been completed by U.S. Army Corps of Engineers, Ordnance and Explosives (OE) Design Center, OE Safety Office (CEHNC-OE-S). There have been no reported accidents involving OE clearance operations while employing a 1/600 MSD (see www.hnd.usace.army.mil).

6. Please explain how the recent discovery of a potentially live mortar, tail fin section has been addressed in the MSD calculations. The tail fin was discovered well outside of the 1250' radius suggested by the ACOE. What impact, if any could this discovery have on the calculations and recommendations provided by the ACOE.

Response: Under USACE procedures if during the design stage of a UXO/OE removal or investigation project new information is discovered, this information is assessed and modifications to the design incorporated as required. The process of managing and acting upon new information is further refined during field execution. USACE regulations governing execution of UXO/OE removal or investigation projects, require that information on the number, type and condition of UXO/OE encountered is assessed daily and acted upon immediately if necessary.

On December 5, 2000 the USACE provided a detailed response to Benicia City Attorney concerning the recent discovery of the tail fin. Any questions or concerns posed by the DTSC that are not addressed in the December 5, 2000 response should be addressed in the Tourtelot RI/FS document (reference (h)) as required by the DTSC Order No. I/SE 98/99-011.

Specific Questions

7. Page 1: Under the <u>Summary:</u> section; paragraph 2. Indicates that the appropriate Most Probably Munition (MPM) for Sector 3a and 3b are an un-armed 60 MM mortar and an un-armed 37 MM projectile, respectively. Please provide documentation to confirm that the 60 MM Mortar found in Sector 3a should be classified as un-armed and was not primed, fuzed and/or fired. Information available to DTSC also indicated that the 60 MM mortar that was found was a high explosive (HE) round. Please confirm that a 60 MM HE mortar was used as the MPM to determine an appropriate MSD in Sector 3a. The map contained in the Memorandum for Record indicates that the 37 MM projectile found in Sector 3b was fuzed. Please provide the justification used by the ACOE to classify this ordnance as un-armed when determining the appropriate MSD for Sector 3b.

Response: The key concept that must be understood by all parties is the impact of classifying an item as 'un-armed' versus 'armed' and the use of the 'Range to No More Than 1 Hazardous Fragment per 600 square feet'.

If an item is classified as 'armed', then the use of 'Range to No More Than 1 Hazardous Fragment per 600 square feet' is not an option under Department of Army regulations. If however, the item is classified as 'un-armed' the option to use the 'Range to No More Than 1 Hazardous Fragment per 600 square feet' is still available.
Whether the item is 'fuzed' is not considered when deciding to

assess the 'Range to No More Than 1 Hazardous Fragment per 600 square feet' option. Moreover, the 37 mm projectile has an internal fuze and must be considered 'fuzed' under normal USACE procedures; hence the identification of 'fuzed' in the MFR map.

The USACE, Ordnance and Explosive Design Center, Structural Branch (CEHNC-ED-CS-S) employed 'latest available information' and professional judgment to classify the MPM of a 37 mm projectile and 60 mm mortar as 'un-armed'. The justification to assign this classification is based on:

(a) The item likely originated from a demolition pit and under normal demolition procedures the item would have to be 'un-armed' in order to allow movement of the item to a demolition pit location; and

(b) The lack of historical records to indicate live fire (i.e. range activity) ever occurred at the Benicia Arsenal.

The USACE acknowledges that information about the 60 mm mortar round indicated that it was a high explosive (HE). USACE also confirms the 60 mm mortar HE was used as the MPM for Sector 3a.

Note: See Attachment (A) and (B) and reference (a) for a detailed description of the relationship between 'Maximum Fragment Range', 'Range to No More Than 1 Hazardous Fragment per 600 square feet', 'Range to 0.9 psi Overpressure' and 'K328 overpressure distance'.

8. Page 1: Under the <u>Summary:</u> section; paragraph 5. Please refer to the Imminent and/or Substantial Endangerment Determination and Remedial Action Order issued by DTSC for the Tourtelot Property on June 1, 1999. The United States Department of the Army is jointly and severally responsible for carrying out all actions required by the order. The CESPK has been attending project meetings, providing technical direction and acting as the official representative of the United States Department of the Army on all aspects of the Tourtelot project. In this capacity CESPK has assumed a much broader scope of responsibility in the Tourtelot matter then just advisor to the City of Benicia. This responsibility includes, but is not limited to the safety of personnel working at the site and public safety of area residents.

Response: A question or comment was not provided. If the reviewer intended to pose a question or comment please revise

accordingly. Please note however, the USACE respectively request that any correspondence related to this subject be forwarded directly to the USACE, Sacramento District Legal counsel.

9. MSD - Please provide the supporting calculation for the MSD in both Sectors 3a and 3b. The 200' MSD appears to be a default value.

Response: Again, the reviewer is referred to Attachment (A) and (B) for supporting calculations. As outlined in reference (f), MSDs smaller than 200' are not allowed under USACE regulations, even though calculations may reflect shorter distances (also see reference (a)).

10. Page 1: Under the Technical Evaluation: section; paragraph 2. Please define what you mean by, "A radius of 1250 feet from the demolition pit has been used to define the potential kick-out area from the pit". Specifically what does the phrase "potential kick-out area represent" mean. Also please define why only one pit has been used to defined the 1250' kick-out when four demolition pits have been identified.

Response: The Technical evaluation has been revised by focusing the discussion on the MPM for each Sector rather than sub-areas within a Sector. The 11 December 2000 MFR reflects this change.

Note: the 1,250-foot distance was employed during the approved EE/CA investigation. We knew little about the type of ordnance that was used at the demolition site so we selected the 1250 default distance as a reasonable distance for limiting our Sector size. This may or may not be an appropriate distance for a removal action, but the solution is to expand the clearance area if we're still finding ordnance at the limits of the area.

Potential kick-out area means an area around the demolition pit within which we would expect to find kick-outs of live ordnance from detonations. The analysis focused on the 'worst case' or largest demolition pit; this is consistent with UXO/OE removal operations where 'worst case' areas would be addressed prior to other areas within the Sector. Moreover, the other 4 demolition pits are in close proximity to the primary pit.

11. Page 2: Conclusions and Recommendations: Item number 2. Please define qualitatively and quantitatively the increase risk to the public identified in the statement; "The

reduction to a 1 Hazardous Fragment in 600 Square Feet MSD is an increase risk to the public that must be assumed by those officials approving the adoption of this reduced MSD".

Response: Determining, quantitatively, the risk from unintentional and intentional detonations is a major challenge to the Department of Defense including the Department of Army. Reaching consensus on the methods, procedures and fundamental assumptions of a quantitative risk assessment is an on-going National effort and major focus of the Department of Defense, regulatory agencies and stakeholders. While much progress has been made in this area, a quantitative answer cannot be provided at this time.

Qualitatively, the risk at maximum fragment distance is minimal (less than 1 percent probability), whereas at the 1/600 distance there's a 1 percent probability of a person in the open being struck by a hazardous fragment (see Reference (a) for additional detail).

12. Page 2: <u>Conclusions and Recommendations:</u> Item number 2. Additional information which will be required to understand the increased risk to the public include:
    1. What is the underlying assumption for choosing the 1 hazardous fragment in 600 square feet as an acceptable risk?

Response: As discussed earlier, the use of professional judgment lead to the underlying assumption that the items are unfired and therefore un-armed.

Reference (a) further discusses the development of, and criteria for, a 'Range to No More than 1 Hazardous Fragment per 600 Square Feet (1/600 Distance)'.

    2. Has the Army used this calculation as the basis for an MSD in other cleanup sites near civilian residential areas?

Response: See attachment (C) for projects that have been successfully completed using a reduced 'Range to no more than one hazardous fragment per 600 square feet' MSD.

    3. Please be sure to include a table to illustrate how the risk will vary with change in distance from the detonation point. For example if the MSD is 234' what

is the risk to an individual standing at 235' from the detonation or at 200', 300', 400'...

Response: See response to question 11 and the following table is provided.

Table 1
QUALITATIVE RISK VERSUS
DISTANCE AWAY FROM DETONATION POINT[1]

Detonation Point	1/600 Distance	Maximum Fragment Distance
Point Removal of OE	Increased Risk. A person (6 ft tall, 1 ft wide) taking no evasive action has a 1% probability of being struck by a hazardous fragment	Minimal risk. A person (6 ft tall, 1 ft wide) taking no evasive action has less than a 1% probability (but not zero) of being struck by a hazardous fragment

[1] Source: DOD 6055.9-STD, DOD Ammunition and Explosive Safety Standards, July 1999.

4. Also please provide information on fragment velocity and striking energy at the select distances included in the table. Since these figures will be somewhat technical please provide an example and/or illustration of what each fragment velocity and striking energy means in laymen's terms.

Response: Striking energy is related to fragment mass and velocity ($E=1/2\ mv^2$). Velocity is dependent on distance traveled and the drag coefficient. The drag coefficient is dependent on fragment weight, shape and velocity.

A hazardous fragment is one with a striking energy of 58 ft-lbs. The 58 ft-lbs criteria was approved by DDESB in April 1971 and is based on a report by the Medical Department of the Army using empirical data from WWI, WWII and the Korean war as well as experimental test data (reference (a)).

In laymen's terms, a 20 lb. bowling ball dropped on your foot from 3 feet high will impact with 60 ft-lb of energy and thus deliver the energy of a hazardous fragment. Figures may be developed upon request of the City of Benicia.

13. Page 2: **Conclusions and Recommendations:** Item number 3. Although a recommendation is made "that the public be made aware of the MSD and the additional hazards." Through our discussions with ACOE representatives it appears the Department of Defense has used the approach of smaller MSD's at other sites. Has the Department of Defense found an effective way to make the public aware of this increased risk. The Arsenal appears to be poised to use the same reduced MSD's. How is the Corps going to make the public aware of the use of the smaller MSD and the associated increase risk to them, including those areas adjacent to highway 680.

Response: For the work the Corps of Engineers is executing under the FUDS program, the method and procedures to inform the public are outlined Section 2.8 of Reference (g). The document is currently under review with DTSC and scheduled to be finalized January 01. In addition, and under the FUDS program, the USACE is developing a Community Ordnance and Explosive Safety Program, which will be presented to the Benicia City Council on 16 January 2001.

The planned method and procedures, augmented by risk communication techniques, have proven to be an effective way to communicate risk to the public.

It is anticipated, for the work executed under the Tourtelot project, the method and procedures to inform the public will be presented in an OE removal Work Plan(s) prepared as part of the RI/FS for the Tourtelot Clean Up Project. See reference (h).

14. Page 2: **Conclusions and Recommendations:** Item number 4. As discussed, the MSD will be part of the explosive safety submission to Department of Defense Explosives Safety Board (DDESB). The approval of the use of the procedure should be provide as soon as possible. This will make the OE Removal Work Plan, Community Safety Plan and Contingency Action Plan easier to review if the previously reviewed and approved procedures have been provided.

Response: A question or comment was not provided. If the reviewer intended to pose a question or comment please revise accordingly. The USACE supports your recommendation that the ESS is approved and made part of the OE Work Plan.

15. Page 2: **Conclusions and Recommendations:** Item number 5.

Based on the potential kick-out area and area 3a and 3b boundary lines, there appears to be an overlap of MSD areas around and overlooking Sector 2 and D-1. Should the MSD be revised to reflect the larger of the two MSD's in areas of overlap?

Response: As previously discussed, to further clarify the MSDs, the single map contained in the 29 September 2000 MFR has been replaced with three separate color-coded maps (figure 1, 2, & 3). The maps reflect a MSD of 200 feet for both Sectors so there is no larger MSD. The original MSD Memorandum For Record (MFR) of 29 September 2000 has been revised by adding the three figures (see attachment (e)).

16. Page 3: **Map;** The MSD for the D-1 area, the western portion of the south valley and the northern portion of the South Valley is not clearly understood. Please provide the approved MSD that should be used in these and any other undefined areas on the Tourtelot site.

Response: A detailed response has been provided under section 3(c) of the 11 December 2000 MFR. Also see Figures 1, 2, and 3 of attachment (e).

17. Please provide a discussion of "hazardous fragment."
    1. What is a "hazardous fragment"?
    2. Define what makes up a hazardous fragment?
    3. How hazardous is a "hazardous fragment"?
    4. How large is a "hazardous fragment"?
    5. What is the potential or likely damage to a person hit with a "hazardous fragment"?
    6. At what distance from the uncontrolled detonation does a piece of fragment become a "non-hazardous fragment"?

Response: A hazardous fragment is defined by DOD 6055.9-STD as one having an impact energy of 58 ft-lb or greater. The size of a hazardous fragment may be large or small. Mass and velocity determine the energy, which in turn determines whether it is a hazardous fragment, or not. At velocities achieved during detonation, fragments smaller than ¼ ounce will not be hazardous.

To give an idea of the other end of the scale, a 20 lb. bowling ball dropped on your foot from 3 feet high will impact with 60 ft-lb of energy and thus deliver the energy of a hazardous fragment.

The damage to a person hit by a hazardous fragment depends upon the shape of the fragment, the angle of impact, and whether it strikes a vital organ or not. The 58 ft-lbs is considered by DOD to be an acceptable risk. The number is a result of injury statistics gathered from WWI, WWII, and the Korean War. This is also the NATO definition of hazardous fragment.

A hazardous fragment becomes a non-hazardous fragment when the energy is less than 58 ft-lbs, which is a function of mass and velocity. Distance does not enter into the equation. See response to question 12(4).

18. What is the likely or potential property damage that could occur from frag within the identified MSD and up to the maximum fragment flight distance?

Response: There will probably be property damage, but how much damage is dependent on the size of the detonation, size of fragments, orientation of the round, depth below the surface, and other factors.

19. What is the likelihood that an uncontrolled detonation will occur?

Response: Based on professional judgment, it is very unlikely that a unintentional detonation will occur, otherwise the USACE wouldn't have proposed to reduced the MSD to 1/600.

ATTACHMENT E

CESPK-DE 11 December 2000

Memorandum for Record

Subject: Recommendations for Minimum Separation distances (MSD) for Tourtelot OE Removal Action, Former Benicia arsenal.

Summary: A technical evaluation of the Most Probable Munitions (MPM) and Minimum Safe Distance has been completed based on the latest available information, and the guidance that would apply if the Corps of Engineers were conducting the work as a Formerly Used Defense Site (FUDS). This memorandum updates the memorandum dated 29 September 2000. Guidance applicable to OE removals at FUDS sites includes guidance from the Department of Defense (DOD), Department of Army (DA), U.S. Army Corps of Engineers (USACE) and Corps Huntsville Center (HNC). The analysis and findings would be applicable to Sectors 3A and 3B, including the potential expansion area adjacent to the sectors, that were recommended for a removal action in the Engineering Evaluation/Cost Analysis (EE/CA) prepared by HNC for the FUDS program.

We have identified the appropriate MPM and MSD for each of the work areas within Sectors 3A and 3B that the Corps of Engineers would use if it were executing the removal action. These are based on an un-armed 37 MM projectile and an un-armed 60 MM Mortar.

The City of Benicia is planning to do additional actions outside the areas recommended for removals in the EE/CA. These areas do not fall within the normal Corps of Engineers OE removal categories and the normal MSD definition process would not be applicable.

However, if the removal action in the EE/CA Sector 3A or Sector 3B removal areas resulted in finding live ordnance items at the edge of the planned removal areas, the normal Corps of Engineers procedure would be to incrementally expand the removal action into the adjacent area until no further OE items are located. During the search for OE items in such an expansion area, the MSD for the MPM in the adjacent Sector A or Sector B area would continue to be used.

The MSD for sector 3A, 3B, and the expansion area would be based on a 1 Hazardous Fragment in 600 Square Feet MSD. In all these areas, a 200 feet arc would extend outward from the edge of intrusive work areas. (See map figures 1, 2, and 3)

The role of CESPK in these efforts is limited to that of providing guidance, technical reviews, site support, and advice to the City of Benicia as described in the MOA with the City of Benicia. Approval of work plans and the adoption of appropriate MSD will be up to the authorities responsible for conducting the OE removal and approving the actions.

Technical Evaluation: In Sector 3A, a 60 MM mortar has been identified as the MPM, and would have a fragmentation distance of 1080 feet. Since the munitions are not likely to be armed, it would be appropriate to a 1 Hazardous Fragment in 600 Square Feet MSD with a minimum separation distance of 200 feet.

The sector 3B area has a 37 MM projectile identified as the MPM. The 37 MM projectile has a fragmentation distance of 1181 feet. Since the munition is not likely to be armed, it would be

appropriate to a 1 Hazardous Fragment in 600 Square Feet MSD with a minimum separation distance of 200 feet.

Based on the assumption the an OE expansion protocol were needed adjacent to sector 3A or 3B, and the item located at the edge of the sector was not larger than a 60MM mortar or 37MM projectile used as the MPM for the sectors, a 200 feet MSD should continued to be used for intrusive work in these areas. An appropriate MSD will need to be calculated for intentional detonations. Engineering controls can be employed during intentional detonations to reduce the blast distance.

Conclusions and Recommendations:

1. Public safety must be a leading concern for the interested parties and the Corps of Engineers in proceeding with the OE response. Public officials, public safety personnel, UXO workers, and public living and working near the site must be made aware of the hazards and responses being made to reduce them.

2. The maximum fragmentation distance calculations for the 37 MM and 60 MM MPM's (if this were a Corps of Engineers project) would be that of 1181 feet and 1080 feet, respectively. Sectors 3A and 3B would be appropriate for reduction of the MSD to a 1 Hazardous Fragment in 600 Square Feet MSD based on the MPM being unfuzed and unarmed. The reduction to a 1 Hazardous Fragment in 600 Square Feet MSD is an increased risk to the public that must be assumed by those officials approving the adoption of this reduced MSD.

3. We recommend that the public be made aware of the (MSD) and the additional hazards that they may be exposed to in the event of an unintentional detonation when using the 1 Hazardous Fragment in 600 Square Feet MSD.

4. Prior to conducting OE removal actions at this site a detailed OE Removal Work Plan will need to be developed, reviewed and approved by the appropriate agencies. The work plan will need to include a Community Safety Plan that addresses issues of public safety, coordination, notification and measures to deal with planned evacuations for both unintentional and intentional detonations. The work plan also needs to include a Contingency Action Plan to evaluate the potential for additional OE items discovered that would change the recommended MSD based on the present MPM, and for intentional detonations.

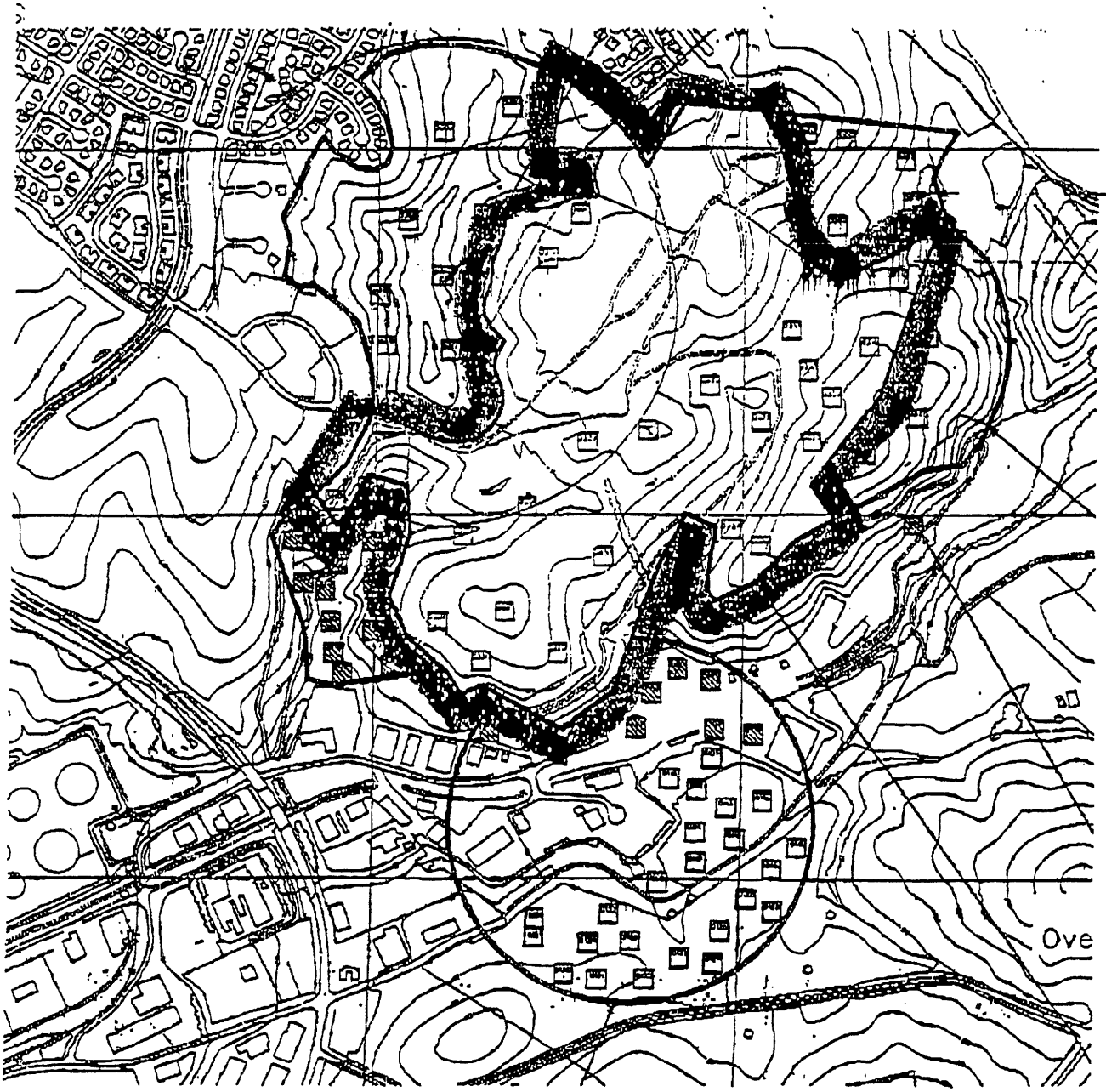
5. If at any time a UXO or a larger MPM is discovered, work must be halted and notifications be made to the appropriate authorities, who must reevaluate the MPM, MSD and the appropriateness of using a 1 Hazardous Fragment in 600 Square feet MSD. This evaluation process would establish new MSD based on the new MPM. A new evaluation and approval for a 1 Hazardous Fragment in 600 Square Feet MSD would need to be completed and be in place before any maximum fragment distance could be reduced.

FIGURE 1. Most Probable Munitions (MPM) and Minimum Separation Distance (MSD) for Sector 3A Tourtelot Property.

KEY

Intrusive Work Areas in Sector 3A.

200-foot MSD Arc around intrusive Work areas In Sector 3A. (MSD based on an unarmed 60 MM Mortar as the MPM, 1 Hazardous Fragment In 600 Sq. Ft. MSD= Arc of 200 Feet.)



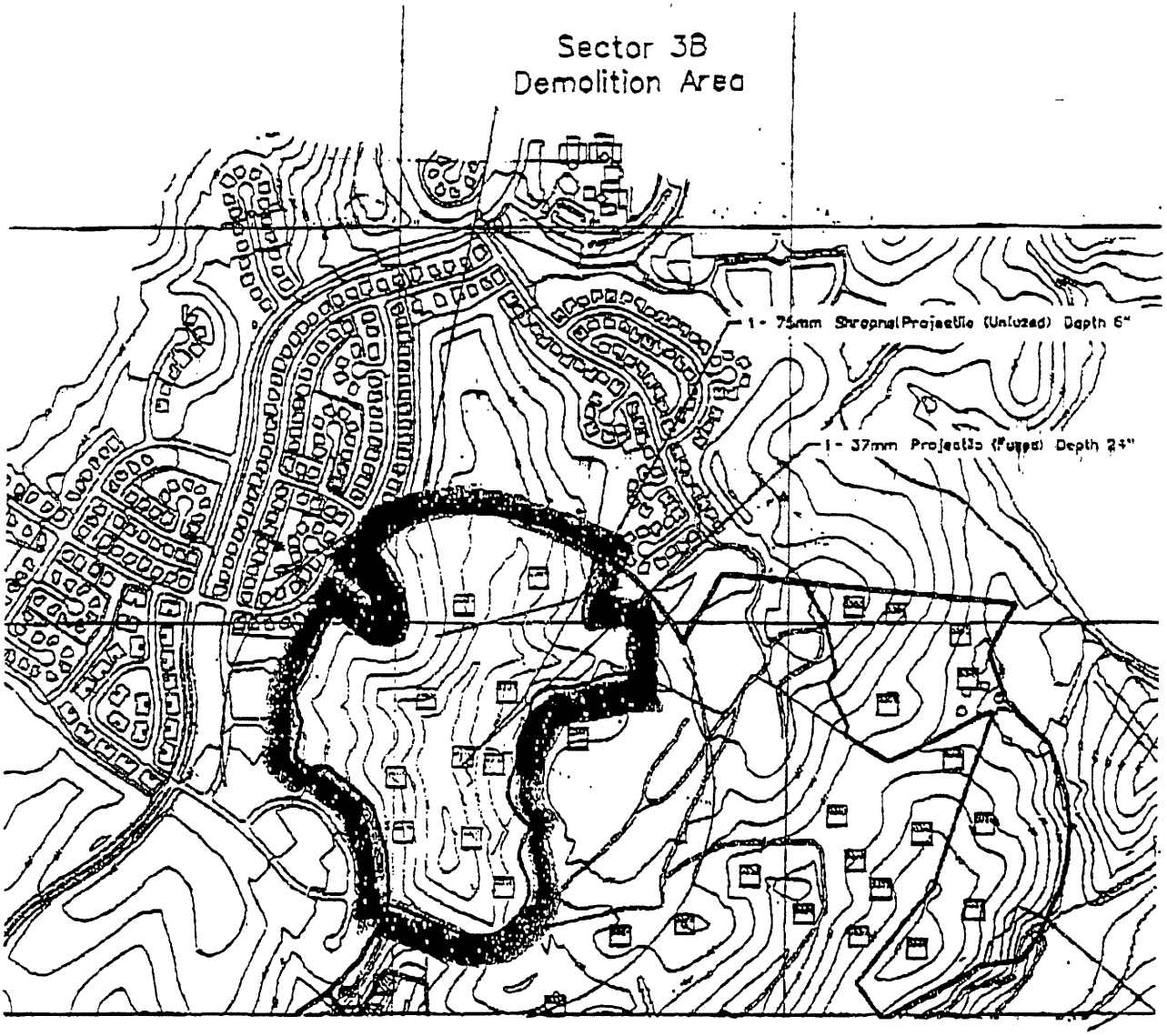


FIGURE 2. Most Probable Munitions (MPM) and Minimum Separation Distance (MSD) for Sector 3B Tourtelot Property.

KEY

Intrusive Work Areas in Sector 3B.

200-foot MSD Arc around intrusive Work areas In Sector 3B. (MSD based on an unarmed 37 MM Projectile As The MPM, 1 Hazardous Fragment In 600 Sq. Ft. MSD= Arc of 200 Feet.)

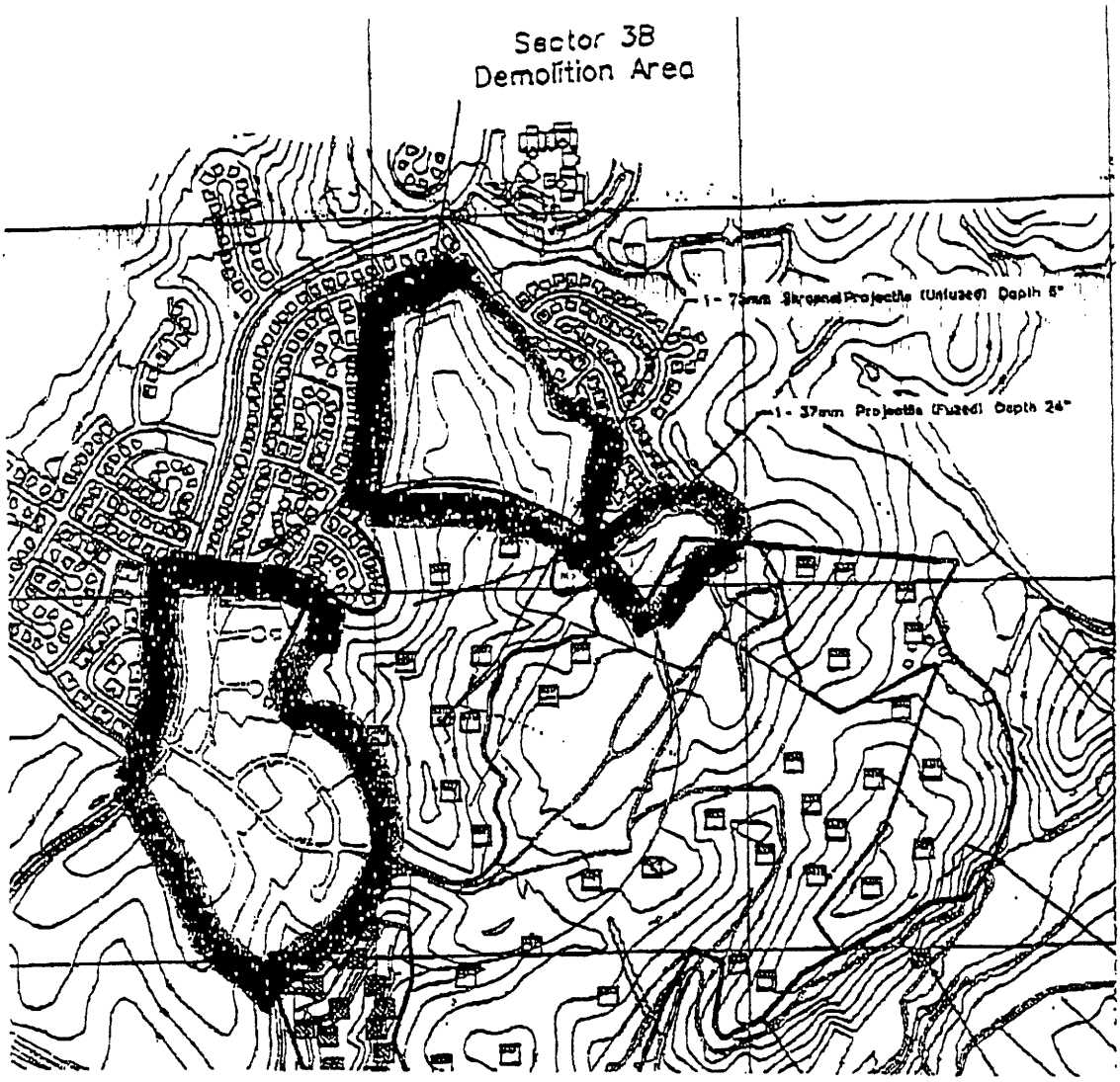


FIGURE 3. Potential Minimum Separation Distance (MSD) for OE Expansion from Sectors 3A and 3B Tourtelot Property.

KEY

Intrusive Work Areas in Potential Expansion Area Adjacent to Sectors 3A and 3B.

200-foot MSD Arc around intrusive Work areas In Expansion Area. (MSD Based Either on an Unarmed 37 MM Projectile or an Unarmed 60 MM Mortar as the MPM Extending From the Adjacent Sector, Both having the same 1 Hazardous Fragment In 600 Sq. Ft. MSD= Arc of 200 Feet.)

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TOURTELOT CLEANUP PROJECT ORDNANCE AND EXPLOSIVES REMEDIATION MINIMUM SEPARATION DISTANCE

Dear Mr. Handel and Mr. Splitter:

The purpose of this letter is to respond to your request to implement the United States Army Corps of Engineer (ACE) recommended Minimum Separation Distance (MSD) of 200 feet during ordnance and explosives (OE) remediation for the Tourtelot Cleanup Project. It is the Department of Toxic Substances Control's (DTSC) understanding that Granite and ACE intend to use the ACE recommended 200 foot MSD to establish an area in which all nonessential personnel will be withdrawn for their protection in the event of an accidental detonation during the OE remedial activities. Although some risk remains to the surrounding people and property, it is DTSC's understanding that Granite and the ACE are willing to appropriately address any injury or damage caused by a detonation at the site.

DTSC initially requested the use of the maximum fragmentation distance of the most probable munition as the MSD for the site. The current maximum fragmentation distance is estimated at 1,080 or 1,181 feet based on the most probable munitions to be found across the site. Granite and ACE have requested the MSD be based on the calculated distance that represents the location at which fragments in flight from an accidental detonation of the most probable munition will equal 1 hazardous fragment in a 600 square foot area (1/600). This is approximately a 1% chance for a person six feet tall and approximately one foot wide, standing in the open at the 1/600 MSD distance to be hit by a hazardous fragment in the event of an accidental detonation.

ACE has advised us that there have been no reported accidents involving clearance operations while employing the 1/600 MSD. The use of the 1/600 is not normally used for OE projects unless certain site and ordnance conditions are met. Additionally, ACE

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goes on to state in writing that "The reduction to 1 hazardous fragment in 600 square feet MSD is a risk to the public that must be assumed by those officials approving the adoption of this reduced MSD". To date, neither Granite nor ACE have provided sufficient supporting information to allow DTSC to fully analyze the associated risk of the recommended 200 foot MSD. DTSC recognizes the ACE's experience with OE safety issues, but has concerns regarding the 1% risk. Given the above, DTSC can accept ACE's recommended 200 foot MSD, with the addition of a voluntary separation distance (VSD) encompassing the maximum fragmentation distance for the most probable munition.

DTSC believes that the OE investigation and remediation can be protective of the local community provided the following requirements are implemented and maintained throughout the course of the investigation and remediation:

1. Granite will delegate safety and quality control oversight of OE investigation, detection and remediation to ACE. All field decisions for blow-in-place or storage for destruction in a chamber will remain with the ACE.

2. ACE, in their oversight capacity, will be assured by Granite that the Minimum Separation Area Notification and Implementation Plan (MSAP) is operational and in place according to the final approved OE Remedial Design Document (RDD).

3. At a minimum, all Defense Department Explosive Safety Board recommendations and requirements will be implemented when performing OE scanning and removal of OE.

4. Properly trained ACE OE experts will be present on the project site with authority to stop work and/or modify procedures if site conditions dictate.

5. ACE will monitor all field activities to provide compliance with Quality Assurance/Quality Control plans and safety procedures. ACE will also be authorized to randomly check the OE work through appropriate means.

6. In addition to the 200 foot MSD recommended by ACE, a VSD encompassing the broader area of all residents, businesses and schools located within the maximum fragmentation distance for the most probable munition, currently 1,080 and 1,181 feet, will be notified of the potential hazards associated with an accidental detonation. The notification of all residents, businesses and schools within the VSD will include a public meeting and notification component so people can make informed decisions on the risks posed to them by this activity. Any residents, schools or businesses located within the VSD choosing to temporarily withdraw, will be offered the same support services as residents, schools and businesses located within the 200 foot MSD.

7. Both the 200 foot MSD and the VSD will be implemented at any time when OE intrusive activities are being performed. Intrusive activities include, but are not limited to, digging to identify surface and subsurface anomalies and excavation and grading activities in OE suspect areas.

8. Affected individuals within the 200 foot MSD and the VSD will be offered support services. Procedures for implementing the withdrawal will be contained in the MSAP approved by DTSC prior to the start of field work. At a minimum, the MSAP will address notification, transportation, hospitality accommodations and issues of special needs for all affected people. The MSAP will also address security for all homes and businesses of those affected individuals. Specific procedures for cost reimbursement to residents for damage caused by detonation associated with OE remediation will also be included in the MSAP as part of the final OE RDD.

9. A separate MSD will be required for handling and treatment of explosive concentrations of Trinitrotoluene (TNT) contaminated soils. To date ACE has not provided a recommended MSD. DTSC will review the proposed MSD and associated safety procedures for TNT when Granite and ACE submit the information in the OE RDD.

10. For controlled intentional detonations or controlled anomaly digs, a different MSD than the 200 foot MSD/VSD approach identified above for accidental detonations may be applied. This MSD would be based on the specific OE location, size and protective measures used for the controlled detonations or anomaly digs. The use of these types of MSDs will need to be discussed as part of the OE RDD.

If additional information or site conditions warrant changes in the above MSDs and associated activities, they may be modified upon written approval by the DTSC. My staff will be available to meet with you to discuss any questions you may have. Please feel free to contact Mr. Stewart Black at (916) 255-3712.

Sincerely,

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To establish a minimum safe distance surrounding the TNT strips during OE operations, the "blast distance" calculated for the greatest TNT concentration hotspot detected during RI/FS sampling will be used. The blast distance is calculated using formulas provided by DoD Manual DA PAM 385-64, which considers soil volume, weight, and TNT concentration to derive an explosive weight according to:

$$\text{Blast Distance} = 40 \times (\text{soil volume} \times \text{soil weight} \times \text{percentage TNT})^{1/3}$$

For the Project Site, the maximum detected TNT concentration is 38 percent, the hotspot radius was 2 feet (as determined from the decrease in concentration in samples offset by 2 feet), the depth of the hotspot was taken as 2 feet bgs (TNT concentration at 2 feet was 11 percent, versus 38 percent a 1 foot bgs), and the soil weight was 115 pounds per cubic foot (as taken from RI/FS sampling results). The calculated blast distance (BD) then is:

$$BD = 40 \times (25.14\ ft^3 \times 115\ lb/ft^3 \times 0.38)^{1/3} = 411.78, \text{ or } 412 \text{ feet.}$$